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NFPA 101®

Life Safety Code

2015 Edition

This edition of NFPA *101*®, *Life Safety Code*®, was prepared by the Technical Committees on Alternative Approaches to Life Safety, Assembly Occupancies, Board and Care Facilities, Building Service and Fire Protection Equipment, Detention and Correctional Occupancies, Educational and Day-Care Occupancies, Fire Protection Features, Fundamentals, Health Care Occupancies, Industrial, Storage, and Miscellaneous Occupancies, Interior Finish and Contents, Means of Egress, Mercantile and Business Occupancies, and Residential Occupancies, released by the Correlating Committee on Safety to Life, and acted on by NFPA at its June Association Technical Meeting held June 9–12, 2014, in Las Vegas, NV. It was issued by the Standards Council on August 14, 2014, with an effective date of September 3, 2014, and supersedes all previous editions.

Several Tentative Interim Amendments (TIAs), indicated by boxed notices at the appropriate areas within the document, were issued on August 14, 2014. These TIAs implement Standards Council Decision D#14-1 to temporarily withdraw NFPA 1124 and end all NFPA standards development activities relating to the storage and retail sales of consumer fireworks. For further information, see Decision D#14-1 at http://www.nfpa.org/sc2014.

Additional TIAs were issued on August 14, 2014, for NFPA *101* addressing topics other than consumer fireworks and similarly indicated by boxed notices at the appropriate areas within the document.

For further information on Tentative Interim Amendments, see Section 5 of the *Regulations Governing the Development of NFPA Standards*, available at http://www.nfpa.org/regs.

This edition of NFPA *101* was approved as an American National Standard on September 3, 2014.

Origin and Development of NFPA 101

The *Life Safety Code* had its origin in the work of the Committee on Safety to Life of the National Fire Protection Association, which was appointed in 1913. In 1912, a pamphlet titled *Exit Drills in Factories, Schools, Department Stores and Theaters* was published following its presentation by the late Committee member R. H. Newbern at the 1911 Annual Meeting of the Association. Although the pamphlet's publication antedated the organization of the Committee, it was considered a Committee publication.

For the first few years of its existence, the Committee on Safety to Life devoted its attention to a study of the notable fires involving loss of life and to analyzing the causes of this loss of life. This work led to the preparation of standards for the construction of stairways, fire escapes, and other egress routes for fire drills in various occupancies, and for the construction and arrangement of exit facilities for factories, schools, and other occupancies. These reports were adopted by the National Fire Protection Association and published in pamphlet form as *Outside Stairs for Fire Exits* (1916) and *Safeguarding Factory Workers from Fire* (1918). These pamphlets served as a groundwork for the present *Code*. These pamphlets were widely circulated and put into general use.

In 1921, the Committee on Safety to Life was enlarged to include representatives of certain interested groups not previously participating in the standard's development. The Committee then began to further develop and integrate previous Committee publications to provide a comprehensive guide to exits and related features of life safety from fire in all classes of occupancy. Known as the *Building Exits Code*, various drafts were published, circulated, and discussed over a period of years, and the first edition of the *Building Exits Code* was published by the National Fire Protection Association in 1927. Thereafter, the Committee continued its deliberations, adding new material on features not originally covered and revising various details in the light of fire experience and practical experience in the use of the *Code*. New editions were published in 1929, 1934, 1936, 1938, 1939, 1942, and 1946 to incorporate the amendments adopted by the National Fire Protection Association.

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National attention was focused on the importance of adequate exits and related fire safety features after the Cocoanut Grove Night Club fire in Boston in 1942 in which 492 lives were lost. Public attention to exit matters was further stimulated by the series of hotel fires in 1946 (LaSalle, Chicago — 61 dead; Canfield, Dubuque — 19 dead; and Winecoff, Atlanta — 119 dead). The *Building Exits Code*, thereafter, was used to an increasing extent for regulatory purposes. However, the *Code* was not written in language suitable for adoption into law, because it had been drafted as a reference document and contained advisory provisions that were useful to building designers but inappropriate for legal use. This led to a decision by the Committee to re-edit the entire *Code*, limiting the body of the text to requirements suitable for mandatory application and placing advisory and explanatory material in notes. The re-editing expanded *Code* provisions to cover additional occupancies and building features to produce a complete document. The *Code* expansion was carried on concurrently with development of the 1948, 1949, 1951, and 1952 editions. The results were incorporated into the 1956 edition and further refined in subsequent editions dated 1957, 1958, 1959, 1960, 1961, and 1963.

In 1955, NFPA 101B, on nursing homes, and NFPA 101C, on interior finish, were published. NFPA 101C was revised in 1956. These publications have since been withdrawn.

In 1963, the Committee on Safety to Life was restructured to represent all interested factions and to include only those members with broad knowledge of fire matters. The Committee served as a review and correlating committee for seven sectional committees whose personnel included members having a special knowledge and interest in various portions of the *Code*.

Under the revised structure, the sectional committees, through the Committee on Safety to Life, prepared the 1966 edition of the *Code*, which was a complete revision of the 1963 edition. The *Code* title was changed from *Building Exits Code* to *Code for Safety to Life from Fire in Buildings and Structures*. The *Code* text was written in enforceable "code language," and all explanatory notes were placed in an appendix.

The *Code* was placed on a 3-year revision schedule, with new editions adopted in 1967, 1970, 1973, and 1976.

In 1977, the Committee on Safety to Life was reorganized as a technical committee, with an executive committee and standing subcommittees responsible for various chapters and sections. The 1981 edition contained major editorial changes, including reorganization within the occupancy chapters, to make them parallel to each other, and the splitting of requirements for new and existing buildings into separate chapters. Chapters on detention and correctional facilities were added, as well as new sections for ambulatory health care centers.

The 1985 edition contained a new Chapter 21 on residential board and care occupancies with related Appendix F and Appendix G, a new Appendix D on alternative calculations for stair width, and Appendix E, a fire safety evaluation system (FSES) for detention and correctional facilities.

The 1988 edition contained a major change in the method of determining egress capacity with the deletion of the traditional units of exit width and the substitution of a straight linear approach to calculating egress capacity. Appendix C through Appendix G were moved from NFPA *101* into a new document, NFPA 101M.

The 1991 edition contained numerous new requirements for mandatory sprinklers in new health care facilities, hotels, apartment buildings, lodging and room houses, and board and care facilities, as well as mandatory sprinkler requirements for existing high-rise hotels and apartment buildings. The requirements for board and care facilities were split into two chapters, Chapter 22 for new construction and Chapter 23 for existing buildings.

The 1994 edition contained new requirements for accessible means of egress, areas of refuge, and ramps, putting the *Code* in substantial agreement with the Americans with Disabilities Act Accessibility Guidelines (ADAAG).

The 1997 edition relocated the material on day-care occupancies from Chapters 10 and 11 for new and existing educational occupancies to new Chapters 30 and 31. The operating features requirements, previously contained in Chapter 31, were interspersed throughout the *Code*, as applicable.

The 2000 edition introduced a performance-based option via Section 4.4 and new Chapter 5. That edition also reformated the *Code* for substantial compliance with the NFPA *Manual of Style:* (1) former Chapter 1, General, was split into Chapter 1, Administration, and Chapter 4, General; (2) the mandatory references list was moved from Chapter 33 to Chapter 2; (3) all definitions were moved into Chapter 3, and each defined term was numbered; (4) the paragraph numbering style that separated the chapter number from the section number using a hyphen was changed to the use of a decimal point as the separator; and (5) the appendixes were renamed annexes. Former Chapter 32 on special structures and high-rise buildings was moved to Chapter 11 to join the core chapters (i.e., the chapters that are not occupancy specific). The subject of interior finish, contents, and furnishings was moved from Section 6.5 into a separate new chapter, Chapter 10. The occupancy chapters, formerly Chapters 8 through 32, became Chapters 12 through 42, with some repositioning of chapters. For example, the day-care occupancies chapters were renumbered from Chapters 30/31 to Chapters 16/17, so as to be positioned immediately after the chapters for educational occupancies.

The 2003 edition reformatted all exceptions into numbered or lettered paragraphs. Some reformatting of paragraphs with multiple requirements was done for additional compliance with the NFPA *Manual of Style*.

The 2006 edition repositioned the inch-pound (U.S. Customary) units to appear first, followed by the metric equivalent (SI) units in parentheses. New Chapter 43, Building Rehabilitation, was added to promote the adaptive reuse of existing buildings without sacrificing needed life safety.

The 2009 edition added provisions to Chapter 7 for electrically controlled egress doors, horizontal-sliding doors serving an area with an occupant load of fewer than 10, elevator lobby access door locking, and door inspection and maintenance. The remoteness criteria of Chapter 7 were expanded to have applicability to all three portions of the means of egress — exit access, exit, and exit discharge. Extensive revisions were made throughout the *Code* to standardize the use of the terms *stories in height, finished ground level, grade plane, basement,* and *level of exit discharge.* Section 9.6 and the applicable occupancy chapters were revised to limit the use of public address systems for occupant alarm notification to large venue assembly occupancies and mercantile mall buildings, where the physical configuration, function, and human behavior present challenges with respect to effective occupant notification by standard means in accordance with NFPA *72*®, *National Fire Alarm Code*®. A subsection was added to Chapter 11 for special provisions applicable to air traffic control towers. The criteria for assembly stage proscenium opening fire curtains were deleted from Chapter 12 and replaced by a reference to the new fire curtain provisions of NFPA 80, *Standard for Fire Doors and Other Opening Protectives.* Provisions were added to Chapters 14 through 17 for the placement and use of alcohol-based hand-rub dispensers in educational and day-care occupancies. The provisions of Chapters 18 and 19 were expanded to address door locking where the needs of patients or clients require specialized protective measures for their safety and security in hospitals, nursing homes, and limited care facilities. Also, a limitation on common path of travel was added to Chapter 18 for new health care occupancies; the requirement for patient sleeping room windows was deleted for new and existing health care occupancies; and all existing high-rise health care occupancy buildings must be sprinklered within 12 years of the adoption of this edition of the *Code.* Numerous occupancy chapters were revised to require emergency plans in accordance with Section 4.8. Chapter 43 on building rehabilitation was revised to address issues not identified when the chapter was written for the 2003 edition and to delete redundancies. An adoptable annex was added for elevators for occupant evacuation prior to Phase I Emergency Recall Operations. Another adoptable annex was added for supplemental escape devices and systems.

The 2012 edition expanded what had been the definitions of *noncombustible material* and *limited-combustible material* and moved the material to new subsections in Chapter 4. The material addressing elevators for occupant controlled evacuation which had comprised Annex B was moved to Chapter 7. A new section was added to Chapter 7 to address normally unoccupied building service equipment support areas. The Chapter 8 table addressing minimum fire protection ratings for opening protectives was expanded. Provisions for carbon monoxide detection were added to Chapter 9. Requirements for carbon monoxide detection were added to some of the occupancy chapters. The health care occupancies provisions were modified to permit the health care setting to be made more homelike.

The 2015 edition includes new provisions in Chapter 4 detailing the code requirements hierarchy to be applied where a provision in one chapter conflicts with a provision in another chapter. Means of egress provisions were revised or added relative to rooms opening directly onto an exit enclosure, door opening threshold height for spaces not normally occupied, door encroachment on egress width, existing door frames without labels, security access turnstiles, handrail orientation on flaring-width stairs, horizontal exit stacking, horizontal exit exterior wall extensions, elevators in towers, occupant evacuation elevators, and occupant load factors for ambulatory health care and concentrated business use. Atrium walls are permitted to serve as part of the separation for creating separated occupancies on a story-by-story basis. The provisions for the inspection of door assemblies were revised so that fire-rated doors are addressed in Chapter 8 and non-rated, egress doors in Chapter 7. The Chapter 8 table addressing minimum fire protection rating for opening protectives was again expanded. Provisions for alcohol-based hand-rub dispensers were added to Chapter 8 so they can be referenced by the occupancy chapters. The high-rise building provisions of Chapter 11 were expanded to include remote video monitoring of exit stair enclosures. The assembly occupancy life safety evaluation provisions were expanded. The day-care and residential board and care occupancy provisions were revised to permit more than one floor level to be considered the level of exit discharge. The health care occupancy provisions were further revised to permit facilities to be made more home-like, including a reduction in nursing home minimum corridor width and the clarification of permitted smoke alarm placement for kitchens that are open to the corridor. Health care occupancy doors subject to locking are permitted to be disguised with murals. Smoke barriers are permitted to be omitted on a non–health care floor below a health care floor. The ambulatory health care occupancy chapters were rewritten to be self-contained, removing the need to reference the business occupancy chapters.

To the User

The following comments are offered to assist in the use of the *Life Safety Code.* Additional help on using the *Life Safety Code* can be obtained by attending one of the seminars NFPA conducts on the *Life Safety Code* or by using the *Life Safety Code Handbook* available from NFPA. Further information on these seminars is available through the NFPA Division of Continuing Education.

Essentially, the *Code* is comprised of four major parts. The first part consists of Chapters 1 through 4, Chapters 6 through 11, and Chapter 43; these are often referred to as the base chapters or fundamental chapters. The second part is Chapter 5, which details the performance-based option. The next part consists of Chapters 12 through 42, which are the occupancy chapters. The fourth and last part consists of Annex A and Annex B, which contain useful additional information.

A thorough understanding of Chapters 1 through 4, Chapters 6 through 11, and Chapter 43 is necessary to use the *Code* effectively, because these chapters provide the building blocks on which the requirements of the occupancy chapters are based. Note that many of the provisions of Chapters 1 through 4 and Chapters 6 through 11 are mandatory for all occupancies. Some provisions are mandated only when referenced by a specific occupancy, while others are exempted for specific occupancies. Often, in one of the base chapters, especially in Chapter 7, the phrase "where permitted by Chapters 11 through 43" appears. In this case, that provision can be used only where specifically permitted by an occupancy chapter. For example, the provisions of 7.2.1.6.1 on delayed-egress locks are permitted only when permitted by Chapters 11 through 43. Permission to use the delayed-egress lock is normally found in the "____.2.2" subsection of each occupancy chapter. For example, 12.2.2.2.5 specifically permits the use of delayed-egress locks in new assembly occupancies. If this permission is not found in an occupancy chapter, the delayed-egress lock cannot be used. Similar types of restricted permission are found for such items as security grilles, double-cylinder locks, revolving doors, and so forth. In other locations in the base chapters, the wording "unless prohibited by Chapters 11 through 43" is used. In this case, the provision is permitted in all occupancies, unless specifically prohibited by an occupancy chapter.

Metric units of measurement in this *Code* are in accordance with the modernized metric system known as the International System of Units (SI). The unit liter, which is outside of but recognized by SI, is commonly used and is therefore used in this *Code*. In this *Code*, inch-pound units for measurements are followed by an equivalent in SI units, as noted in 1.5.2. The inch-pound value and the SI value are each acceptable for use as primary units for satisfying the requirements of this *Code*.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the protection of human life from fire and other circumstances capable of producing similar consequences and for the non-emergency and emergency movement of people.

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John E. Mahoney, Arup, DC [SE]
(Alt. to R. A. Grill)
Gary L. Nuschler, Otis Elevator Company, CT [M]
(Alt. to B. D. Black)
Kelly Thompson, EYP Architecture & Engineering, NY [SE]
(Alt. to D. J. Lazarz)
Paul J. Vautour, Tyco/SimplexGrinnell, MA [M]
(Alt. to R. Reiswig)

Nonvoting

Steven Orlowski, National Association of Home Builders, DC [U]

Gregory E. Harrington, NFPA Staff Liaison

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the application of fire protection systems including detection, alarm, and suppression, and the life safety impact of various building systems.

Technical Committee on Detention and Correctional Occupancies

Michael DiMascio, *Chair*
Arup, MA [SE]

Ron Coté, *Administrative Secretary*
National Fire Protection Association, MA

Clay P. Aler, Koffel Associates, Inc., MD [SE]
David L. Bondor, Texas Association of Counties, TX [I]
Peter J. Collins, U.S. Department of Justice, DC [U]
Randy Gaw, Correctional Service of Canada, Canada [E]
A. Larry Iseminger, Jr., Maryland State Fire Marshals Office, MD [E]
Rep. International Fire Marshals Association
Kenneth E. Isman, National Fire Sprinkler Association, Inc., NY [M]
John Kelly, Washington DC Fire & EMS Department, MD [E]
Troy Lumley, South McCreary Fire & Rescue, KY [E]
Jack McNamara, Bosch Security Systems, NY [M]
Rep. National Electrical Manufacturers Association
Robert R. Perry, Robert Perry Associates Inc., IL [M]
Rep. Door and Hardware Institute
Terry Schultz, Code Consultants, Inc., MO [SE]
James A. Stapleton, Jr., Habersham Metal Products Company, GA [M]
Rep. National Assn. of Architectural Metal Manufacturers
Jeffrey D. Zwirn, IDS Research & Development, Inc., NJ [M]
Rep. Automatic Fire Alarm Association, Inc.

Alternates

Chris Gaut, National Fire Sprinkler Association, Inc., MO [M]
(Alt. to K. E. Isman)
William E. Koffel, Koffel Associates, Inc., MD [SE]
(Alt. to C. P. Aler)
Joseph Plati, Code Consultants, Inc., NY [SE]
(Alt. to T. Schultz)

Ron Coté, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the emergency movement of people in detention and correctional occupancies.

Technical Committee on Educational and Day-Care Occupancies

Aleksy L. Szachnowicz, *Chair*
Anne Arundel County Public Schools, MD [U]

Ron Coté, *Administrative Secretary*
National Fire Protection Association, MA

Steven D. Admire, Communication Concepts, TX [IM]
Judy Biddle, AFCESA, FL [U]
Samuel S. Dannaway, S. S. Dannaway Associates, Inc., HI [SE]
Victor L. Dubrowski, Code Consultants, Inc., MO [SE]
Keith S. Frangiamore, Fire Safety Consultants, Inc., IL [SE]
Dominick G. Kasmauskas, National Fire Sprinkler Association, Inc., NY [M]
Alfred J. Longhitano, Alfred J. Longhitano, P.E., LLC, NY [SE]
Maria B. Marks, Siemens Industry, Inc., MD [M]
Rep. National Electrical Manufacturers Association
Vern L. Martindale, Church of Jesus Christ of Latter-day Saints, UT [U]
Richard E. Merck, Montgomery County Fire & Rescue Service, MD [E]
Matthew J. Mertens, North Shore Fire Department, WI [E]
Rep. International Fire Marshals Association
Kurt A. Roeper, ASSA ABLOY, CT [M]
Rep. Steel Door Institute
Michael L. Savage, Sr., Middle Department Inspection Agency, Inc., MD [E]
Jeffrey Shirey, Maryland State Fire Marshal's Office, MD [E]
Michael L. Sinsigalli, West Hartford Fire Department, CT [E]
Catherine L. Stashak, Office of the Illinois State Fire Marshal, IL [E]
Rep. Office of the Illinois State Fire Marshal
Billy E. Upton, Ballou Justice Upton Architects, VA [SE]
Ann Marie A. Wolf, Sonora Environmental Research Institute, Inc., AZ [C]

Alternates

Richard M. DiMisa, Code Consultants, Inc., MO [SE]
(Alt. to V. L. Dubrowski)
Max L. Gandy, Church of Jesus Christ of Latter-day Saints, UT [U]
(Alt. to V. L. Martindale)
Carmen A. Rao, Wallingford Fire Prevention Bureau, CT [E]
(Alt. to M. L. Sinsigalli)
Richard Jay Roberts, Honeywell Life Safety, IL [M]
(Alt. to M. B. Marks)
Daniel W. Uthe, Sonora Environmental Research Institute, Inc., AZ [C]
(Alt. to A. M. A. Wolf)
Kenneth Wood, Office of the Illinois State Fire Marshal, IL [E]
(Alt. to C. L. Stashak)

Ron Coté, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the emergency movement of people in educational occupancies and day-care occupancies.

Technical Committee on Fire Protection Features

John F. Devlin, *Chair*
Aon Fire Protection Engineering Corporation, MD [I]

Kristin Bigda, *Administrative Secretary*
National Fire Protection Association, MA

Gregory J. Cahanin, Cahanin Fire & Code Consulting, FL [U]
Rep. Louisiana State Firemen's Association
Joseph A. Castellano, The RJA Group, Inc., GA [SE]
Nicholas A. Dawe, Cobb County Fire Marshal's Office, GA [E]
Jeffry T. Dudley, National Aeronautics & Space Administration, FL [U]
Sam W. Francis, American Wood Council, PA [M]
Michael O. Gencarelli, U.S. Department of the Navy, DC [E]
Ralph D. Gerdes, Ralph Gerdes Consultants, LLC, IN [SE]
Jack A. Gump, Babcock & Wilcox Y-12, LLC, TN [U]
Wayne D. Holmes, HSB Professional Loss Control, NC [I]
Gene L. Hortz, The Dow Chemical Company, PA [U]
Jeffrey M. Hugo, National Fire Sprinkler Association, Inc., MI [M]
Rep. National Fire Sprinkler Association
Jonathan Humble, American Iron and Steel Institute, CT [M]
Waymon Jackson, University of Texas at Austin, TX [U]
Adam C. Jones, Buechel Fire Protection District, KY [E]
Marshall A. Klein, Marshall A. Klein & Associates, Inc., MD [SE]
William E. Koffel, Koffel Associates, Inc., MD [M]
Rep. Glazing Industry Code Committee
Vickie J. Lovell, InterCode Incorporated, FL [M]
Rep. Air Movement & Control Association
William J. McHugh, Jr., Firestop Contractors International Association, IL [IM]
Rep. Firestop Contractors International Association
Kevin D. Morin, Code Consultants, Inc., NY [SE]
Jon W. Pasqualone, Martin County Board of County Commissioners, FL [E]
Rep. Florida Fire Marshals & Inspectors Association
Brian T. Rhodes, Hughes Associates, Inc., MD [SE]
Kurt A. Roeper, ASSA ABLOY, CT [M]
Rep. Steel Door Institute
Andrew F. Weisfield, Michael Baker Corporation, PA [SE]
Kenneth Wood, Office of the Illinois State Fire Marshal, IL [E]

Alternates

Farid Alfawakhiri, American Iron and Steel Institute, IL [M]
(Alt. to J. Humble)
Eric J. Apolenis, The RJA Group, Inc., GA [SE]
(Alt. to J. A. Castellano)
Richard C. Butcher, Tarpon Springs Fire Rescue, FL [E]
(Alt. to J. W. Pasqualone)
David Cook, Ralph Gerdes Consultants, LLC, IN [SE]
(Alt. to R. D. Gerdes)
Erin N. Crowley, Code Consultants, Inc., MO [SE]
(Alt. to K. D. Morin)
Timmy Dee, Babcock & Wilcox Y-12, LLC, TN [U]
(Alt. to J. A. Gump)
Rick Glenn, Aon Fire Protection Engineering Corporation, IL [I]
(Alt. to J. F. Devlin)
David M. Hammerman, Marshall A. Klein and Associates, Inc., MD [SE]
(Alt. to M. A. Klein)
Joseph Patrick Higgins, U.S. Department of the Navy, AE [E]
(Alt. to M. O. Gencarelli)
Howard Hopper, UL LLC, CA [RT]
(Voting Alt. to UL Rep.)
Thomas R. Janicak, Ceco Door Products, IL [M]
(Alt. to K. A. Roeper)
Josh Lambert, University of Texas at Austin, TX [U]
(Alt. to W. Jackson)
Timothy J. Orris, AMCA International, Inc., IL [M]
(Alt. to V. J. Lovell)
Eric R. Rosenbaum, Hughes Associates, Inc., MD [SE]
(Alt. to B. T. Rhodes)
Robert A. Speed, North Carolina Office of the State Fire Marshal, NC [E]
(Voting Alt. to NC State Fire Marshal rep.)
Catherine L. Stashak, Office of the Illinois State Fire Marshal, IL [E]
(Alt. to K. Wood)
Andrew M. Wahl, Michael Baker Corporation, PA [SE]
(Alt. to A. F. Weisfield)

Nonvoting

Michael Earl Dillon, Dillon Consulting Engineers, Inc., CA [SE]
Rep. TC on Air Conditioning
Steven Orlowski, National Association of Home Builders, DC [U]

Kristin Bigda, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on construction compartmentation, including the performance of assemblies, openings, and penetrations, as related to the protection of life and property from fire and other circumstances capable of producing similar consequences.

Technical Committee on Fundamentals

Wayne G. Carson, *Chair*
Carson Associates, Inc., VA [SE]

Ron Coté, *Administrative Secretary*
National Fire Protection Association, MA

Farid Alfawakhiri, American Iron and Steel Institute, IL [M]
Andrew Blum, Exponent, Inc., GA [SE]
Amy Y. Cheng, Clark County Department of Development Services, NV [E]
Salvatore DiCristina, Rutgers, The State University of New Jersey, NJ [E]
Tod Doebler, Menomonee Falls Fire Department, WI [E]
Rep. International Fire Marshals Association
Robert J. Eugene, UL LLC, WA [RT]
David W. Frable, U.S. General Services Administration, IL [U]
Marshall J. Gaubert, Jefferson Parish Fire Department, LA [E]
Michael O. Gencarelli, U.S. Department of the Navy, DC [E]
Ralph D. Gerdes, Ralph Gerdes Consultants, LLC, IN [SE]
Rep. American Institute of Architects
Norman E. Groner, John Jay College of Criminal Justice, NY [SE]
Morgan J. Hurley, Society of Fire Protection Engineers, MD [U]
David J. Jacoby, Simpson Gumpertz & Heger, NY [SE]
David P. Klein, U.S. Department of Veterans Affairs, DC [U]
Scott T. Laramee, Aon Fire Protection Engineering Corporation, CA [I]
James K. Lathrop, Koffel Associates, Inc., CT [SE]
Vickie J. Lovell, InterCode Incorporated, FL [M]
Rep. Alliance for Fire & Smoke Containment & Control, Inc.
Jack McNamara, Bosch Security Systems, NY [M]
Rep. National Electrical Manufacturers Association
Ricardo Murga, U.S. Department of Health & Human Services, AZ [E]
Jake Pauls, Jake Pauls Consulting Services in Building Use & Safety, MD [C]
Rep. American Public Health Association
Dennis L. Pitts, American Wood Council, TX [M]
Milosh T. Puchovsky, Worcester Polytechnic Institute, MA [SE]
Rodger Reiswig, Tyco/SimplexGrinnell, FL [M]
Rep. Automatic Fire Alarm Association, Inc.
Patrick S. Saba, Hewlett Packard Company, MD [M]
Victoria B. Valentine, National Fire Sprinkler Association, Inc., NY [M]
Steven F. Wydeveld, Wydeveld Construction & Consulting, Inc., FL [SE]

Alternates

William P. Adams, Apollo America, GA [M]
(Alt. to J. McNamara)
Sharon S. Gilyeat, Koffel Associates, Inc., MD [SE]
(Alt. to J. K. Lathrop)
Thomas P. Hammerberg, Automatic Fire Alarm Association, Inc., GA [M]
(Alt. to R. Reiswig)
Jeffrey M. Hugo, National Fire Sprinkler Association, Inc., MI [M]
(Alt. to V. B. Valentine)
Jonathan Humble, American Iron and Steel Institute, CT [M]
(Alt. to F. Alfawakhiri)
Moriel E. Kaplan, Aon Fire Protection Engineering, MD [I]
(Alt. to S. T. Laramee)
Richard T. Long, Jr., Exponent, Inc., MD [SE]
(Alt. to A. Blum)
Rodney A. McPhee, Canadian Wood Council, Canada [M]
(Alt. to D. L. Pitts)
Robert A. Speed, North Carolina Office of the State Fire Marshal, NC [E]
(Voting Alt. to NC State Fire Marshal Rep.)

Nonvoting

Pichaya Chantranuwat, Fusion Consultants Co. Ltd/Thailand, Thailand [SE]
Steven Orlowski, National Association of Home Builders, DC [U]

Ron Coté, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on the basic goals, objectives, performance requirements, and definitions for protection of human life and property from fire, earthquake, flood, wind, and other circumstances capable of producing similar consequences, on the non-emergency and emergency movement of people, and on high-rise buildings.

Technical Committee on Health Care Occupancies

David P. Klein, *Chair*
U.S. Department of Veterans Affairs, DC [U]

Ron Coté, *Administrative Secretary*
National Fire Protection Association, MA

Kenneth E. Bush, Maryland State Fire Marshals Office, MD [E]
Rep. International Fire Marshals Association
Wayne G. Carson, Carson Associates, Inc., VA [SE]
Michael A. Crowley, The RJA Group, Inc., TX [SE]
Samuel S. Dannaway, S. S. Dannaway Associates, Inc., HI [SE]
Buddy Dewar, National Fire Sprinkler Association, Inc., FL [M]
Alice L. Epstein, CNA Insurance, CO [I]
Martin J. Farraher, Siemens Industry, Inc., IL [M]
John E. Fishbeck, The Joint Commission, IL [E]
Gary Furdell, State of Florida, FL [E]
Michael O. Gencarelli, U.S. Department of the Navy, DC [E]
Robert J. Harmeyer, MSKTD & Associates, IN [SE]
Rep. American Institute of Architects
Donald W. Harris, California Office of Health Planning & Development, CA [E]
David R. Hood, Russell Phillips & Associates, LLC, NY [U]
Rep. NFPA Health Care Section
Richard M. Horeis, HDR Architecture, Inc., NE [SE]
Henry Kowalenko, Illinois Department of Public Health, IL [E]
James Merrill II, U.S. Department of Health & Human Services, MD [E]
Rep. U.S. Dept. of Health & Human Services/CMS
Daniel J. O'Connor, Aon Fire Protection Engineering, IL [I]
Ben Pethe, Health Care Consultant, FL [SE]
G. Brian Prediger, U.S. Army Medical Command Headquarters, TX [U]
John A. Rickard, Katus, LLC, TX [SE]
Richard Jay Roberts, Honeywell Life Safety, IL [M]
Rep. Automatic Fire Alarm Association, Inc.
Eric R. Rosenbaum, Hughes Associates, Inc., MD [U]
Rep. American Health Care Association
Terry Schultz, Code Consultants, Inc., MO [SE]
Saundra J. Stevens, Adams County Regional Medical Center, OH [U]
Geza Szakats, Arup North America Ltd., CA [SE]
Michael D. Widdekind, Zurich Services Corporation, MD [I]
Fred Worley, Texas Department of Aging & Disability Services, TX [E]

Alternates

Doug Beardsley, Care Providers of Minnesota, MN [U]
(Alt. to E. R. Rosenbaum)
Chad E. Beebe, ASHE - AHA, WA [U]
(Voting Alt. to ASHE - AHA Rep.)
William M. Dorfler, The RJA Group, Inc., IL [SE]
(Alt. to M. A. Crowley)
Joshua W. Elvove, Aurora, CO [SE]
(Alt. to S. S. Dannaway)
A. Richard Fasano, Russell Phillips & Associates Inc., CA [U]
(Alt. to D. R. Hood)
Charles J. Giblin III, Maryland State Fire Marshal's Office, MD [E]
(Alt. to K. E. Bush)
Philip J. Hoge, U.S. Army Corps of Engineers, VA [U]
(Alt. to G. B. Prediger)
Robert G. Kleinheinz, National Fire Sprinkler Association, Inc., IL [M]
(Alt. to B. Dewar)
William E. Koffel, Koffel Associates, Inc., MD [SE]
(Alt. to W. G. Carson)
Peter A. Larrimer, U.S. Department of Veterans Affairs, PA [U]
(Alt. to D. P. Klein)
John E. Mahoney, Arup, DC [SE]
(Alt. to G. Szakats)
Kenneth Sun, U.S. Public Health Service, CO [E]
(Alt. to J. Merrill II)
Peter W. Tately, Siemens Building Technologies, PA [M]
(Alt. to M. J. Farraher)
Dale D. Wilson, Aon Fire Protection Engineering, IL [I]
(Alt. to D. J. O'Connor)
Michael Zakowski, Code Consultants, Inc., MO [SE]
(Alt. to T. Schultz)

Nonvoting

Pichaya Chantranuwat, Fusion Consultants Co. Ltd/Thailand, Thailand [SE]
David M. Sine, National Center for Patient Safety, MI [U]
Rep. National Association of Psychiatric Health Systems

Ron Coté, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the emergency movement of people in health care occupancies.

Technical Committee on Industrial, Storage, and Miscellaneous Occupancies

Carl D. Wren, *Chair*
Austin Fire Department, TX [E]

Kristin Bigda, *Administrative Secretary*
National Fire Protection Association, MA

Thomas L. Allison, Savannah River Nuclear Solutions, SC [U]
Raymond E. Arntson, Rayden Research, LLC, WI [SE]
Justin B. Biller, AECOM Building Engineering, VA [SE]
Donald C. Birchler, FP&C Consultants, Inc., MO [SE]
Ryan Cummings, U.S. Department of Transportation, DC [E]
Stephen E. Dale, Cincinnati Insurance Company, OH [I]
Nicholas A. Dawe, Cobb County Fire Marshal's Office, GA [E]
Jeffry T. Dudley, National Aeronautics & Space Administration, FL [U]
John F. Farney, Jr., Sargent & Lundy Engineers, IL [SE]
James E. Golinveaux, Tyco Fire Suppression & Building Products, RI [IM]
Rep. American Fire Sprinkler Association
Wayne D. Holmes, HSB Professional Loss Control, NC [I]
Jonathan Humble, American Iron and Steel Institute, CT [M]
Adam C. Jones, Buechel Fire Protection District, KY [E]
Marshall A. Klein, Marshall A. Klein & Associates, Inc., MD [U]
Rep. Automotive Aftermarket Industry Association
Richard J. Kobelski, Hanford Fire Department, WA [U]
Neal W. Krantz, Sr., Krantz Systems & Associates, LLC, MI [M]
Rep. Automatic Fire Alarm Association, Inc.
Richard S. Kraus, API/Petroleum Safety Consultants, VA [U]
Rep. American Petroleum Institute
Raymond W. Lonabaugh, National Fire Sprinkler Association, Inc., PA [M]
Patrick A. McLaughlin, McLaughlin & Associates, ID [U]
Rep. Semiconductor Industry Association
Jerald Pierrottie, Lonza Group Ltd., GA [M]
Rep. Lonza Group, Ltd.
Scot Pruett, Black & Veatch Corporation, KS [SE]
Roberto Lozano Rosales, Delphi Corporation, TX [U]
Rep. NFPA Industrial Fire Protection Section
Jerrold Sameth, Compressed Gas Association, Inc., VA [M]
Rep. Compressed Gas Association
Steven A. Sheldon, Fisher Engineering, Inc., AZ [SE]
Cleveland B. Skinker, Bechtel Power Corporation, MD [SE]
Bruce J. Swiecicki, National Propane Gas Association, IL [IM]
Rep. National Propane Gas Association
David C. Tabar, The Sherwin-Williams Company, OH [U]

Alternates

Farid Alfawakhiri, American Iron and Steel Institute, IL [M]
(Alt. to J. Humble)
Kathryn M. Cifa, Bechtel National, Inc., MD [SE]
(Alt. to C. B. Skinker)
Richard A. Craig, Compressed Gas Association, VA [M]
(Alt. to J. Sameth)
David M. Hammerman, Marshall A. Klein and Associates, Inc., MD [U]
(Alt. to M. A. Klein)
Roland J. Huggins, American Fire Sprinkler Association, Inc., TX [IM]
(Alt. to J. E. Golinveaux)
Andrew S. Klein, Marshall A. Klein & Associates, Inc., WA [U]
(Alt. to M. A. Klein)
Bruce Lecair, National Fire Sprinkler Association, Inc., CA [M]
(Alt. to R. W. Lonabaugh)
Katherine A. Pothier, Fisher Engineering, Inc., GA [SE]
(Alt. to S. A. Sheldon)
Marko J. Saric, Jr., The Sherwin-Williams Company, OH [U]
(Alt. to D. C. Tabar)
Jeffrey A. Scott, FP&C Consultants, Inc., MO [SE]
(Alt. to D. C. Birchler)
Bobbie L. Smith, Micron Technology, Inc., ID [U]
(Alt. to P. A. McLaughlin)
John R. Stauder, AECOM, CA [SE]
(Alt. to J. B. Biller)

Nonvoting

Matthew I. Chibbaro, U.S. Department of Labor, DC [E]
Rep. Occupational Safety & Health Administration

Kristin Bigda, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the emergency movement of people in industrial and storage occupancies, special structures, and windowless and underground buildings.

Technical Committee on Interior Finish and Contents

Henry Paszczuk, *Chair*
Connecticut Department of Public Safety, CT [E]

Kristin Bigda, *Administrative Secretary*
National Fire Protection Association, MA

Vytenis Babrauskas, Fire Science and Technology Inc., WA [SE]
Patrick Boyer, State Farm Insurance Company, IL [I]
Matthew Carrigan, Montgomery County Fire Rescue Service, MD [L]
Rep. International Association of Fire Fighters
Nicholas A. Dawe, Cobb County Fire Marshal's Office, GA [E]
William E. Fitch, Phyrefish.com, FL [SE]
Marcelo M. Hirschler, GBH International, CA [SE]
James K. Lathrop, Koffel Associates, Inc., CT [M]
Rep. Bobrick Washroom Equipment, Inc.
Richard T. Long, Jr., Exponent, Inc., MD [M]
Rep. Upholstered Furniture Action Council
C. Anthony Penaloza, Intertek Testing Services, TX [RT]
Milosh T. Puchovsky, Worcester Polytechnic Institute, MA [SE]
Shelley Siegel, Universal Design & Education Network, FL [U]
Rep. American Society of Interior Designers
Dwayne E. Sloan, UL LLC, NC [RT]

Alternates

Rick J. Daughtery, City of Fort Thomas Fire Department, KY [L]
(Alt. to M. Carrigan)
Timothy Earl, GBH International, MI [SE]
(Alt. to M. M. Hirschler)
Joseph Kingston, Connecticut Office of State Fire Marshal, CT [E]
(Alt. to H. Paszczuk)
James K. Lathrop, Koffel Associates, Inc. [M]
(Voting Alt. to CRI Rep.)
Randall K. Laymon, UL LLC, IL [RT]
(Alt. to D. E. Sloan)

Kristin Bigda, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on limiting the impact of interior finish, furnishings and building contents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the emergency movement of people.

Technical Committee on Means of Egress

James K. Lathrop, *Chair*
Koffel Associates, Inc., CT [SE]

Ron Coté, *Administrative Secretary*
National Fire Protection Association, MA

Ryan Alles, High Rise Escape Systems, Inc., FL [M]
Rep. The Safe Evacuation Coalition
Jason D. Averill, National Institute of Standards & Technology, MD [RT]
Charles V. Barlow, EverGlow NA, Inc., NC [M]
Warren D. Bonisch, Aon Fire Protection Engineering Corporation, TX [I]
Kenneth E. Bush, Maryland State Fire Marshals Office, MD [E]
Rep. International Fire Marshals Association
David S. Collins, The Preview Group, Inc., OH [SE]
Rep. American Institute of Architects
Richard L. Day, Michigan State Fire Marshal's Office, MI [E]
David A. de Vries, Firetech Engineering Inc., IL [SE]
Steven Di Pilla, ESIS Global Risk Control Services, NJ [I]
Paul L. Dove, City of Coldwater Fire Department, MI [E]
Rep. Michigan Fire Inspectors Society
David W. Frable, U.S. General Services Administration, IL [U]
Rita C. Guest, Carson Guest, Inc., GA [U]
Rep. American Society of Interior Designers
Waymon Jackson, University of Texas at Austin, TX [U]
Gary L. Nuschler, Otis Elevator Company, CT [M]
Rep. National Elevator Industry Inc.
Steven Orlowski, National Association of Home Builders, DC [U]
Denise L. Pappas, Valcom, Inc., VA [M]
Rep. National Electrical Manufacturers Association
Jake Pauls, Jake Pauls Consulting Services in Building Use & Safety, MD [C]
Rep. American Public Health Association
Robert R. Perry, Robert Perry Associates Inc., IL [M]
Rep. Door and Hardware Institute
Vincent Quinterno, Rhode Island State Fire Marshal's Office, RI [E]
Eric R. Rosenbaum, Hughes Associates, Inc., MD [SE]
Roy W. Schwarzenberg, U.S. Central Intelligence Agency, MD [U]
Michael S. Shulman, UL LLC, CA [RT]
Leslie Strull, The RJA Group, Inc., PA [SE]
Michael Tierney, Kellen Company, CT [M]
Rep. Builders Hardware Manufacturers Association
Joseph H. Versteeg, Versteeg Associates, CT [SE]

Alternates

Brian D. Black, BDBlack Codes, Inc., NY [M]
(Alt. to G. L. Nuschler)
William J. Burrus, Aon Fire Protection Engineering Corporation, TX [I]
(Alt. to W. D. Bonisch)
Michael A. Crowley, The RJA Group, Inc., TX [SE]
(Alt. to L. Strull)
Greg Drake, Door and Hardware Institute, VA [M]
(Alt. to R. R. Perry)
Joshua W. Elvove, Aurora, CO [SE]
(Alt. to D. A. de Vries)
William E. Koffel, Koffel Associates, Inc., MD [SE]
(Alt. to J. K. Lathrop)
Josh Lambert, University of Texas at Austin, TX [U]
(Alt. to W. Jackson)
R. T. Leicht, State of Delaware, DE [E]
(Alt. to K. E. Bush)
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Brian T. Rhodes, Hughes Associates, Inc., MD [SE]
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Ron Coté, NFPA Staff Liaison

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the general requirements for safe egress for protection of human life from fire and other circumstances capable of producing similar consequences, and on the nonemergency and emergency movement of people.

Technical Committee on Mercantile and Business Occupancies

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Anthony W. Cole, Wal-Mart Stores, Inc., CA [U]
Nicholas A. Dawe, Cobb County Fire Marshal's Office, GA [E]
Kevin L. Derr, U.S. Architect of the Capitol, DC [E]
David A. Dodge, Safety and Forensic Consulting, ME [SE]
David W. Frable, U.S. General Services Administration, IL [U]
Sam W. Francis, American Wood Council, PA [M]
Douglas R. Freels, Oak Ridge National Laboratory, TN [U]
Joseph R. Garzone, Siemens Industries, Inc., MI [M]
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Daniel J. Gauvin, Tyco/SimplexGrinnell, MA [M]
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Wayne D. Holmes, HSB Professional Loss Control, NC [I]
Jonathan Humble, American Iron and Steel Institute, CT [M]
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Rep. National Fire Sprinkler Association
Jeff Martin, Elite Fire Protection, Canada [IM]
Rep. National Association of Fire Equipment Distributors
Amy J. Murdock, Code Consultants, Inc., MO [SE]
Sarah A. Rice, The Preview Group, Inc., OH [SE]
Warren G. Stocker, Safeway Inc., CA [U]
David C. Tabar, The Sherwin-Williams Company, OH [U]
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Kristin Bigda, NFPA Staff Liaison

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Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and for the emergency movement of people in mercantile and business occupancies.

Technical Committee on Residential Occupancies

Warren D. Bonisch, *Chair*
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Rep. Rhode Island Association of Fire Marshals
Daniel P. Finnegan, Siemens Industry, Inc., NJ [M]
Rep. Automatic Fire Alarm Association, Inc.
Sam W. Francis, American Wood Council, PA [M]
Ralph D. Gerdes, Ralph Gerdes Consultants, LLC, IN [SE]
Stanley C. Harbuck, School of Building Inspection, UT [C]
Rep. American Public Health Association
Kenneth E. Isman, National Fire Sprinkler Association, Inc., NY [M]
Marshall A. Klein, Marshall A. Klein & Associates, Inc., MD [SE]
Josh Lambert, University of Texas at Austin, TX [U]
Richard T. Long, Jr., Exponent, Inc., MD [M]
Rep. Upholstered Furniture Action Council
Alfred J. Longhitano, Alfred J. Longhitano, P.E., LLC, NY [SE]
Eric N. Mayl, Core Engineers Consulting Group, LLC, DC [SE]
Ronald G. Nickson, National Multi Housing Council, DC [U]
Steven Orlowski, National Association of Home Builders, DC [U]
Henry Paszczuk, Connecticut Department of Public Safety, CT [E]
Peter Puhlick, University of Connecticut, CT [U]
Richard Jay Roberts, Honeywell Life Safety, IL [M]
Rep. National Electrical Manufacturers Association
Andrew M. Schneider, Koffel Associates, Inc., MD [SE]
John A. Sharry, Beakmann Properties, CA [U]
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Diana E. Hugue, Koffel Associates, Inc., MD [SE]
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Waymon Jackson, University of Texas at Austin, TX [U]
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David Newhouse, Gentex Corporation, MI [M]
(Alt. to R. J. Roberts)
Jake Pauls, Jake Pauls Consulting Services in Building Use & Safety, MD [C]
(Alt. to S. C. Harbuck)
Dennis L. Pitts, American Wood Council, TX [M]
(Alt. to S. W. Francis)
Kevin Spangler, Michael Baker Jr. Corporation, PA [SE]
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David P. Wilmot, Aon Fire Protection Engineering, MD [I]
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Gregory E. Harrington, NFPA Staff Liaison

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the emergency movement of people in hotels, dormitories, apartments, lodging and rooming houses, and one- and two-family dwellings.

NFPA 101

Life Safety Code

2015 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1* Scope.

1.1.1 Title. NFPA *101, Life Safety Code,* shall be known as the *Life Safety Code*®, is cited as such, and shall be referred to herein as "this *Code*" or "the *Code*."

1.1.2 Danger to Life from Fire. The *Code* addresses those construction, protection, and occupancy features necessary to minimize danger to life from the effects of fire, including smoke, heat, and toxic gases created during a fire.

1.1.3 Egress Facilities. The *Code* establishes minimum criteria for the design of egress facilities so as to allow prompt escape of occupants from buildings or, where desirable, into safe areas within buildings.

1.1.4 Other Fire-Related Considerations. The *Code* addresses other considerations that are essential to life safety in recognition of the fact that life safety is more than a matter of egress. The *Code* also addresses protective features and systems, building services, operating features, maintenance activities, and other provisions in recognition of the fact that achieving an acceptable degree of life safety depends on additional safeguards to provide adequate egress time or protection for people exposed to fire.

1.1.5* Considerations Not Related to Fire. The *Code* also addresses other considerations that, while important in fire conditions, provide an ongoing benefit in other conditions of use, including non-fire emergencies.

1.1.6 Areas Not Addressed. The *Code* does not address the following:

(1)*General fire prevention or building construction features that are normally a function of fire prevention codes and building codes
(2) Prevention of injury incurred by an individual due to that individual's failure to use reasonable care
(3) Preservation of property from loss by fire

1.2* Purpose. The purpose of this *Code* is to provide minimum requirements, with due regard to function, for the design, operation, and maintenance of buildings and structures for safety to life from fire. Its provisions will also aid life safety in similar emergencies.

1.3 Application.

1.3.1* New and Existing Buildings and Structures. The *Code* shall apply to both new construction and existing buildings and existing structures.

1.3.2 Vehicles and Vessels. The *Code* shall apply to vehicles, vessels, or other similar conveyances, as specified in Section 11.6, in which case such vehicles and vessels shall be treated as buildings.

1.4* Equivalency. Nothing in this *Code* is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this *Code*.

1.4.1 Technical Documentation. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 Approval. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.4.3* Equivalent Compliance. Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this *Code*.

1.5 Units and Formulas.

1.5.1 SI Units. Metric units of measurement in this *Code* are in accordance with the modernized metric system known as the International System of Units (SI).

1.5.2 Primary Values. The inch-pound value for a measurement, and the SI value given in parentheses, shall each be acceptable for use as primary units for satisfying the requirements of this *Code*.

1.6 Enforcement. This *Code* shall be administered and enforced by the authority having jurisdiction designated by the governing authority.

Chapter 2 Referenced Publications

2.1 General. The documents referenced in this chapter, or portions of such documents, are referenced within this *Code*, shall be considered part of the requirements of this *Code*, and the following shall also apply:

(1)*Documents referenced in this chapter, or portion of such documents, shall only be applicable to the extent called for within other chapters of this *Code*.
(2) Where the requirements of a referenced code or standard differ from the requirements of this *Code*, the requirements of this *Code* shall govern.
(3)*Existing buildings or installations that do not comply with the provisions of the codes or standards referenced in this chapter shall be permitted to be continued in service, provided that the lack of conformity with these documents does not present a serious hazard to the occupants as determined by the authority having jurisdiction.

Section 2.2 was revised by a tentative interim amendment (TIA). See page 1.

2.2* NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2010 edition.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2011 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2009 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* 2013 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,* 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2012 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2011 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2013 edition.

NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products,* 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2011 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film,* 2011 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals,* 2011 edition.

NFPA 54, *National Fuel Gas Code,* 2015 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2014 edition.

NFPA 88A, *Standard for Parking Structures,* 2015 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2015 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2010 edition.

NFPA 92, *Standard for Smoke Control Systems,* 2012 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2014 edition.

NFPA 99, *Health Care Facilities Code,* 2015 edition.

NFPA 101A, *Guide on Alternative Approaches to Life Safety,* 2013 edition.

NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives,* 2013 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems,* 2013 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems,* 2013 edition.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience,* 2011 edition.

NFPA 170, *Standard for Fire Safety and Emergency Symbols,* 2012 edition.

NFPA 204, *Standard for Smoke and Heat Venting,* 2012 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2013 edition.

NFPA 220, *Standard on Types of Building Construction,* 2015 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2015 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations,* 2013 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* 2012 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source,* 2011 edition.

NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies,* 2012 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials,* 2013 edition.

NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture,* 2013 edition.

NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes,* 2013 edition.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls,* 2011 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2011 edition.

NFPA 288, *Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies,* 2012 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages,* 2013 edition.

NFPA 400, *Hazardous Materials Code,* 2013 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways,* 2013 edition.

NFPA 418, *Standard for Heliports,* 2011 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2010 edition.

NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials,* 2015 edition.

NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment,* 2015 edition.

NFPA 731, *Standard for the Installation of Electronic Premises Security Systems,* 2015 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.

NFPA 914, *Code for Fire Protection of Historic Structures,* 2010 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience,* 2011 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2012 edition.

2.3 Other Publications.

2.3.1 ACI Publications. American Concrete Institute, P.O. Box 9094, Farmington Hills, MI 48333. www.concrete.org

ACI 216.1/TMS 0216.1, *Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies*, 2008.

2.3.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI A14.3, *Safety Requirements for Fixed Ladders*, 1992.

ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, 2009.

ANSI/BHMA A156.3 *Exit Devices*, 2008.

BHMA/ANSI A156.19, *American National Standard for Power Assist and Low Energy Power Operated Doors*, 2007.

ANSI Z223.1, *National Fuel Gas Code*, 2006.

2.3.3 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400. www.asce.org

ASCE/SFPE 29, *Standard Calculation Methods for Structural Fire Protection*, 2005.

2.3.4 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990. www.asme.org

ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, 2007.

ASME A17.3, *Safety Code for Existing Elevators and Escalators*, 2008.

ASME A17.7/CSA B44.7, *Performance-Based Safety Code for Elevators and Escalators*, 2007.

2.3.5 ASSE Publications. American Society of Sanitary Engineering, 901 Canterbury Road, Suite A, Westlake, OH 44145-1480.

ANSI/ASSE A1264.1, *Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrails Systems*, 2007.

2.3.6 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. www.astm.org

ASTM C 1629/C 1629M, *Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels*, 2006 (2011).

ASTM D 1929, *Standard Test Method for Determining Ignition Temperatures of Plastic*, 2012.

ASTM D 2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*, 2006 (2011).

ASTM D 2898, *Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*, 2010.

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2013.

ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, 2011.

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, 2012.

ASTM E 648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, 2010 e1.

ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, 2011a.

ASTM E 1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2011b.

ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, 2012.

ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses*, 2012.

ASTM E 1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*, 2007.

ASTM E 1966, *Standard Test Method for Fire-Resistive Joint Systems*, 2007 (2011).

ASTM E 2072, *Standard Specification for Photoluminescent (Phosphorescent) Safety Markings*, 2010.

ASTM E 2307, *Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus*, 2010.

ASTM E 2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) Wall or Ceiling Coverings, and of Facings and Wood Veneers Intended to be Applied on Site Over a Wood Substrate, to Assess Surface Burning Characteristics*, 2012.

ASTM E 2573, *Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics*, 2012.

ASTM E 2599, *Standard Practice for Specimen Preparation and Mounting of Reflective Insulation, Radiant Barrier, and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics*, 2011.

ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*, 2012.

ASTM E 2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)*, 2011.

ASTM F 851, *Standard Test Method for Self-Rising Seat Mechanisms*, 1987 (2005).

ASTM F 1577, *Standard Test Methods for Detention Locks for Swinging Doors*, 2005.

ASTM G 155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*, 2005a.

2.3.7 FM Publications. FM Global, 1301 Atwood Avenue, P.O. Box 7500, Johnston, RI 02919. www.fmglobal.com

ANSI/FM 4880, *American National Standard for Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior or Exterior Finish Systems*, 2007.

FM Approval Standard 6921, *Containers for Combustible Waste*, 2004.

2.3.8 NEMA Publications. National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

NEMA SB 30, *Fire Service Annunciator and Interface*, 2005.

2.3.9 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. www.ul.com

ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*, 2009.

ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*, 2008, Revised 2009.

ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*, 2009.

ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, 2011.

ANSI/UL 294, *Standard for Access Control System Units*, 1999, Revised 2010.

ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment,* 2005, Revised 2010.

UL 300A, *Extinguishing System Units for Residential Range Top Cooking Surfaces,* 2006.

ANSI/UL 305, *Standard for Safety Panic Hardware*, 1997, Revised 2012.

ANSI/UL 555, *Standard for Fire Dampers*, 2006, Revised 2012.

ANSI/UL 555S, *Standard for Smoke Dampers*, 1999, Revised 2012.

ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, 2008, Revised 2010.

ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*, 2004, Revised 2008.

ANSI/UL 924, *Standard for Emergency Lighting and Power Equipment*, 2006, Revised 2011.

ANSI/UL 1040, *Standard for Fire Test of Insulated Wall Construction*, 2009, Revised 2013.

ANSI/UL 1315, *Standard for Safety for Metal Waste Paper Containers*, 2007, Revised 2013.

ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, 2003, Revised 2012.

ANSI/UL 1715, *Standard for Fire Test of Interior Finish Material*, 1997, Revised 2013.

ANSI/UL 1784, *Standard for Air Leakage Tests for Door Assemblies*, 2001, Revised 2009.

ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, 2006.

ANSI/UL 1994, *Standard for Luminous Egress Path Marking Systems*, 2004, Revised 2010.

ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*, 2004, Revised 2012.

2.3.10 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402. www.access.gpo.gov

Title 16, Code of Federal Regulations, Part 1500 and Part 1507.

Title 16, Code of Federal Regulations, Part 1632, "Standard for the Flammability of Mattresses and Mattress Pads" (FF 4-72).

2.3.11 Other Publication.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code,* 2015 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.

NFPA 88A, *Standard for Parking Structures,* 2015 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* 2015 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* 2012 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source,* 2011 edition.

NFPA 288, *Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies,* 2012 edition.

NFPA 301, *Code for Safety to Life from Fire on Merchant Vessels,* 2013 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways,* 2013 edition.

NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials,* 2015 edition.

NFPA 914, *Code for Fire Protection of Historic Structures,* 2010 edition.

NFPA 921, *Guide for Fire and Explosion Investigations,* 2014 edition.

ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*, 2010.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this *Code*. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

3.2.7 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Accessible Area of Refuge. See 3.3.22.1.

3.3.2 Accessible Means of Egress. See 3.3.172.1.

3.3.3 Accessible Route. A continuous unobstructed path that complies with this *Code* and ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities* (SAF-MEA).

3.3.4* Actuating Member or Bar. The activating mechanism of a panic hardware or fire exit hardware device located on the egress side of a door. (SAF-MEA)

3.3.5 Addition. An increase in building area, aggregate floor area, building height, or number of stories of a structure. (SAF-FUN)

3.3.6 Air Traffic Control Tower. See 3.3.281.1.

3.3.7 Aircraft Loading Walkway. An aboveground device through which passengers move between a point in an airport terminal building and an aircraft. Included in this category are walkways that are essentially fixed and permanently placed, or walkways that are essentially mobile in nature and that fold, telescope, or pivot from a fixed point at the airport terminal building. [**415,** 2013] (SAF-AXM)

3.3.8 Air-Inflated Structure. See 3.3.272.1.

3.3.9 Airport Terminal Building. See 3.3.36.1.

3.3.10 Air-Supported Structure. See 3.3.272.2.

3.3.11* Aisle Accessway. The initial portion of an exit access that leads to an aisle. (SAF-AXM)

3.3.12 Aisle Ramp. See 3.3.221.1.

3.3.13 Aisle Stair. See 3.3.265.1.

3.3.14 Alarm.

3.3.14.1 ***Single Station Alarm.*** A detector comprising an assembly that incorporates a sensor, control components, and an alarm notification appliance in one unit operated from a power source either located in the unit or obtained at the point of installation. [***72,*** 2013] (SAF-BSF)

3.3.14.2 ***Smoke Alarm.*** A single or multiple-station alarm responsive to smoke. [***72,*** 2013] (SAF-BSF)

3.3.15 Alternative Calculation Procedure. A calculation procedure that differs from the procedure originally employed by the design team but that provides predictions for the same variables of interest. (SAF-FUN)

3.3.16 Ambulatory Health Care Occupancy. See 3.3.190.1.

3.3.17 Analysis.

3.3.17.1 ***Sensitivity Analysis.*** An analysis performed to determine the degree to which a predicted output will vary given a specified change in an input parameter, usually in relation to models. (SAF-FUN)

3.3.17.2 ***Uncertainty Analysis.*** An analysis performed to determine the degree to which a predicted value will vary. (SAF-FUN)

3.3.18 Anchor Building. See 3.3.36.2.

3.3.19 Apartment Building. See 3.3.36.3.

3.3.20 Approved Existing. See 3.3.81.1.

3.3.21 Area.

3.3.21.1 ***Detention and Correctional Residential Housing Area.*** Sleeping areas and any contiguous day room, group activity space, or other common space for customary access of residents. (SAF-DET)

3.3.21.2 ***Floor Area.***

3.3.21.2.1* ***Gross Floor Area.*** The floor area within the inside perimeter of the outside walls of the building under consideration with no deductions for hallways, stairs, closets, thickness of interior walls, columns, elevator and building services shafts, or other features, but excluding floor openings associated with atriums and communicating spaces. (SAF-MEA)

3.3.21.2.2 ***Net Floor Area.*** The floor area within the inside perimeter of the outside walls, or the outside walls and fire walls of a building, or outside and/or inside walls that bound an occupancy or incidental use area requiring the occupant load to be calculated using net floor area under consideration with deductions for hallways, stairs, closets, thickness of interior walls, columns, or other features. (SAF-MEA)

3.3.21.3 ***Gross Leasable Area.*** Fifty percent of major tenant areas, and 100 percent of all other floor areas designated for tenant occupancy and exclusive use, including storage areas. The area of tenant occupancy is measured from the centerlines of joint partitions to the outside of the tenant walls. (SAF-MER)

3.3.21.4* ***Hazardous Area.*** An area of a structure or building that poses a degree of hazard greater than that normal to the general occupancy of the building or structure. (SAF-FIR)

3.3.21.5 ***Living Area.*** Any normally occupiable space in a residential occupancy, other than sleeping rooms or rooms that are intended for combination sleeping/living, bathrooms, toilet compartments, kitchens, closets, halls, storage or utility spaces, and similar areas. (SAF-RES)

3.3.21.6* ***Normally Unoccupied Building Service Equipment Support Area.*** A building service equipment support area in which people are not expected to be present on a regular basis. (SAF-MEA)

3.3.21.7 ***Occupiable Area.*** An area of a facility occupied by people on a regular basis. (SAF-FUN)

3.3.21.8 ***Rehabilitation Work Area.*** That portion of a building affected by any renovation, modification, or reconstruction work as initially intended by the owner, and indicated as such in the permit, but excluding other portions of the building where incidental work entailed by the intended work must be performed, and excluding portions of the building where work not initially intended by the owner is specifically required. (SAF-FUN)

3.3.22* Area of Refuge. An area that is either (1) a story in a building where the building is protected throughout by an approved, supervised automatic sprinkler system and has not less than two accessible rooms or spaces separated from each other by smoke-resisting partitions; or (2) a space located in a path of travel leading to a public way that is protected from the effects of fire, either by means of separation from other spaces in the same building or by virtue of location, thereby permitting a delay in egress travel from any level. (SAF-MEA)

3.3.22.1 ***Accessible Area of Refuge.*** An area of refuge that complies with the accessible route requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities* (SAF-MEA).

3.3.23 Assembly.

3.3.23.1 ***Door Assembly.*** Any combination of a door, frame, hardware, and other accessories that is placed in an opening in a wall that is intended primarily for access or for human entrance or exit. [**252**, 2012] (SAF-MEA)

3.3.23.1.1 ***Fire Door Assembly.*** Any combination of a fire door, a frame, hardware, and other accessories that together provide a specific degree of fire protection to the opening. [**80,** 2013] (SAF-FIR)

3.3.23.1.1.1 ***Horizontal Fire Door Assembly.*** A combination of a fire door, a frame, hardware, and other accessories installed in a horizontal plane, which together provide a specific degree of fire protection to a through-opening in a fire resistance–rated floor or roof. [**288,** 2012] (SAF-FIR)

3.3.23.2 ***Fire Window Assembly.*** A window or glass block assembly having a fire protection rating. [**80,** 2013] (SAF-FIR)

3.3.24 Assembly Occupancy. See 3.3.190.2.

3.3.25 Assisted Mechanical Type Parking Structure. See 3.3.272.7.1.

3.3.26 Atmosphere.

3.3.26.1 ***Common Atmosphere.*** The atmosphere that exists between rooms, spaces, or areas within a building that are not separated by an approved smoke barrier. (SAF-END)

3.3.26.2 ***Separate Atmosphere.*** The atmosphere that exists between rooms, spaces, or areas that are separated by an approved smoke barrier. (SAF-END)

3.3.27* Atrium. A large-volume space created by a floor opening or series of floor openings connecting two or more stories that is covered at the top of the series of openings and is used for purposes other than an enclosed stairway; an elevator hoistway; an escalator opening; or as a utility shaft used for plumbing, electrical, air-conditioning, or communications facilities. (SAF-FIR)

3.3.28* Attic. The space located between the ceiling of a story and the roof directly above that habitable story. (SAF-FUN)

3.3.29 Automated Type Parking Structure. See 3.3.272.7.2.

3.3.30 Automatic. Capable of performing a function without the necessity of human intervention. (SAF-FUN)

3.3.31 Barrier.

3.3.31.1* ***Fire Barrier.*** A continuous membrane or a membrane with discontinuities created by protected openings with a specified fire protection rating, where such membrane is designed and constructed with a specified fire resistance rating to limit the spread of fire. (SAF-FIR)

3.3.31.2* ***Smoke Barrier.*** A continuous membrane, or a membrane with discontinuities created by protected openings, where such membrane is designed and constructed to restrict the movement of smoke. (SAF-FIR)

3.3.31.3* ***Thermal Barrier.*** A material that limits the average temperature rise of an unexposed surface to not more than 250°F (139°C) for a specified fire exposure complying with the standard time-temperature curve of ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials.* (SAF-BCF)

3.3.32 Basement. Any story of a building wholly or partly below grade plane that is not considered the first story above grade plane. *(See also 3.3.126.1, First Story Above Grade Plane.)* (SAF-FUN)

3.3.33* Birth Center. A facility in which low-risk births are expected following normal, uncomplicated pregnancies, and in which professional midwifery care is provided to women during pregnancy, birth, and postpartum. (SAF-MER)

3.3.34 Bleachers. A grandstand in which the seats are not provided with backrests. (SAF-AXM)

3.3.35 Board and Care. See 3.3.190.12, Residential Board and Care Occupancy.

3.3.36* Building. Any structure used or intended for supporting or sheltering any use or occupancy. (SAF-FUN)

3.3.36.1 ***Airport Terminal Building.*** A structure used primarily for air passenger enplaning or deplaning, including ticket sales, flight information, baggage handling, and other necessary functions in connection with air transport operations. This term includes any extensions and satellite buildings used for passenger handling or aircraft flight service functions. Aircraft loading walkways and "mobile lounges" are excluded. [**415,** 2013] (SAF-AXM)

3.3.36.2 ***Anchor Building.*** A building housing any occupancy having low or ordinary hazard contents and having direct access to a mall building, but having all required means of egress independent of the mall. (SAF-MER)

3.3.36.3* ***Apartment Building.*** A building or portion thereof containing three or more dwelling units with independent cooking and bathroom facilities. (SAF-RES)

3.3.36.4 ***Bulk Merchandising Retail Building.*** A building in which the sales area includes the storage of combustible materials on pallets, in solid piles, or in racks in excess of 12 ft (3660 mm) in storage height. (SAF-MER)

3.3.36.5* ***Existing Building.*** A building erected or officially authorized prior to the effective date of the adoption of this edition of the *Code* by the agency or jurisdiction. (SAF-FUN)

3.3.36.6* ***Flexible Plan and Open Plan Educational or Day-Care Building.*** A building or portion of a building designed for multiple teaching stations. (SAF-END)

3.3.36.7* ***High-Rise Building.*** A building where the floor of an occupiable story is greater than 75 ft (23 m) above the lowest level of fire department vehicle access. (SAF-FUN)

3.3.36.8* ***Historic Building.*** A building or facility deemed to have historical, architectural, or cultural significance by a local, regional, or national jurisdiction. (SAF-FUN)

3.3.36.9* ***Mall Building.*** A single building enclosing a number of tenants and occupancies wherein two or more tenants have a main entrance into one or more malls. For the purpose of this *Code*, anchor buildings shall not be considered as a part of the mall building. (SAF-MER)

3.3.36.10* ***Special Amusement Building.*** A building that is temporary, permanent, or mobile and contains a device or system that conveys passengers or provides a walkway along, around, or over a course in any direction as a form of amusement arranged so that the egress path is not readily apparent due to visual or audio distractions or an intentionally confounded egress path, or is not readily available due to the mode of conveyance through the building or structure. (SAF-AXM)

3.3.37* Building Code. The building code enforced by the jurisdiction or agency enforcing this *Code*. (SAF-FUN)

3.3.38 Bulk Merchandising Retail Building. See 3.3.36.4.

3.3.39 Business Occupancy. See 3.3.190.3.

3.3.40 Categories of Rehabilitation Work. The nature and extent of rehabilitation work undertaken in an existing building. (SAF-FUN)

3.3.41* Cellular or Foamed Plastic. A heterogeneous system comprised of not less than two phases, one of which is a continuous, polymeric, organic material, and the second of which is deliberately introduced for the purpose of distributing gas in voids throughout the material. (SAF-INT)

3.3.42 Change of Occupancy Classification. The change in the occupancy classification of a structure or portion of a structure. (SAF-FUN)

3.3.43 Change of Use. A change in the purpose or level of activity within a structure that involves a change in application of the requirements of the *Code*. (SAF-FUN)

3.3.44 Combustible (Material). See 3.3.171.1.

3.3.45 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame. (SAF-FUN)

3.3.46 Common Atmosphere. See 3.3.26.1.

3.3.47* Common Path of Travel. The portion of exit access that must be traversed before two separate and distinct paths of travel to two exits are available. (SAF-MEA)

3.3.48 Compartment.

3.3.48.1* ***Fire Compartment.*** A space within a building that is enclosed by fire barriers on all sides, including the top and bottom. (SAF-FIR)

3.3.48.2* ***Smoke Compartment.*** A space within a building enclosed by smoke barriers on all sides, including the top and bottom. (SAF-FIR)

> The definition of Consumer Fireworks 1.4G was deleted by a tentative interim amendment (TIA). See page 1.

3.3.49 Contents and Furnishings. Any movable objects in a building that normally are secured or otherwise put in place for functional reasons, excluding (1) parts of the internal structure of the building, and (2) any items meeting the definition of interior finish. (SAF-INT)

3.3.50 Court. An open, uncovered, unoccupied space, unobstructed to the sky, bounded on three or more sides by exterior building walls. (SAF-MEA)

3.3.50.1 ***Enclosed Court.*** A court bounded on all sides by the exterior walls of a building or by the exterior walls and lot lines on which walls are permitted. (SAF-MEA)

3.3.50.2 ***Food Court.*** A public seating area located in a mall that serves adjacent food preparation tenant spaces. (SAF-MER)

3.3.51* Critical Radiant Flux. The level of incident radiant heat energy in units of W/cm^2 on a floor-covering system at the most distant flameout point. (SAF-INT)

3.3.52 Data Conversion. The process of developing the input data set for the assessment method of choice. (SAF-FUN)

3.3.53 Day-Care Home. See 3.3.142.1.

3.3.54 Day-Care Occupancy. See 3.3.190.4.

3.3.55 Deep-Fat Frying. A cooking method that involves fully immersing food in hot oil. (SAF-HEA)

3.3.56 Design Fire Scenario. See 3.3.105.1.

3.3.57 Design Specification. See 3.3.262.1.

3.3.58 Design Team. A group of stakeholders including, but not limited to, representatives of the architect, client, and any pertinent engineers and other designers. (SAF-FUN)

3.3.59 Detention and Correctional Occupancy. See 3.3.190.5.

3.3.60 Detention and Correctional Residential Housing Area. See 3.3.21.1.

3.3.61 Device.

3.3.61.1* ***Emergency Stair Travel Device.*** Device designed and constructed to facilitate travel over interior floor surfaces, interior and exterior stairs, and exterior accessible pathways. (SAF-MEA)

3.3.61.2 ***Multiple-Station Alarm Device.*** Two or more single-station alarm devices that can be interconnected so that actuation of one causes all integral or separate audible alarms to operate; or one single-station alarm device having connections to other detectors or to a manual fire alarm box. [***72,*** 2013] (SAF-BSF)

3.3.62 Door.

3.3.62.1 ***Elevator Lobby Door.*** A door between an elevator lobby and another building space other than the elevator shaft. (SAF-MEA)

3.3.62.2 ***Fire Door.*** The door component of a fire door assembly. (SAF-FIR)

3.3.63 Door Assembly. See 3.3.23.1.

3.3.64* Dormitory. A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities. (SAF-RES)

3.3.65 Draft Stop. A continuous membrane used to subdivide a concealed space to resist the passage of smoke and heat. (SAF-FIR)

3.3.66* Dwelling Unit. One or more rooms arranged for complete, independent housekeeping purposes with space for eating, living, and sleeping; facilities for cooking; and provisions for sanitation. (SAF-RES)

3.3.66.1* ***One- and Two-Family Dwelling Unit.*** A building that contains not more than two dwelling units with independent cooking and bathroom facilities. (SAF-RES)

3.3.66.2 ***One-Family Dwelling Unit.*** A building that consists solely of one dwelling unit with independent cooking and bathroom facilities. (SAF-RES)

3.3.66.3 ***Two-Family Dwelling Unit.*** A building that consists solely of two dwelling units with independent cooking and bathroom facilities. (SAF-RES)

3.3.67 Educational Occupancy. See 3.3.190.6.

3.3.68* Electroluminescent. Refers to a light-emitting capacitor in which alternating current excites phosphor atoms placed between electrically conductive surfaces and produces light. (SAF-MEA)

3.3.69 Elevator Evacuation System. See 3.3.274.1.

3.3.70 Elevator Lobby. A landing from which occupants directly enter an elevator car(s) and into which occupants directly enter upon leaving an elevator car(s). (SAF-MEA)

3.3.71 Elevator Lobby Door. See 3.3.62.1.

3.3.72 Emergency Stair Travel Device. See 3.3.61.1.

3.3.73 Enclosed Court. See 3.3.50.1.

3.3.74 Enclosed Parking Structure. See 3.3.272.7.3.

3.3.75 Equipment or Fixture. Any plumbing, heating, electrical, ventilating, air-conditioning, refrigerating, and fire protection equipment; and elevators, dumbwaiters, escalators, boilers, pressure vessels, or other mechanical facilities or installations that are related to building services. (SAF-FUN)

3.3.76 Equivalency. An alternative means of providing an equal or greater degree of safety than that afforded by strict conformance to prescribed codes and standards. (SAF-FUN)

3.3.77 Evacuation. The withdrawal of occupants from a building. [**72,** 2013] (SAF-BSF)

3.3.78* Evacuation Capability. The ability of occupants, residents, and staff as a group either to evacuate a building or to relocate from the point of occupancy to a point of safety.

3.3.78.1 ***Impractical Evacuation Capability.*** The inability of a group to reliably move to a point of safety in a timely manner. (SAF-BCF)

3.3.78.2 ***Prompt Evacuation Capability.*** The ability of a group to move reliably to a point of safety in a timely manner that is equivalent to the capacity of a household in the general population. (SAF-BCF)

3.3.78.3 ***Slow Evacuation Capability.*** The ability of a group to move reliably to a point of safety in a timely manner, but not as rapidly as members of a household in the general population. (SAF-BCF)

3.3.79 Exhibit. A space or portable structure used for the display of products or services. (SAF-AXM)

3.3.80 Exhibitor. An individual or entity engaged in the display of the products or services offered. (SAF-AXM)

3.3.81* Existing. That which is already in existence on the date this edition of the *Code* goes into effect. (SAF-FUN)

3.3.81.1 ***Approved Existing.*** That which is already in existence on the date this edition of the *Code* goes into effect and is acceptable to the authority having jurisdiction. (SAF-FUN)

3.3.82 Existing Building. See 3.3.36.5.

3.3.83* Exit. That portion of a means of egress that is separated from all other spaces of the building or structure by construction, location, or equipment as required to provide a protected way of travel to the exit discharge. (SAF-MEA)

3.3.83.1* ***Horizontal Exit.*** A way of passage from one building to an area of refuge in another building on approximately the same level, or a way of passage through or around a fire barrier to an area of refuge on approximately the same level in the same building that affords safety from fire and smoke originating from the area of incidence and areas communicating therewith. (SAF-MEA)

3.3.84 Exit Access. That portion of a means of egress that leads to an exit. (SAF-MEA)

3.3.85 Exit Discharge. That portion of a means of egress between the termination of an exit and a public way. (SAF-MEA)

3.3.85.1* ***Level of Exit Discharge.*** The story that is either (1) the lowest story from which not less than 50 percent of the required number of exits and not less than 50 percent of the required egress capacity from such a story discharge directly outside at the finished ground level; or (2) where no story meets the conditions of item (1), the story that is provided with one or more exits that discharge directly to the outside to the finished ground level via the smallest elevation change. (SAF-MEA)

3.3.86 Exposition. An event in which the display of products or services is organized to bring together the provider and user of the products or services. (SAF-AXM)

3.3.87 Exposition Facility. See 3.3.90.1.

3.3.88* Exposure Fire. A fire that starts at a location that is remote from the area being protected and grows to expose that which is being protected. (SAF-FUN)

3.3.89 Externally Illuminated. See 3.3.146.1.

3.3.90 Facility.

3.3.90.1 ***Exposition Facility.*** A convention center, hotel, or other building at which exposition events are held. (SAF-AXM)

3.3.90.2* ***Limited Care Facility.*** A building or portion of a building used on a 24-hour basis for the housing of four or more persons who are incapable of self-preservation because of age; physical limitations due to accident or illness; or limitations such as mental retardation/developmental disability, mental illness, or chemical dependency. (SAF-HEA)

3.3.91 Festival Seating. See 3.3.239.1.

3.3.92 Finish.

3.3.92.1 ***Interior Ceiling Finish.*** The interior finish of ceilings. (SAF-INT)

3.3.92.2* ***Interior Finish.*** The exposed surfaces of walls, ceilings, and floors within buildings. (SAF-INT)

3.3.92.3* ***Interior Floor Finish.*** The interior finish of floors, ramps, stair treads and risers, and other walking surfaces. (SAF-INT)

3.3.92.4 ***Interior Wall Finish.*** The interior finish of columns, fixed or movable walls, and fixed or movable partitions. (SAF-INT)

3.3.93 Finished Ground Level (Grade). The level of the finished ground (earth or other surface on ground). *(See also 3.3.126, Grade Plane.)* (SAF-FUN)

3.3.94 Fire Barrier. See 3.3.31.1.

3.3.95 Fire Barrier Wall. See 3.3.288.1.

3.3.96* Fire Code. The fire code enforced by the jurisdiction or agency enforcing this *Code* (SAF-FUN).

3.3.97 Fire Compartment. See 3.3.48.1.

3.3.98 Fire Door. See 3.3.62.2.

3.3.99 Fire Door Assembly. See 3.3.23.1.1.

3.3.100 Fire Exit Hardware. See 3.3.135.1.

3.3.101* Fire Model. A structured approach to predicting one or more effects of a fire. (SAF-FUN)

3.3.102 Fire Protection Rating. See 3.3.223.1.

3.3.103 Fire Resistance Rating. See 3.3.223.2.

3.3.104 Fire Safety Functions. Building and fire control functions that are intended to increase the level of life safety for occupants or to control the spread of the harmful effects of fire. (SAF-BSF)

3.3.105* Fire Scenario. A set of conditions that defines the development of fire, the spread of combustion products throughout a building or portion of a building, the reactions of people to fire, and the effects of combustion products. (SAF-FUN)

3.3.105.1 ***Design Fire Scenario.*** A fire scenario selected for evaluation of a proposed design. (SAF-FUN)

3.3.106 Fire Watch. The assignment of a person or persons to an area for the express purpose of notifying the fire department, the building occupants, or both of an emergency; preventing a fire from occurring; extinguishing small fires; or protecting the public from fire or life safety dangers. [**1**, 2015] (SAF-BSF)

3.3.107 Fire Window Assembly. See 3.3.23.2.

3.3.108 Fire-Rated Glazing. Glazing with either a fire protection rating or a fire resistance rating. (SAF-FIR)

3.3.109 Fire-Retardant–Treated Wood. A wood product impregnated with chemical by a pressure process or other means during manufacture, treated to exhibit reduced surface-burning characteristics and resist propagation of fire. [**703**, 2015] (SAF-FIR)

3.3.110 First Story Above Grade Plane. See 3.3.126.1.

3.3.111 Fixed Seating. See 3.3.239.2.

3.3.112* Flame Spread. The propagation of flame over a surface. (SAF-INT)

3.3.113 Flame Spread Index. See 3.3.149.1.

3.3.114 Flashover. A stage in the development of a contained fire in which all exposed surfaces reach ignition temperature more or less simultaneously and fire spreads rapidly throughout the space. (SAF-INT)

3.3.115 Flexible Plan and Open Plan Educational or Day-Care Building. See 3.3.36.6.

3.3.116 Floor Fire Door Assembly. See 3.3.23.1.1.1.

3.3.117 Flow Time. A component of total evacuation time that is the time during which there is crowd flow past a point in the means of egress system. (SAF-AXM)

3.3.118 Fly Gallery. A raised floor area above a stage from which the movement of scenery and operation of other stage effects are controlled. (SAF-AXM)

3.3.119 Foam Plastic Insulation. See 3.3.152.1.

3.3.120 Folding and Telescopic Seating. See 3.3.239.3.

3.3.121 Food Court. See 3.3.50.2.

3.3.122 Fuel Load. See 3.3.164.1.

3.3.123 General Industrial Occupancy. See 3.3.190.8.1.

3.3.124 Goal. A nonspecific overall outcome to be achieved that is measured on a qualitative basis. (SAF-FUN)

3.3.125 Grade. See 3.3.93, Finished Ground Level (Grade).

3.3.126* Grade Plane. A reference plane upon which vertical measurements of a building are based representing the average of the finished ground level adjoining the building at all exterior walls. (SAF-FUN)

3.3.126.1 ***First Story Above Grade Plane.*** Any story having its finished floor surface entirely above grade plane, except that a basement is to be considered as a first story above grade plane where the finished surface of the floor above the basement is (1) more than 6 ft (1830 mm) above grade plane or (2) more than 12 ft (3660 mm) above the finished ground level at any point. (SAF-FUN)

3.3.127* Grandstand. A structure that provides tiered or stepped seating. (SAF-AXM)

3.3.128 Gridiron. The structural framing over a stage supporting equipment for hanging or flying scenery and other stage effects. (SAF-AXM)

3.3.129 Gross Floor Area. See 3.3.21.2.1.

3.3.130 Gross Leasable Area. See 3.3.21.3.

3.3.131 Guard. A vertical protective barrier erected along exposed edges of stairways, balconies, and similar areas. (SAF-MEA)

3.3.132 Guest Room. An accommodation combining living, sleeping, sanitary, and storage facilities within a compartment. (SAF-RES)

3.3.133 Guest Suite. See 3.3.273.1.

3.3.134 Handrail. A bar, pipe, or similar member designed to furnish persons with a handhold. (SAF-MEA)

3.3.135 Hardware.

3.3.135.1 ***Fire Exit Hardware.*** A type of panic hardware that additionally provides fire protection where used as part of a fire door assembly. (SAF-MEA)

3.3.135.2 ***Panic Hardware.*** A door-latching assembly incorporating an actuating member or bar that releases the latch bolt upon the application of a force in the direction of egress travel. (SAF-MEA)

3.3.136 Hazardous Area. See 3.3.21.4.

3.3.137 Health Care Occupancy. See 3.3.190.7.

3.3.138* Heat Release Rate (HRR). The rate at which heat energy is generated by burning. [**921,** 2014] (SAF-INT)

3.3.139 High Hazard Industrial Occupancy. See 3.3.190.8.2.

3.3.140 High-Rise Building. See 3.3.36.7.

3.3.141 Historic Building. See 3.3.36.8.

3.3.142 Home.

3.3.142.1* ***Day-Care Home.*** A building or portion of a building in which more than 3 but not more than 12 clients receive care, maintenance, and supervision, by other than their relative(s) or legal guardians(s), for less than 24 hours per day. (SAF-END)

3.3.142.2 ***Nursing Home.*** A building or portion of a building used on a 24-hour basis for the housing and nursing care of four or more persons who, because of mental or physical incapacity, might be unable to provide for their own needs and safety without the assistance of another person. (SAF-HEA)

3.3.143 Horizontal Exit. See 3.3.83.1.

3.3.144 Hospital. A building or portion thereof used on a 24-hour basis for the medical, psychiatric, obstetrical, or surgical care of four or more inpatients. (SAF-HEA)

3.3.145* Hotel. A building or groups of buildings under the same management in which there are sleeping accommodations for more than 16 persons and primarily used by transients for lodging with or without meals. (SAF-RES)

3.3.146 Illuminated.

3.3.146.1* ***Externally Illuminated.*** Refers to an illumination source that is contained outside of the device or sign legend area that is to be illuminated. (SAF-MEA)

3.3.146.2* ***Internally Illuminated.*** Refers to an illumination source that is contained inside the device or legend that is illuminated. (SAF-MEA)

3.3.147 Impractical Evacuation Capability. See 3.3.78.1.

3.3.148 Incapacitation. A condition under which humans do not function adequately and become unable to escape untenable conditions. (SAF-FUN)

3.3.149 Index.

3.3.149.1 ***Flame Spread Index.*** A comparative measure, expressed as a dimensionless number, derived from visual measurements of the spread of flame versus time for a material tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Burning Materials.* (SAF-INT)

3.3.149.2 ***Smoke Developed Index.*** A comparative measure, expressed as a dimensionless number, derived from measurements of smoke obscuration versus time for a material tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Burning Materials.* (SAF-INT)

3.3.150 Industrial Occupancy. See 3.3.190.8.

3.3.151 Input Data Specification. See 3.3.262.2.

3.3.152 Insulation.

3.3.152.1 ***Foam Plastic Insulation.*** A cellular plastic, used for thermal insulating or acoustical applications, having a density of 20 lb/ft^3 (320 kg/m^3) or less, containing open or closed cells, and formed by a foaming agent. (SAF-INT)

3.3.152.2 ***Reflective Insulation.*** Thermal insulation consisting of one or more low-emittance surfaces bounding one or more enclosed air spaces. (SAF-INT)

3.3.153 Interior Ceiling Finish. See 3.3.92.1.

3.3.154 Interior Finish. See 3.3.92.2.

3.3.155 Interior Floor Finish. See 3.3.92.3.

3.3.156 Interior Wall Finish. See 3.3.92.4.

3.3.157 Internally Illuminated. See 3.3.146.2.

3.3.158 Joint. A linear opening in or between adjacent assemblies that is designed to allow independent movement of the building. (SAF-FIR)

3.3.159 Level of Exit Discharge. See 3.3.85.1.

3.3.160 Life Safety Evaluation. A written review dealing with the adequacy of life safety features relative to fire, storm, collapse, crowd behavior, and other related safety considerations. (SAF-AXM)

3.3.161 Limited Access Structure. See 3.3.272.3.

3.3.162 Limited Care Facility. See 3.3.90.2.

3.3.163 Living Area. See 3.3.21.5.

3.3.164 Load.

3.3.164.1* ***Fuel Load.*** The total quantity of combustible contents of a building, space, or fire area. (SAF-FUN)

3.3.164.2 ***Occupant Load.*** The total number of persons that might occupy a building or portion thereof at any one time. (SAF-MEA)

3.3.165 Load-Bearing Element. Any column, girder, beam, joist, truss, rafter, wall, floor, or roof sheathing that supports any vertical load in addition to its own weight, or any lateral load. (SAF-FIR)

3.3.166 Lock-Up. An incidental use area in other than a detention and correctional occupancy where occupants are restrained and such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control. (SAF-DET)

3.3.167 Lodging or Rooming House. A building or portion thereof that does not qualify as a one- or two-family dwelling, that provides sleeping accommodations for a total of 16 or fewer people on a transient or permanent basis, without personal care services, with or without meals, but without separate cooking facilities for individual occupants. (SAF-RES)

3.3.168 Major Tenant. A tenant space, in a mall building, with one or more main entrances from the exterior that also serve as exits and are independent of the mall. (SAF-MER)

3.3.169 Mall. A roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants and does not exceed three levels that are open to each other. (SAF-MER)

3.3.170 Mall Building. See 3.3.36.9.

3.3.171 Material.

3.3.171.1 ***Combustible (Material).*** A material that, in the form in which it is used and under the conditions anticipated, will ignite and burn; a material that does not meet the definition of noncombustible or limited-combustible. (SAF-FUN)

3.3.171.2 ***Limited-Combustible (Material).*** See 4.6.14.

3.3.171.3 ***Metal Composite Material (MCM).*** A factory-manufactured panel consisting of metal skins bonded to both faces of a core made of any plastic other than foamed plastic insulation as defined in 3.3.152.1. (SAF-MER)

3.3.171.4 ***Noncombustible (Material).*** See 4.6.13.

3.3.171.5 ***Weathered-Membrane Material.*** Membrane material that has been subjected to a minimum of 3000 hours in a weatherometer in accordance with ASTM G 155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*, or approved equivalent. (SAF-IND)

3.3.172* Means of Egress. A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. (SAF-MEA)

3.3.172.1 ***Accessible Means of Egress.*** A means of egress that provides an accessible route to an area of refuge, a horizontal exit, or a public way. (SAF-MEA)

3.3.173 Means of Escape. A way out of a building or structure that does not conform to the strict definition of means of egress but does provide an alternate way out. (SAF-MEA)

3.3.174* Membrane. A thin layer of construction material. (SAF-FIR)

3.3.175 Membrane Structure. See 3.3.272.4.

3.3.176 Mercantile Occupancy. See 3.3.190.9.

3.3.177 Metal Composite Material (MCM). See 3.3.171.3.

3.3.178 Mezzanine. An intermediate level between the floor and the ceiling of any room or space. (SAF-FIR)

3.3.179 Mixed Occupancy. See 3.3.190.10.

3.3.180* Modification. The reconfiguration of any space; the addition or elimination of any door or window; the addition or elimination of load-bearing elements; the reconfiguration or extension of any system; or the installation of any additional equipment. (SAF-FUN)

3.3.181 Multilevel Play Structure. See 3.3.272.5.

3.3.182 Multiple Occupancy. See 3.3.190.11.

3.3.183 Multiple Station Alarm Device. See 3.3.61.2.

3.3.184 Multipurpose Assembly Occupancy. See 3.3.190.2.1.

3.3.185 Net Floor Area. See 3.3.21.2.2.

3.3.186 Non-Patient-Care Suite (Health Care Occupancies). See 3.3.273.2.

3.3.187 Normally Unoccupied Building Service Equipment Support Area. See 3.3.21.6.

3.3.188 Nursing Home. See 3.3.142.2.

3.3.189* Objective. A requirement that needs to be met to achieve a goal. (SAF-FUN)

3.3.190 Occupancy. The purpose for which a building or other structure, or part thereof, is used or intended to be used. [**ASCE/SEI 7:**1.2] (SAF-FUN)

3.3.190.1* ***Ambulatory Health Care Occupancy.*** An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following: (1) treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (2) anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others; (3) emergency or urgent care for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others. (SAF-HEA)

3.3.190.2* ***Assembly Occupancy.*** An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. (SAF-AXM)

3.3.190.2.1 ***Multipurpose Assembly Occupancy.*** An assembly room designed to accommodate temporarily any of several possible assembly uses. (SAF-AXM)

3.3.190.3* ***Business Occupancy.*** An occupancy used for the transaction of business other than mercantile. (SAF-MER)

3.3.190.4* ***Day-Care Occupancy.*** An occupancy in which four or more clients receive care, maintenance, and supervision, by other than their relatives or legal guardians, for less than 24 hours per day. (SAF-END)

3.3.190.5* ***Detention and Correctional Occupancy.*** An occupancy used to house one or more persons under varied degrees of restraint or security where such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control. (SAF-DET)

3.3.190.6* ***Educational Occupancy.*** An occupancy used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week. (SAF-END)

3.3.190.7* ***Health Care Occupancy.*** An occupancy used to provide medical or other treatment or care simultaneously to four or more patients on an inpatient basis, where such patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control. (SAF-HEA)

3.3.190.8* ***Industrial Occupancy.*** An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted. (SAF-IND)

3.3.190.8.1* ***General Industrial Occupancy.*** An industrial occupancy in which ordinary and low hazard industrial operations are conducted in buildings of conventional design suitable for various types of industrial processes. (SAF-IND)

3.3.190.8.2* ***High Hazard Industrial Occupancy.*** An industrial occupancy in which industrial operations that include high hazard materials, processes, or contents are conducted. (SAF-IND)

3.3.190.8.3 ***Special-Purpose Industrial Occupancy.*** An industrial occupancy in which ordinary and low hazard industrial operations are conducted in buildings designed for, and suitable only for, particular types of operations, characterized by a relatively low density of employee population, with much of the area occupied by machinery or equipment. (SAF-IND)

3.3.190.9* ***Mercantile Occupancy.*** An occupancy used for the display and sale of merchandise. (SAF-MER)

3.3.190.10 ***Mixed Occupancy.*** A multiple occupancy where the occupancies are intermingled. (SAF-FUN)

3.3.190.11 ***Multiple Occupancy.*** A building or structure in which two or more classes of occupancy exist. (SAF-FUN)

3.3.190.12* ***Residential Board and Care Occupancy.*** An occupancy used for lodging and boarding of four or more residents, not related by blood or marriage to the owners or operators, for the purpose of providing personal care services. (SAF-BCF)

3.3.190.13* ***Residential Occupancy.*** An occupancy that provides sleeping accommodations for purposes other than health care or detention and correctional. (SAF-RES)

3.3.190.14 ***Separated Occupancy.*** A multiple occupancy where the occupancies are separated by fire resistance–rated assemblies. (SAF-FUN)

3.3.190.15* ***Storage Occupancy.*** An occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles. (SAF-IND)

3.3.191 Occupant Characteristics. The abilities or behaviors of people before and during a fire. (SAF-FUN)

3.3.192 Occupant Load. See 3.3.164.2.

3.3.193 Occupiable Area. See 3.3.21.7.

3.3.194 Occupiable Story. See 3.3.269.1.

3.3.195 One- and Two-Family Dwelling Unit. See 3.3.66.1.

3.3.196 One-Family Dwelling Unit. See 3.3.66.2.

3.3.197 Open Parking Structure. See 3.3.272.7.4.

3.3.198 Open Structure. See 3.3.272.6.

3.3.199 Open-Air Mercantile Operation. An operation conducted outside of all structures, with the operations area devoid of all walls and roofs except for small, individual, weather canopies. (SAF-MER)

3.3.200 Outside Stair. See 3.3.265.2.

3.3.201 Panic Hardware. See 3.3.135.2.

3.3.202 Parking Structure. See 3.3.272.7.

3.3.203 Patient Care Non-Sleeping Suite (Health Care Occupancies). See 3.3.273.3.

3.3.204 Patient Care Sleeping Suite (Health Care Occupancies). See 3.3.273.4.

3.3.205 Patient Care Suite (Health Care Occupancies). See 3.3.273.5.

3.3.206* Performance Criteria. Threshold values on measurement scales that are based on quantified performance objectives. (SAF-FUN)

3.3.207 Permanent Structure. See 3.3.272.8.

3.3.208* Personal Care. The care of residents who do not require chronic or convalescent medical or nursing care. (SAF-BCF)

3.3.209* Photoluminescent. Having the ability to store incident electromagnetic radiation typically from ambient light sources, and release it in the form of visible light. [**301,** 2013] (SAF-MEA)

3.3.210 Pinrail. A rail on or above a stage through which belaying pins are inserted and to which lines are fastened. (SAF-AXM)

3.3.211* Platform. The raised area within a building used for the presentation of music, plays, or other entertainment. (SAF-AXM)

3.3.211.1 ***Temporary Platform.*** A platform erected within an area for not more than 30 days. (SAF-AXM)

3.3.212 Plenum. A compartment or chamber to which one or more air ducts are connected and that forms part of the air-distribution system. (SAF-FIR)

3.3.213 Point of Safety. A location that (a) is exterior to and away from a building; or (b) is within a building of any construction type protected throughout by an approved automatic sprinkler system and that is either (1) within an exit enclosure meeting the requirements of this *Code,* or (2) within another portion of the building that is separated by smoke barriers in accordance with Section 8.5 having a minimum ½-hour fire resistance rating, and that portion of the building has access to a means of escape or exit that conforms to the requirements of this *Code* and does not necessitate return to the area of fire involvement; or (c) is within a building of Type I, Type II(222), Type II(111), Type III(211), Type IV, or Type V(111) construction *(see 8.2.1.2)* and is either (1) within an exit enclosure meeting the requirements of this *Code,* or (2) within another portion of the building that is separated by smoke barriers in accordance with Section 8.5 having a minimum ½-hour fire resistance rating, and that portion of the building has access to a means of escape or exit that conforms to the requirements of this *Code* and does not necessitate return to the area of fire involvement. (SAF-BCF)

3.3.214 Previously Approved. That which was acceptable to the authority having jurisdiction prior to the date this edition of the *Code* went into effect. (SAF-FUN)

3.3.215 Private Party Tent. See 3.3.279.1. (SAF-AXM)

3.3.216 Professional Engineer. A person registered or licensed to practice engineering in a jurisdiction, subject to all laws and limitations imposed by the jurisdiction. (SAF-FUN)

3.3.217 Prompt Evacuation Capability. See 3.3.78.2. (SAF-BCF)

3.3.218* Proposed Design. A design developed by a design team and submitted to the authority having jurisdiction for approval. (SAF-FUN)

3.3.219 Proscenium Wall. See 3.3.288.2.

3.3.220 Public Way. A street, alley, or other similar parcel of land essentially open to the outside air deeded, dedicated, or otherwise permanently appropriated to the public for public use and having a clear width and height of not less than 10 ft (3050 mm). (SAF-MEA)

3.3.221* Ramp. A walking surface that has a slope steeper than 1 in 20. (SAF-MEA)

3.3.221.1 ***Aisle Ramp.*** A ramp within a seating area of an assembly occupancy that directly serves rows of seating to the side of the ramp. (SAF-AXM)

3.3.222 Ramp Type Parking Structure. See 3.3.272.7.5.

3.3.223 Rating.

3.3.223.1* ***Fire Protection Rating.*** The designation indicating the duration of the fire test exposure to which an opening protective assembly was exposed. [**221,** 2015] (SAF-FIR)

3.3.223.2 ***Fire Resistance Rating.*** The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this *Code.* (SAF-FIR)

3.3.224* Reconstruction. The reconfiguration of a space that affects an exit or a corridor shared by more than one occupant space; or the reconfiguration of a space such that the rehabilitation work area is not permitted to be occupied because existing means of egress and fire protection systems, or their equivalent, are not in place or continuously maintained. (SAF-FUN)

3.3.225 Reflective Insulation. See 3.3.152.2.

3.3.226 Registered Architect. A person licensed to practice architecture in a jurisdiction, subject to all laws and limitations imposed by the jurisdiction. (SAF-FUN)

3.3.227 Registered Design Professional (RDP). An individual who is registered or licensed to practice his/her respective design profession as defined by the statutory requirements of the professional registration laws of the state or jurisdiction in which the project is to be constructed. (SAF-FUN)

3.3.228 Regular Stage. See 3.3.264.2.

3.3.229 Rehabilitation Work Area. See 3.3.21.8

3.3.230 Relocation. The movement of occupants to a safer area within the same building. (SAF-FUN)

3.3.231 Repair. The patching, restoration, or painting of materials, elements, equipment, or fixtures for the purpose of maintaining such materials, elements, equipment, or fixtures in good or sound condition. (SAF-FUN)

3.3.232 Residential Board and Care Occupancy. See 3.3.190.12.

3.3.233 Residential Board and Care Resident. A person who receives personal care and resides in a residential board and care facility. (SAF-BCF)

3.3.234 Residential Occupancy. See 3.3.190.13.

3.3.235 Safe Location. A location remote or separated from the effects of a fire so that such effects no longer pose a threat. (SAF-FUN)

3.3.236 Safety Factor. A factor applied to a predicted value to ensure that a sufficient safety margin is maintained. (SAF-FUN)

3.3.237 Safety Margin. The difference between a predicted value and the actual value where a fault condition is expected. (SAF-FUN)

3.3.238 Sally Port (Security Vestibule). A compartment provided with two or more doors where the intended purpose is to prevent continuous and unobstructed passage by allowing the release of only one door at a time. (SAF-DET)

3.3.239 Seating.

3.3.239.1* ***Festival Seating.*** A form of audience/spectator accommodation in which no seating, other than a floor or finished ground level, is provided for the audience/spectators gathered to observe a performance. (SAF-AXM)

3.3.239.2 ***Fixed Seating.*** Seating that is secured to the building structure. (SAF-AXM)

3.3.239.3 ***Folding and Telescopic Seating.*** A structure that is used for tiered seating of persons and whose overall shape and size can be reduced, without being dismantled, for purposes of moving or storing. (SAF-AXM)

3.3.239.4 ***Smoke-Protected Assembly Seating.*** Seating served by means of egress that is not subject to smoke accumulation within or under the structure. (SAF-AXM)

3.3.240 Self-Closing. Equipped with an approved device that ensures closing after opening. (SAF-MEA)

3.3.241* Self-Luminous. Illuminated by a self-contained power source and operated independently of external power sources. (SAF-MEA)

3.3.242* Self-Preservation (Day-Care Occupancy). The ability of a client to evacuate a day-care occupancy without direct intervention by a staff member. (SAF-END)

3.3.243 Sensitivity Analysis. See 3.3.17.1.

3.3.244 Separate Atmosphere. See 3.3.26.2.

3.3.245 Separated Occupancy. See 3.3.190.14.

3.3.246 Severe Mobility Impairment. The ability to move to stairs but without the ability to use the stairs. (SAF-MEA)

3.3.247 Single Station Alarm. See 3.3.14.1.

3.3.248 Site-Fabricated Stretch System. See 3.3.274.2.

3.3.249* Situation Awareness. The perception of the elements in the environment within a volume of time and space, the comprehension of their meaning, and the projection of their status in the near future. (SAF-FUN)

3.3.250 Slow Evacuation Capability. See 3.3.78.3.

3.3.251 Smoke Alarm. See 3.3.14.2.

3.3.252 Smoke Barrier. See 3.3.31.2.

3.3.253 Smoke Compartment. See 3.3.48.2.

3.3.254 Smoke Detector. A device that detects visible or invisible particles of combustion. [***72,*** 2013] (SAF-BSF)

3.3.255 Smoke Developed Index. See 3.3.149.2.

3.3.256* Smoke Partition. A continuous membrane that is designed to form a barrier to limit the transfer of smoke. (SAF-FIR)

3.3.257* Smokeproof Enclosure. An enclosure designed to limit the movement of products of combustion produced by a fire. (SAF-MEA)

3.3.258 Smoke-Protected Assembly Seating. See 3.3.239.4.

3.3.259 Special Amusement Building. See 3.3.36.10.

3.3.260 Special Inspection. Services provided by a qualified person, retained by the owner and approved by the authority having jurisdiction, who observes the installation and witnesses the pretesting and operation of the system or systems. (SAF-BSF)

3.3.261 Special-Purpose Industrial Occupancy. See 3.3.190.8.3.

3.3.262 Specification.

3.3.262.1* ***Design Specification.*** A building characteristic and other conditions that are under the control of the design team. (SAF-FUN)

3.3.262.2 ***Input Data Specification.*** Information required by the verification method. (SAF-FUN)

3.3.263 Staff (Residential Board and Care). Persons who provide personal care services, supervision, or assistance. (SAF-BCF)

3.3.264 Stage. A space within a building used for entertainment and utilizing drops or scenery or other stage effects. (SAF-AXM)

3.3.264.1 ***Legitimate Stage.*** A stage with a height greater than 50 ft (15 m) measured from the lowest point on the stage floor to the highest point of the roof or floor deck above. (SAF-AXM)

3.3.264.2 ***Regular Stage.*** A stage with a height of 50 ft (15 m) or less measured from the lowest point on the stage floor to the highest point of the roof or floor deck above. (SAF-AXM)

3.3.265* Stair.

3.3.265.1 ***Aisle Stair.*** A stair within a seating area of an assembly occupancy that directly serves rows of seats to the side of the stair, including transition stairs that connect to an aisle or a landing. (SAF-AXM)

3.3.265.2 ***Outside Stair.*** A stair with not less than one side open to the outer air. (SAF-MEA)

3.3.266 Stakeholder. An individual, or representative of same, having an interest in the successful completion of a project. (SAF-FUN)

3.3.267 Storage Occupancy. See 3.3.190.15.

3.3.268* Stories in Height. The story count starting with the level of exit discharge and ending with the highest occupiable story containing the occupancy considered. (SAF-FUN)

3.3.269* Story. The portion of a building located between the upper surface of a floor and the upper surface of the floor or roof next above. (SAF-FUN)

3.3.269.1 ***Occupiable Story.*** A story occupied by people on a regular basis. (SAF-FUN)

3.3.270 Street. A public thoroughfare that has been dedicated for vehicular use by the public and can be used for access by fire department vehicles. (SAF-MEA)

3.3.271* Street Floor. A story or floor level accessible from the street or from outside the building at the finished ground level, with the floor level at the main entrance located not more than three risers above or below the finished ground level, and arranged and utilized to qualify as the main floor. (SAF-MER)

3.3.272* Structure. That which is built or constructed. (SAF-FUN)

3.3.272.1 ***Air-Inflated Structure.*** A structure whose shape is maintained by air pressure in cells or tubes forming all or part of the enclosure of the usable area and in which the occupants are not within the pressurized area used to support the structure. (SAF-IND)

3.3.272.2* ***Air-Supported Structure.*** A structure where shape is maintained by air pressure and in which occupants are within the elevated pressure area. (SAF-IND)

3.3.272.3 ***Limited Access Structure.*** A structure or portion of a structure lacking emergency openings. (SAF-IND)

3.3.272.4 ***Membrane Structure.*** A building or portion of a building incorporating an air-inflated, air-supported, tensioned-membrane structure; a membrane roof; or a membrane-covered rigid frame to protect habitable or usable space. (SAF-IND)

3.3.272.5 ***Multilevel Play Structure.*** A structure that consists of tubes, slides, crawling areas, and jumping areas that is located within a building and is used for climbing and entertainment, generally by children. (SAF-AXM)

3.3.272.6* ***Open Structure.*** A structure that supports equipment and operations not enclosed within building walls. (SAF-IND)

3.3.272.7* ***Parking Structure.*** A building, structure, or portion thereof used for the parking, storage, or both, of motor vehicles. [**88A,** 2015] (SAF-IND)

3.3.272.7.1 ***Assisted Mechanical Type Parking Structure.*** A parking structure that uses lifts or other mechanical devices to transport vehicles to the floors of a parking structure, where the vehicles are then parked by a person. [**88A,** 2015] (SAF-IND)

3.3.272.7.2 ***Automated Type Parking Structure.*** A parking structure that uses computer controlled machines to store and retrieve vehicles, without drivers, in multi-level storage racks with no floors. [**88A,** 2015] (SAF-IND)

3.3.272.7.3 ***Enclosed Parking Structure.*** Any parking structure that is not an open parking structure. [**88A,** 2015] (SAF-IND)

3.3.272.7.4 ***Open Parking Structure.*** A parking structure that meets the requirements of 42.8.1.3 (SAF-IND).

3.3.272.7.5 ***Ramp Type Parking Structure.*** A parking structure that utilizes sloped floors for vertical vehicle circulation. [**88A,** 2015] (SAF-IND)

3.3.272.8 ***Permanent Structure.*** A building or structure that is intended to remain in place for a period of more than 180 days in any consecutive 12-month period. (SAF-FUN)

3.3.272.9 ***Temporary Structure.*** A building or structure not meeting the definition of *permanent structure. (See also 3.3.272.8, Permanent Structure.)* (SAF-FUN)

3.3.272.10 ***Tensioned-Membrane Structure.*** A membrane structure incorporating a membrane and a structural support system such as arches, columns and cables, or beams wherein the stresses developed in the tensioned membrane interact with those in the structural support so that the entire assembly acts together to resist the applied loads. (SAF-IND)

3.3.272.11* ***Underground Structure.*** A structure or portions of a structure in which the floor level is below the level of exit discharge. (SAF-IND)

3.3.272.12 ***Water-Surrounded Structure.*** A structure fully surrounded by water. (SAF-IND)

3.3.273 Suite.

3.3.273.1 ***Guest Suite.*** An accommodation with two or more contiguous rooms comprising a compartment, with or without doors between such rooms, that provides living, sleeping, sanitary, and storage facilities. (SAF-RES)

3.3.273.2 ***Non-Patient-Care Suite (Heath Care Occupancies).*** A suite within a health care occupancy that is not intended for sleeping or treating patients. (SAF-HEA)

3.3.273.3 ***Patient Care Non-Sleeping Suite (Health Care Occupancies).*** A suite for treating patients with or without patient beds not intended for overnight sleeping. (SAF-HEA)

3.3.273.4 ***Patient Care Sleeping Suite (Health Care Occupancies).*** A suite containing one or more patient beds intended for overnight sleeping. (SAF-HEA)

3.3.273.5 ***Patient Care Suite (Health Care Occupancies).*** A series of rooms or spaces or a subdivided room separated from the remainder of the building by walls and doors. (SAF-HEA)

3.3.274 System.

3.3.274.1 ***Elevator Evacuation System.*** A system, including a vertical series of elevator lobbies and associated elevator lobby doors, an elevator shaft(s), and a machine room(s), that provides protection from fire effects for elevator passengers, people waiting to use elevators, and elevator equipment so that elevators can be used safely for egress. (SAF-MEA)

3.3.274.2 ***Site-Fabricated Stretch System.*** A system, fabricated on-site, and intended for acoustical, tackable, or aesthetic purposes, that is comprised of three elements: (1) a frame (constructed of plastic, wood, metal, or other material) used to hold fabric in place, (2) a core material (infill, with the correct properties for the application), and (3) an outside layer, comprised of a textile, fabric, or vinyl, that is stretched taut and held in place by tension or mechanical fasteners via the frame. (SAF-INT)

3.3.275 Technically Infeasible. A change to a building that has little likelihood of being accomplished because the existing structural conditions require the removal or alteration of a load-bearing member that is an essential part of the structural frame, or because other existing physical or site constraints prohibit modification or addition of elements, spaces, or features that are in full and strict compliance with applicable requirements. (SAF-FUN)

3.3.276 Temporary Platform. See 3.3.211.1.

3.3.277 Temporary Structure. See 3.3.272.9.

3.3.278 Tensioned-Membrane Structure. See 3.3.272.10.

3.3.279* Tent. A temporary structure, the covering of which is made of pliable material that achieves its support by mechanical means such as beams, columns, poles, or arches, or by rope or cables, or both. (SAF-IND)

3.3.279.1 ***Private Party Tent.*** A tent erected in the yard of a private residence for entertainment, recreation, dining, a reception, or similar function. (SAF-AXM)

3.3.280 Thermal Barrier. See 3.3.31.3.

3.3.281 Tower. An enclosed independent structure or portion of a building with elevated levels for support of equipment or occupied for observation, control, operation, signaling, or similar limited use. (SAF-IND)

3.3.281.1 ***Air Traffic Control Tower.*** An enclosed structure or building at airports with elevated levels for support of equipment and occupied for observation, control, operation, and signaling of aircraft in flight and on the ground. (SAF-IND)

3.3.282 Two-Family Dwelling Unit. See 3.3.66.3.

3.3.283 Uncertainty Analysis. See 3.3.17.2.

3.3.284 Underground Structure. See 3.3.272.11.

3.3.285 Verification Method. A procedure or process used to demonstrate or confirm that the proposed design meets the specified criteria. (SAF-FUN)

3.3.286* Vertical Opening. An opening through a floor or roof. (SAF-FIR)

3.3.287 Vomitory. An entrance to a means of egress from an assembly seating area that pierces the seating rows. (SAF-AXM)

3.3.288 Wall.

3.3.288.1 ***Fire Barrier Wall.*** A wall, other than a fire wall, that has a fire resistance rating. (SAF-FIR)

3.3.288.2 ***Proscenium Wall.*** The wall that separates the stage from the auditorium or house. (SAF-AXM)

3.3.289* Wall or Ceiling Covering. A textile-, paper-, or polymeric-based product designed to be attached to a wall or ceiling surface for decorative or acoustical purposes. (SAF-INT)

3.3.290 Water-Surrounded Structure. See 3.3.272.12.

3.3.291 Weathered-Membrane Material. See 3.3.171.5.

3.3.292 Yard. An open, unoccupied space other than a court, unobstructed from the finished ground level to the sky on the lot on which a building is situated. (SAF-MEA)

Chapter 4 General

4.1* Goals.

4.1.1* Fire. A goal of this *Code* is to provide an environment for the occupants that is reasonably safe from fire by the following means:

(1)*Protection of occupants not intimate with the initial fire development
(2) Improvement of the survivability of occupants intimate with the initial fire development

4.1.2* Comparable Emergencies. An additional goal is to provide life safety during emergencies that can be mitigated using methods comparable to those used in case of fire.

4.1.3* Crowd Movement. An additional goal is to provide for reasonably safe emergency crowd movement and, where required, reasonably safe nonemergency crowd movement.

4.2 Objectives.

4.2.1 Occupant Protection. A structure shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

4.2.2 Structural Integrity. Structural integrity shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development.

4.2.3 Systems Effectiveness. Systems utilized to achieve the goals of Section 4.1 shall be effective in mitigating the hazard or condition for which they are being used, shall be reliable, shall be maintained to the level at which they were designed to operate, and shall remain operational.

4.3* Assumptions.

4.3.1* General. The protection methods of this *Code* are based on the hazards associated with fire and other events that have comparable impact on a building and its occupants.

4.3.2 Single Fire Source. The fire protection methods of this *Code* assume a single fire source.

4.4 Life Safety Compliance Options.

4.4.1 Options. Life safety meeting the goals and objectives of Sections 4.1 and 4.2 shall be provided in accordance with either of the following:

(1) Prescriptive-based provisions per 4.4.2
(2) Performance-based provisions per 4.4.3

4.4.2 Prescriptive-Based Option.

4.4.2.1 A prescriptive-based life safety design shall be in accordance with Chapters 1 through 4, Chapters 6 through 11, Chapter 43, and the applicable occupancy chapter, Chapters 12 through 42.

4.4.2.2 Prescriptive-based designs meeting the requirements of Chapters 1 through 3, Sections 4.5 through 4.8, and Chapters 6 through 43 of this *Code* shall be deemed to satisfy the provisions of Sections 4.1 and 4.2.

4.4.2.3 Where a requirement of this *Code* conflicts with another requirement of this *Code*, the following shall apply:

(1)*Where a specific requirement contained in Chapters 11 through 43 conflicts with a general requirement contained in Chapters 1 through 4 and Chapters 6 through 10, the requirement of Chapters 11 through 43 shall govern.
(2)*Where a requirement contained in Chapters 1 through 4 and Chapters 6 through 10 conflicts with another requirement contained in Chapters 1 through 4 and Chapters 6 through 10, the more specific requirement shall govern.
(3)*Where a requirement contained in Chapters 11 through 43 conflicts with another requirement contained in Chapters 11 through 43, the more specific requirement shall govern.

4.4.3 Performance-Based Option. A performance-based life safety design shall be in accordance with Chapters 1 through 5.

4.5 Fundamental Requirements.

4.5.1 Multiple Safeguards. The design of every building or structure intended for human occupancy shall be such that reliance for safety to life does not depend solely on any single safeguard. An additional safeguard(s) shall be provided for life safety in case any single safeguard is ineffective due to inappropriate human actions or system failure.

4.5.2 Appropriateness of Safeguards. Every building or structure shall be provided with means of egress and other fire and life safety safeguards of the kinds, numbers, locations, and capacities appropriate to the individual building or structure, with due regard to the following:

(1) Character of the occupancy, including fire load
(2) Capabilities of the occupants
(3) Number of persons exposed
(4) Fire protection available
(5) Capabilities of response personnel
(6) Height and construction type of the building or structure
(7) Other factors necessary to provide occupants with a reasonable degree of safety

4.5.3 Means of Egress.

4.5.3.1 Number of Means of Egress. Two means of egress, as a minimum, shall be provided in every building or structure, section, and area where size, occupancy, and arrangement endanger occupants attempting to use a single means of egress that is blocked by fire or smoke. The two means of egress shall be arranged to minimize the possibility that both might be rendered impassable by the same emergency condition.

4.5.3.2 Unobstructed Egress. In every occupied building or structure, means of egress from all parts of the building shall be maintained free and unobstructed. Means of egress shall be accessible to the extent necessary to ensure reasonable safety for occupants having impaired mobility.

4.5.3.3 Awareness of Egress System. Every exit shall be clearly visible, or the route to reach every exit shall be conspicuously indicated. Each means of egress, in its entirety, shall be arranged or marked so that the way to a place of safety is indicated in a clear manner.

4.5.3.4 Lighting. Where artificial illumination is needed in a building or structure, egress facilities shall be included in the lighting design.

4.5.4* Occupant Notification. In every building or structure of such size, arrangement, or occupancy that a fire itself might not provide adequate occupant warning, fire alarm systems shall be provided where necessary to warn occupants of the existence of fire.

4.5.5* Situation Awareness. Systems used to achieve the goals of Section 4.1 shall be effective in facilitating and enhancing situation awareness, as appropriate, by building management, other occupants and emergency responders of the functionality or state of critical building systems, the conditions that might warrant emergency response, and the appropriate nature and timing of such responses.

4.5.6 Vertical Openings. Every vertical opening between the floors of a building shall be suitably enclosed or protected, as necessary, to afford reasonable safety to occupants while using the means of egress and to prevent the spread of fire, smoke, or fumes through vertical openings from floor to floor before occupants have entered exits.

4.5.7 System Design/Installation. Any fire protection system, building service equipment, feature of protection, or safeguard provided to achieve the goals of this *Code* shall be designed, installed, and approved in accordance with applicable NFPA standards.

4.5.8 Maintenance. Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, or any other feature is required for compliance with the provisions of this *Code*, such device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be maintained, unless the *Code* exempts such maintenance.

4.6 General Requirements.

4.6.1 Authority Having Jurisdiction.

4.6.1.1 The authority having jurisdiction shall determine whether the provisions of this *Code* are met.

4.6.1.2 Any requirements that are essential for the safety of building occupants and that are not specifically provided for by this *Code* shall be determined by the authority having jurisdiction.

4.6.1.3 Where it is evident that a reasonable degree of safety is provided, any requirement shall be permitted to be modified if, in the judgment of the authority having jurisdiction, its application would be hazardous under normal occupancy conditions.

4.6.1.4 Technical Assistance.

4.6.1.4.1 The authority having jurisdiction shall be permitted to require a review by an approved independent third party with expertise in the matter to be reviewed at the submitter's expense. [**1:**1.15.1]

4.6.1.4.2 The independent reviewer shall provide an evaluation and recommend necessary changes of the proposed design, operation, process, or new technology to the authority having jurisdiction. [**1:**1.15.2]

4.6.1.4.3 The authority having jurisdiction shall be authorized to require design submittals to bear the stamp of a registered design professional. [**1:**1.15.3]

4.6.2 Previously Approved Features. Where another provision of this *Code* exempts a previously approved feature from a requirement, the exemption shall be permitted, even where the following conditions exist:

(1) The area is being modernized, renovated, or otherwise altered.
(2) A change of occupancy has occurred, provided that the feature's continued use is approved by the authority having jurisdiction.

4.6.3 Stories in Height. Unless otherwise specified in another provision of this *Code*, the stories in height of a building shall be determined as follows:

(1) The stories in height shall be counted starting with the level of exit discharge and ending with the highest occupiable story containing the occupancy considered.
(2) Stories below the level of exit discharge shall not be counted as stories.
(3) Interstitial spaces used solely for building or process systems directly related to the level above or below shall not be considered a separate story.
(4) A mezzanine shall not be counted as a story for the purpose of determining the allowable stories in height.
(5) For purposes of application of the requirements for occupancies other than assembly, health care, detention and correctional, and ambulatory health care, where a maximum one-story abovegrade parking structure, enclosed, open, or a combination thereof, of Type I or Type II (222) construction or open Type IV construction, with grade entrance, is provided under a building, the number of stories shall be permitted to be measured from the floor above such a parking area.

4.6.4 Historic Buildings.

4.6.4.1 Rehabilitation projects in historic buildings shall comply with Chapter 43.

4.6.4.2* The provisions of this *Code* shall be permitted to be modified by the authority having jurisdiction for buildings or structures identified and classified as historic buildings or structures where it is evident that a reasonable degree of safety is provided.

4.6.5* Modification of Requirements for Existing Buildings. Where it is evident that a reasonable degree of safety is provided, the requirements for existing buildings shall be permitted to be modified if their application would be impractical in the judgment of the authority having jurisdiction.

4.6.6 Time Allowed for Compliance. A limited but reasonable time, commensurate with the magnitude of expenditure, disruption of services, and degree of hazard, shall be allowed for compliance with any part of this *Code* for existing buildings.

4.6.7 Building Rehabilitation.

4.6.7.1 Rehabilitation work on existing buildings shall be classified as one of the following work categories in accordance with 43.2.2.1:

(1) Repair
(2) Renovation
(3) Modification
(4) Reconstruction
(5) Change of use or occupancy classification
(6) Addition

4.6.7.2 Rehabilitation work on existing buildings shall comply with Chapter 43.

4.6.7.3 Except where another provision of this *Code* exempts a previously approved feature from a requirement, the resulting feature shall be not less than that required for existing buildings.

4.6.7.4* Existing life safety features that exceed the requirements for new buildings shall be permitted to be decreased to those required for new buildings.

4.6.7.5* Existing life safety features that do not meet the requirements for new buildings, but that exceed the requirements for existing buildings, shall not be further diminished.

4.6.8 Provisions in Excess of *Code* Requirements. Nothing in this *Code* shall be construed to prohibit a better building construction type, an additional means of egress, or an otherwise safer condition than that specified by the minimum requirements of this *Code*.

4.6.9 Conditions for Occupancy.

4.6.9.1 No new construction or existing building shall be occupied in whole or in part in violation of the provisions of this *Code*, unless the following conditions exist:

(1) A plan of correction has been approved.
(2) The occupancy classification remains the same.
(3) No serious life safety hazard exists as judged by the authority having jurisdiction.

4.6.9.2 Where compliance with this *Code* is effected by means of a performance-based design, the owner shall annually certify compliance with the conditions and limitations of the design by submitting a warrant of fitness acceptable to the authority having jurisdiction. The warrant of fitness shall attest that the building features, systems, and use have been inspected and confirmed to remain consistent with design specifications outlined in the documentation required by Section 5.8 and that such features, systems, and use continue to satisfy the goals and objectives specified in Sections 4.1 and 4.2. *(See Chapter 5.)*

4.6.10 Construction, Repair, and Improvement Operations.

4.6.10.1* Buildings, or portions of buildings, shall be permitted to be occupied during construction, repair, alterations, or additions only where required means of egress and required fire protection features are in place and continuously maintained for the portion occupied or where alternative life safety measures acceptable to the authority having jurisdiction are in place.

4.6.10.2* In buildings under construction, adequate escape facilities shall be maintained at all times for the use of construction workers. Escape facilities shall consist of doors, walkways, stairs, ramps, fire escapes, ladders, or other approved means or devices arranged in accordance with the general principles of the *Code* insofar as they can reasonably be applied to buildings under construction.

4.6.10.3 Flammable or explosive substances or equipment for repairs or alterations shall be permitted in a building while the building is occupied if the condition of use and safeguards provided do not create any additional danger or impediment to egress beyond the normally permissible conditions in the building.

4.6.11 Change of Use or Occupancy Classification. In any building or structure, whether or not a physical alteration is needed, a change from one use or occupancy classification to another shall comply with 4.6.7.

4.6.12 Maintenance, Inspection, and Testing.

4.6.12.1 Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, fire-resistive construction, or any other feature is required for compliance with the provisions of this *Code*, such device, equipment, system, condition, arrangement, level of protection, fire-resistive construction, or other feature shall thereafter be continuously maintained. Maintenance shall be provided in accordance with applicable NFPA requirements or requirements developed as part of a performance-based design, or as directed by the authority having jurisdiction.

4.6.12.2 No existing life safety feature shall be removed or reduced where such feature is a requirement for new construction.

4.6.12.3* Existing life safety features obvious to the public, if not required by the *Code*, shall be either maintained or removed.

4.6.12.4 Any device, equipment, system, condition, arrangement, level of protection, fire-resistive construction, or any other feature requiring periodic testing, inspection, or operation to ensure its maintenance shall be tested, inspected, or operated as specified elsewhere in this *Code* or as directed by the authority having jurisdiction.

4.6.12.5 Maintenance, inspection, and testing shall be performed under the supervision of a responsible person who shall ensure that testing, inspection, and maintenance are made at specified intervals in accordance with applicable NFPA standards or as directed by the authority having jurisdiction.

4.6.13* Noncombustible Material.

4.6.13.1 A material that complies with any of the following shall be considered a noncombustible material:

(1)*A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat
(2) A material that is reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*
(3) A material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C*

4.6.13.2 Where the term *limited-combustible* is used in this *Code*, it shall also include the term *noncombustible*.

4.6.14* Limited-Combustible Material. A material shall be considered a limited-combustible material where all the conditions of 4.6.14.1 and 4.6.14.2, and the conditions of either 4.6.14.3 or 4.6.14.4, are met.

4.6.14.1 The material shall not comply with the requirements for noncombustible material in accordance with 4.6.13.

4.6.14.2 The material, in the form in which it is used, shall exhibit a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg) where tested in accordance with NFPA 259, *Standard Test Method for Potential Heat of Building Materials*.

4.6.14.3 The material shall have the structural base of a noncombustible material with a surfacing not exceeding a thickness of ⅛ in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.

4.6.14.4 The material shall be composed of materials that, in the form and thickness used, neither exhibit a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* and shall be of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E 84 or ANSI/UL 723.

4.6.14.5 Where the term *limited-combustible* is used in this *Code*, it shall also include the term *noncombustible*.

4.6.15 Grade Plane. The grade plane shall be established by calculating the average of the finished ground level adjoining the building at all exterior walls. Where the finished ground level slopes down from the exterior walls, the grade plane shall be established by the lowest points within the area between the building and the lot line or, where the lot line is more than 6 ft (1.8 m) from the building, between the building and a point 6 ft (1.8 m) from the building.

4.7* Fire Drills.

4.7.1 Where Required. Emergency egress and relocation drills conforming to the provisions of this *Code* shall be conducted as specified by the provisions of Chapters 11 through 43, or by appropriate action of the authority having jurisdiction. Drills shall be designed in cooperation with the local authorities.

4.7.2* Drill Frequency. Emergency egress and relocation drills, where required by Chapters 11 through 43 or the authority having jurisdiction, shall be held with sufficient frequency to familiarize occupants with the drill procedure and to establish conduct of the drill as a matter of routine. Drills shall include suitable procedures to ensure that all persons subject to the drill participate.

4.7.3 Orderly Evacuation. When conducting drills, emphasis shall be placed on orderly evacuation rather than on speed.

4.7.4* Simulated Conditions. Drills shall be held at expected and unexpected times and under varying conditions to simulate the unusual conditions that can occur in an actual emergency.

4.7.5 Relocation Area. Drill participants shall relocate to a predetermined location and remain at such location until a recall or dismissal signal is given.

4.7.6* A written record of each drill shall be completed by the person responsible for conducting the drill and maintained in an approved manner.

4.8 Emergency Action Plan.

4.8.1 Where Required. Emergency action plans shall be provided as follows:

(1) Where required by the provisions of Chapters 11 through 42
(2) Where required by action of the authority having jurisdiction

4.8.2 Plan Requirements.

4.8.2.1* Emergency action plans shall include the following:

(1) Procedures for reporting of emergencies
(2) Occupant and staff response to emergencies
(3)*Evacuation, relocation, and shelter-in-place procedures appropriate to the building, its occupancy, emergencies, and hazards
(4) Appropriateness of the use of elevators
(5) Design and conduct of fire drills
(6) Type and coverage of building fire protection systems
(7) Other items required by the authority having jurisdiction

4.8.2.2 Required emergency action plans shall be submitted to the authority having jurisdiction for review.

4.8.2.3* Emergency action plans shall be reviewed and updated as required by the authority having jurisdiction.

Chapter 5 Performance-Based Option

5.1 General Requirements.

5.1.1* Application. The requirements of this chapter shall apply to life safety systems designed to the performance-based option permitted by 4.4.1 and 4.4.3.

5.1.2 Goals and Objectives. The performance-based design shall meet the goals and objectives of this *Code* in accordance with Sections 4.1 and 4.2.

5.1.3 Qualifications. The performance-based design shall be prepared by a registered design professional.

5.1.4* Independent Review. The authority having jurisdiction shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the authority having jurisdiction.

5.1.5 Sources of Data. Data sources shall be identified and documented for each input data requirement that must be met using a source other than a design fire scenario, an assumption, or a building design specification. The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

5.1.6* Final Determination. The authority having jurisdiction shall make the final determination as to whether the performance objectives have been met.

5.1.7* Maintenance of Design Features. The design features required for the building to continue to meet the performance goals and objectives of this *Code* shall be maintained for the life of the building. Such performance goals and objectives shall include complying with all documented assumptions and design specifications. Any variations shall require the approval of the authority having jurisdiction prior to the actual change. *(See also 4.6.9.2.)*

5.1.8 Definitions.

5.1.8.1 General. For definitions, see Chapter 3, Definitions.

5.1.8.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Alternative Calculation Procedure.** See 3.3.15.
(2) **Data Conversion.** See 3.3.52.
(3) **Design Fire Scenario.** See 3.3.105.1.
(4) **Design Specification.** See 3.3.262.1.
(5) **Design Team.** See 3.3.57.
(6) **Exposure Fire.** See 3.3.88.
(7) **Fire Model.** See 3.3.101.
(8) **Fire Scenario.** See 3.3.105.
(9) **Fuel Load.** See 3.3.164.1.
(10) **Incapacitation.** See 3.3.148.
(11) **Input Data Specification.** See 3.3.262.2.
(12) **Occupant Characteristics.** See 3.3.191.
(13) **Performance Criteria.** See 3.3.206.
(14) **Proposed Design.** See 3.3.218.
(15) **Safe Location.** See 3.3.235.
(16) **Safety Factor.** See 3.3.236.
(17) **Safety Margin.** See 3.3.237.
(18) **Sensitivity Analysis.** See 3.3.17.1.
(19) **Stakeholder.** See 3.3.266.
(20) **Uncertainty Analysis.** See 3.3.17.2.
(21) **Verification Method.** See 3.3.285.

5.2 Performance Criteria.

5.2.1 General. A design shall meet the objectives specified in Section 4.2 if, for each design fire scenario, assumption, and design specification, the performance criterion in 5.2.2 is met.

5.2.2* Performance Criterion. Any occupant who is not intimate with ignition shall not be exposed to instantaneous or cumulative untenable conditions.

5.3 Retained Prescriptive Requirements.

5.3.1* Systems and Features. All fire protection systems and features of the building shall comply with applicable NFPA standards for those systems and features.

5.3.2 Means of Egress. The design shall comply with the following requirements in addition to the performance criteria of Section 5.2 and the methods of Sections 5.4 through 5.8:

(1) Changes in level in means of egress — 7.1.7
(2) Guards — 7.1.8
(3) Doors — 7.2.1
(4) Stairs — 7.2.2, excluding the provisions of 7.2.2.5.1, 7.2.2.5.2, 7.2.2.6.2, 7.2.2.6.3, and 7.2.2.6.4
(5) Ramps — 7.2.5, excluding the provisions of 7.2.5.4.1, 7.2.5.5, and 7.2.5.7.1
(6) Fire escape ladders — 7.2.9
(7) Alternating tread devices — 7.2.11
(8) Capacity of means of egress — Section 7.3, excluding the provisions of 7.3.3 and 7.3.4
(9) Impediments to egress — 7.5.2

(10) Illumination of means of egress — Section 7.8
(11) Emergency lighting — Section 7.9
(12) Marking of means of egress — Section 7.10

5.3.3 Equivalency. Equivalent designs for the features covered in the retained prescriptive requirements mandated by 5.3.2 shall be addressed in accordance with the equivalency provisions of Section 1.4.

5.4 Design Specifications and Other Conditions.

5.4.1* Clear Statement. Design specifications and other conditions used in the performance-based design shall be clearly stated and shown to be realistic and sustainable.

5.4.2 Assumptions and Design Specifications Data.

5.4.2.1 Each assumption and design specification used in the design shall be accurately translated into input data specifications, as appropriate for the method or model.

5.4.2.2 Any assumption and design specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.4.2.3 Any assumption and design specifications modified in the input data specifications, because of limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.4.3 Building Characteristics. Characteristics of the building or its contents, equipment, or operations that are not inherent in the design specifications, but that affect occupant behavior or the rate of hazard development, shall be explicitly identified.

5.4.4* Operational Status and Effectiveness of Building Features and Systems. The performance of fire protection systems, building features, and emergency procedures shall reflect the documented performance and reliability of the components of those systems or features, unless design specifications are incorporated to modify the expected performance.

5.4.5 Occupant Characteristics.

5.4.5.1* General. The selection of occupant characteristics to be used in the design calculations shall be approved by the authority having jurisdiction and shall provide an accurate reflection of the expected population of building users. Occupant characteristics shall represent the normal occupant profile, unless design specifications are used to modify the expected occupant features. Occupant characteristics shall not vary across fire scenarios, except as authorized by the authority having jurisdiction.

5.4.5.2* Response Characteristics. The basic response characteristics of sensibility, reactivity, mobility, and susceptibility shall be evaluated. Such evaluation shall include the expected distribution of characteristics of a population appropriate to the use of the building. The source of data for these characteristics shall be documented.

5.4.5.3 Location. It shall be assumed that, in every normally occupied room or area, at least one person shall be located at the most remote point from the exits.

5.4.5.4* Number of Occupants. The design shall be based on the maximum number of people that every occupied room or area is expected to contain. Where the success or failure of the design is contingent on the number of occupants not exceeding a specified maximum, operational controls shall be used to ensure that the maximum number of occupants is not exceeded.

5.4.5.5* Staff Assistance. The inclusion of trained employees as part of the fire safety system shall be identified and documented.

5.4.6 Emergency Response Personnel. Design characteristics or other conditions related to the availability, speed of response, effectiveness, roles, and other characteristics of emergency response personnel shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.7* Post-Construction Conditions. Design characteristics or other conditions related to activities during the life of a building that affect the ability of the building to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.8 Off-Site Conditions. Design characteristics or other conditions related to resources or conditions outside the property being designed that affect the ability of the building to meet the stated goals and objectives shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.4.9* Consistency of Assumptions. The design shall not include mutually inconsistent assumptions, specifications, or statements of conditions.

5.4.10* Special Provisions. Additional provisions that are not covered by the design specifications, conditions, estimations, and assumptions provided in Section 5.4, but that are required for the design to comply with the performance objectives, shall be documented.

5.5* Design Fire Scenarios.

5.5.1 Approval of Parameters. The authority having jurisdiction shall approve the parameters involved in design fire scenarios. The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design fire scenario. *(See 5.5.3.)*

5.5.2* Evaluation. Design fire scenarios shall be evaluated using a method acceptable to the authority having jurisdiction and appropriate for the conditions. Each design fire scenario shall be as challenging as any that could occur in the building, but shall be realistic, with respect to at least one of the following scenario specifications:

(1) Initial fire location
(2) Early rate of growth in fire severity
(3) Smoke generation

5.5.3* Required Design Fire Scenarios. Design fire scenarios shall comply with the following:

(1) Scenarios selected as design fire scenarios shall include, but shall not be limited to, those specified in 5.5.3.1 through 5.5.3.8.
(2) Design fire scenarios demonstrated by the design team to the satisfaction of the authority having jurisdiction as inappropriate for the building use and conditions shall not be required to be evaluated fully.

5.5.3.1* Design Fire Scenario 1. Design Fire Scenario 1 shall be described as follows:

(1) It is an occupancy-specific fire representative of a typical fire for the occupancy.
(2) It explicitly accounts for the following:
    (a) Occupant activities

(b) Number and location of occupants
(c) Room size
(d) Contents and furnishings
(e) Fuel properties and ignition sources
(f) Ventilation conditions
(g) Identification of the first item ignited and its location

5.5.3.2* Design Fire Scenario 2. Design Fire Scenario 2 shall be described as follows:

(1) It is an ultrafast-developing fire, in the primary means of egress, with interior doors open at the start of the fire.
(2) It addresses the concern regarding a reduction in the number of available means of egress.

5.5.3.3* Design Fire Scenario 3. Design Fire Scenario 3 shall be described as follows:

(1) It is a fire that starts in a normally unoccupied room, potentially endangering a large number of occupants in a large room or other area.
(2) It addresses the concern regarding a fire starting in a normally unoccupied room and migrating into the space that potentially holds the greatest number of occupants in the building.

5.5.3.4* Design Fire Scenario 4. Design Fire Scenario 4 shall be described as follows:

(1) It is a fire that originates in a concealed wall or ceiling space adjacent to a large occupied room.
(2) It addresses the concern regarding a fire originating in a concealed space that does not have either a detection system or a suppression system and then spreading into the room within the building that potentially holds the greatest number of occupants.

5.5.3.5* Design Fire Scenario 5. Design Fire Scenario 5 shall be described as follows:

(1) It is a slowly developing fire, shielded from fire protection systems, in close proximity to a high occupancy area.
(2) It addresses the concern regarding a relatively small ignition source causing a significant fire.

5.5.3.6* Design Fire Scenario 6. Design Fire Scenario 6 shall be described as follows:

(1) It is the most severe fire resulting from the largest possible fuel load characteristic of the normal operation of the building.
(2) It addresses the concern regarding a rapidly developing fire with occupants present.

5.5.3.7* Design Fire Scenario 7. Design Fire Scenario 7 shall be described as follows:

(1) It is an outside exposure fire.
(2) It addresses the concern regarding a fire starting at a location remote from the area of concern and either spreading into the area, blocking escape from the area, or developing untenable conditions within the area.

5.5.3.8* Design Fire Scenario 8. Design Fire Scenario 8 shall be described as follows:

(1) It is a fire originating in ordinary combustibles in a room or area with each passive or active fire protection system independently rendered ineffective.
(2) It addresses concerns regarding the unreliability or unavailability of each fire protection system or fire protection feature, considered individually.
(3)*It is not required to be applied to fire protection systems for which both the level of reliability and the design performance in the absence of the system are acceptable to the authority having jurisdiction.

5.5.4 Design Fire Scenarios Data.

5.5.4.1 Each design fire scenario used in the performance-based design proposal shall be translated into input data specifications, as appropriate for the calculation method or model.

5.5.4.2 Any design fire scenario specifications that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.5.4.3 Any design fire scenario specifications modified in input data specifications, because of limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.6* Evaluation of Proposed Designs.

5.6.1 General. A proposed design's performance shall be assessed relative to each performance objective in Section 4.2 and each applicable scenario in 5.5.3, with the assessment conducted through the use of appropriate calculation methods. The authority having jurisdiction shall approve the choice of assessment methods.

5.6.2 Use. The design professional shall use the assessment methods to demonstrate that the proposed design will achieve the goals and objectives, as measured by the performance criteria in light of the safety margins and uncertainty analysis, for each scenario, given the assumptions.

5.6.3 Input Data.

5.6.3.1 Data. Input data for computer fire models shall be obtained in accordance with ASTM E 1591, *Standard Guide for Obtaining Data for Deterministic Fire Models.* Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

5.6.3.2 Data Requirements. A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

5.6.3.3* Uncertainty and Conservatism of Data. Uncertainty in input data shall be analyzed and, as determined appropriate by the authority having jurisdiction, addressed through the use of conservative values.

5.6.4* Output Data. The assessment methods used shall accurately and appropriately produce the required output data from input data, based on the design specifications, assumptions, and scenarios.

5.6.5 Validity. Evidence shall be provided to confirm that the assessment methods are valid and appropriate for the proposed building, use, and conditions.

5.7* Safety Factors. Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

5.8 Documentation Requirements.

5.8.1* General. All aspects of the design, including those described in 5.8.2 through 5.8.14, shall be documented. The format and content of the documentation shall be acceptable to the authority having jurisdiction.

5.8.2* Technical References and Resources. The authority having jurisdiction shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods. The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

5.8.3 Building Design Specifications. All details of the proposed building design that affect the ability of the building to meet the stated goals and objectives shall be documented.

5.8.4 Performance Criteria. Performance criteria, with sources, shall be documented.

5.8.5 Occupant Characteristics. Assumptions about occupant characteristics shall be documented.

5.8.6 Design Fire Scenarios. Descriptions of design fire scenarios shall be documented.

5.8.7 Input Data. Input data to models and assessment methods, including sensitivity analyses, shall be documented.

5.8.8 Output Data. Output data from models and assessment methods, including sensitivity analyses, shall be documented.

5.8.9 Safety Factors. The safety factors utilized shall be documented.

5.8.10 Prescriptive Requirements. Retained prescriptive requirements shall be documented.

5.8.11* Modeling Features.

5.8.11.1 Assumptions made by the model user, and descriptions of models and methods used, including known limitations, shall be documented.

5.8.11.2 Documentation shall be provided to verify that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios.

5.8.12 Evidence of Modeler Capability. The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

5.8.13 Performance Evaluation. The performance evaluation summary shall be documented.

5.8.14 Use of Performance-Based Design Option. Design proposals shall include documentation that provides anyone involved in the ownership or management of the building with notification of the following:

(1) Approval of the building as a performance-based design with certain specified design criteria and assumptions
(2) Need for required re-evaluation and reapproval in cases of remodeling, modification, renovation, change in use, or change in established assumptions

Chapter 6 Classification of Occupancy and Hazard of Contents

6.1 Classification of Occupancy.

6.1.1 General.

6.1.1.1 Occupancy Classification. The occupancy of a building or structure, or portion of a building or structure, shall be classified in accordance with 6.1.2 through 6.1.13. Occupancy classification shall be subject to the ruling of the authority having jurisdiction where there is a question of proper classification in any individual case.

6.1.1.2 Special Structures. Occupancies in special structures shall conform to the requirements of the specific occupancy chapter, Chapters 12 through 43, except as modified by Chapter 11.

6.1.2 Assembly. For requirements, see Chapters 12 and 13.

6.1.2.1* Definition — Assembly Occupancy. An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load.

6.1.2.2 Other. (Reserved)

6.1.3 Educational. For requirements, see Chapters 14 and 15.

6.1.3.1* Definition — Educational Occupancy. An occupancy used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week.

6.1.3.2 Other Occupancies. Other occupancies associated with educational institutions shall be in accordance with the appropriate parts of this *Code*.

6.1.3.3 Incidental Instruction. In cases where instruction is incidental to some other occupancy, the section of this *Code* governing such other occupancy shall apply.

6.1.4 Day Care. For requirements, see Chapters 16 and 17.

6.1.4.1* Definition — Day-Care Occupancy. An occupancy in which four or more clients receive care, maintenance, and supervision, by other than their relatives or legal guardians, for less than 24 hours per day.

6.1.4.2 Other. (Reserved)

6.1.5 Health Care. For requirements, see Chapters 18 and 19.

6.1.5.1* Definition — Health Care Occupancy. An occupancy used to provide medical or other treatment or care simultaneously to four or more patients on an inpatient basis, where such patients are mostly incapable of self-preservation due to age, physical or mental disability, or because of security measures not under the occupants' control.

6.1.5.2 Other. (Reserved)

6.1.6 Ambulatory Health Care. For requirements, see Chapters 20 and 21.

6.1.6.1* Definition — Ambulatory Health Care Occupancy. An occupancy used to provide services or treatment simultaneously to four or more patients that provides, on an outpatient basis, one or more of the following:

(1) Treatment for patients that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others

(2) Anesthesia that renders the patients incapable of taking action for self-preservation under emergency conditions without the assistance of others
(3) Emergency or urgent care for patients who, due to the nature of their injury or illness, are incapable of taking action for self-preservation under emergency conditions without the assistance of others

6.1.6.2 Other. (Reserved)

6.1.7 Detention and Correctional. For requirements, see Chapters 22 and 23.

6.1.7.1* Definition — Detention and Correctional Occupancy. An occupancy used to house one or more persons under varied degrees of restraint or security where such occupants are mostly incapable of self-preservation because of security measures not under the occupants' control.

6.1.7.2* Nonresidential Uses. Within detention and correctional facilities, uses other than residential housing shall be in accordance with the appropriate chapter of the *Code. (See 22.1.3.3 and 23.1.3.3.)*

6.1.8 Residential. For requirements, see Chapters 24 through 31.

6.1.8.1 Definition — Residential Occupancy. An occupancy that provides sleeping accommodations for purposes other than health care or detention and correctional.

6.1.8.1.1* Definition — One- and Two-Family Dwelling Unit. A building that contains not more than two dwelling units with independent cooking and bathroom facilities.

6.1.8.1.2 Definition — Lodging or Rooming House. A building or portion thereof that does not qualify as a one- or two-family dwelling, that provides sleeping accommodations for a total of 16 or fewer people on a transient or permanent basis, without personal care services, with or without meals, but without separate cooking facilities for individual occupants.

6.1.8.1.3* Definition — Hotel. A building or groups of buildings under the same management in which there are sleeping accommodations for more than 16 persons and primarily used by transients for lodging with or without meals.

6.1.8.1.4* Definition — Dormitory. A building or a space in a building in which group sleeping accommodations are provided for more than 16 persons who are not members of the same family in one room, or a series of closely associated rooms, under joint occupancy and single management, with or without meals, but without individual cooking facilities.

6.1.8.1.5 Definition — Apartment Building. A building or portion thereof containing three or more dwelling units with independent cooking and bathroom facilities.

6.1.8.2 Other. (Reserved)

6.1.9 Residential Board and Care. For requirements, see Chapters 32 and 33.

6.1.9.1* Definition — Residential Board and Care Occupancy. An occupancy used for lodging and boarding of four or more residents, not related by blood or marriage to the owners or operators, for the purpose of providing personal care services.

6.1.9.2 Other. (Reserved)

6.1.10 Mercantile. For requirements, see Chapters 36 and 37.

6.1.10.1* Definition — Mercantile Occupancy. An occupancy used for the display and sale of merchandise.

6.1.10.2 Other. (Reserved)

6.1.11 Business. For requirements, see Chapters 38 and 39.

6.1.11.1* Definition — Business Occupancy. An occupancy used for the transaction of business other than mercantile.

6.1.11.2 Other. (Reserved)

6.1.12 Industrial. For requirements, see Chapter 40.

6.1.12.1* Definition — Industrial Occupancy. An occupancy in which products are manufactured or in which processing, assembling, mixing, packaging, finishing, decorating, or repair operations are conducted.

6.1.12.2 Other. (Reserved)

6.1.13 Storage. For requirements, see Chapter 42.

6.1.13.1* Definition — Storage Occupancy. An occupancy used primarily for the storage or sheltering of goods, merchandise, products, or vehicles.

6.1.13.2 Other. (Reserved)

6.1.14 Multiple Occupancies.

6.1.14.1 General.

6.1.14.1.1 Multiple occupancies shall comply with the requirements of 6.1.14.1 and one of the following:

(1) Mixed occupancies — 6.1.14.3
(2) Separated occupancies — 6.1.14.4

6.1.14.1.2 Where exit access from an occupancy traverses another occupancy, the multiple occupancy shall be treated as a mixed occupancy.

6.1.14.1.3* Where incidental to another occupancy, areas used as follows shall be permitted to be considered part of the predominant occupancy and shall be subject to the provisions of the *Code* that apply to the predominant occupancy:

(1) Mercantile, business, industrial, or storage use
(2)*Nonresidential use with an occupant load fewer than that established by Section 6.1 for the occupancy threshold

6.1.14.2 Definitions.

6.1.14.2.1 Multiple Occupancy. A building or structure in which two or more classes of occupancy exist.

6.1.14.2.2 Mixed Occupancy. A multiple occupancy where the occupancies are intermingled.

6.1.14.2.3 Separated Occupancy. A multiple occupancy where the occupancies are separated by fire resistance–rated assemblies.

6.1.14.3 Mixed Occupancies.

6.1.14.3.1 Each portion of the building shall be classified as to its use in accordance with Section 6.1.

6.1.14.3.2* The building shall comply with the most restrictive requirements of the occupancies involved, unless separate safeguards are approved.

6.1.14.4 Separated Occupancies. *(See also 6.1.14.1.2.)*

6.1.14.4.1 Where separated occupancies are provided, each part of the building comprising a distinct occupancy, as described in this chapter, shall be completely separated from other occupancies by fire-resistive assemblies, as specified in 6.1.14.4.2, 6.1.14.4.3, Table 6.1.14.4.1(a), and Table 6.1.14.4.1(b), unless separation is provided by approved existing separations or as otherwise permitted by 6.1.14.4.6.

Table 6.1.14.4.1(a) Required Separation of Occupancies (hours)†, Part 1

Occupancy	Assembly ≤300	Assembly >300 to ≤1000	Assembly >1000	Educational	Day-Care >12 Clients	Day-Care Homes	Health Care	Ambulatory Health Care	Detention & Correctional	One- & Two-Family Dwellings	Lodging or Rooming Houses	Hotels & Dormitories
Assembly ≤ 300	—	0	0	2	2	1	2‡	2	2‡	2	2	2
Assembly >300 to ≤1000	0	—	0	2	2	2	2‡	2	2‡	2	2	2
Assembly >1000	0	0	—	2	2	2	2‡	2	2‡	2	2	2
Educational	2	2	2	—	2	2	2‡	2	2‡	2	2	2
Day-Care >12 Clients	2	2	2	2	—	1	2‡	2	2‡	2	2	2
Day-Care Homes	1	2	2	2	1	—	2‡	2	2‡	2	2	2
Health Care	2‡	2‡	2‡	2‡	2‡	2‡	—	2‡	2‡	2‡	2‡	2‡
Ambulatory Health Care	2	2	2	2	2	2	2‡	—	2‡	2	2	2
Detention & Correctional	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	—	2‡	2‡	2‡
One- & Two-Family Dwellings	2	2	2	2	2	2	2‡	2	2‡	—	1	1
Lodging or Rooming Houses	2	2	2	2	2	2	2‡	2	2‡	1	—	1
Hotels & Dormitories	2	2	2	2	2	2	2‡	2	2‡	1	1	—
Apartment Buildings	2	2	2	2	2	2	2‡	2	2‡	1	1	1
Board & Care, Small	2	2	2	2	2	2	2‡	2	2‡	1	2	2
Board & Care, Large	2	2	2	2	2	2	2‡	2	2‡	2	2	2
Mercantile	2	2	2	2	2	2	2‡	2	2‡	2	2	2
Mercantile, Mall	2	2	2	2	2	2	2‡	2	2‡	2	2	2
Mercantile, Bulk Retail	3	3	3	3	3	3	2‡	2‡	2‡	3	3	3
Business	1	2	2	2	2	2	2‡	1	2‡	2	2	2
Industrial, General Purpose	2	2	3	3	3	3	2‡	2	2‡	2	2	2
Industrial, Special-Purpose	2	2	2	3	3	3	2‡	2	2‡	2	2	2
Industrial, High Hazard	3	3	3	3	3	3	2‡	2‡	NP	3	3	3
Storage, Low & Ordinary Hazard	2	2	3	3	3	2	2‡	2	2‡	2	2	2
Storage, High Hazard	3	3	3	3	3	3	2‡	2‡	NP	3	3	3

NP: Not permitted.
†*Minimum Fire Resistance Rating.* The fire resistance rating is permitted to be reduced by 1 hour, but in no case to less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1) and supervised in accordance with 9.7.2.
‡The 1-hour reduction due to the presence of sprinklers in accordance with the single-dagger footnote is not permitted.

Table 6.1.14.4.1(b) Required Separation of Occupancies (hours)†, Part 2

Occupancy	Apartment Buildings	Board & Care, Small	Board & Care, Large	Mercantile	Mercantile, Mall	Mercantile, Bulk Retail	Business	Industrial, General Purpose	Industrial, Special-Purpose	Industrial, High Hazard	Storage, Low & Ordinary Hazard	Storage, High Hazard
Assembly ≤ 300	2	2	2	2	2	3	1	2	2	3	2	3
Assembly >300 to ≤1000	2	2	2	2	2	3	2	2	2	3	2	3
Assembly >1000	2	2	2	2	2	3	2	3	2	3	3	3
Educational	2	2	2	2	2	3	2	3	3	3	3	3
Day-Care >12 Clients	2	2	2	2	2	3	2	3	3	3	3	3
Day-Care Homes	2	2	2	2	2	3	2	3	3	3	2	3
Health Care	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡
Ambulatory Health Care	2	2	2	2	2	2‡	1	2	2	2‡	2	2‡
Detention & Correctional	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	2‡	NP	2‡	NP
One- & Two-Family Dwellings	1	1	2	2	2	3	2	2	2	3	2	3
Lodging or Rooming Houses	1	2	2	2	2	3	2	2	2	3	2	3
Hotels & Dormitories	1	2	2	2	2	3	2	2	2	3	2	3
Apartment Buildings	—	2	2	2	2	3	2	2	2	3	2	3
Board & Care, Small	2	—	1	2	2	3	2	3	3	3	3	3
Board & Care, Large	2	1	—	2	2	3	2	3	3	3	3	3
Mercantile	2	2	2	—	0	3	2	2	2	3	2	3
Mercantile, Mall	2	2	2	0	—	3	2	3	3	3	2	3
Mercantile, Bulk Retail	3	3	3	3	3	—	2	2	2	3	2	2
Business	2	2	2	2	2	2	—	2	2	2	2	2
Industrial, General Purpose	2	3	3	2	3	2	2	—	1	1	1	1
Industrial, Special-Purpose	2	3	3	2	3	2	2	1	—	1	1	1
Industrial, High Hazard	3	3	3	3	3	3	2	1	1	—	1	1
Storage, Low & Ordinary Hazard	2	3	3	2	2	2	2	1	1	1	—	1
Storage, High Hazard	3	3	3	3	3	2	2	1	1	1	1	—

NP: Not permitted.
†*Minimum Fire Resistance Rating.* The fire resistance rating is permitted to be reduced by 1 hour, but in no case to less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1) and supervised in accordance with 9.7.2.
‡The 1-hour reduction due to the presence of sprinklers in accordance with the single-dagger footnote is not permitted.

6.1.14.4.2 Occupancy separations shall be classified as 3-hour fire resistance–rated, 2-hour fire resistance–rated, or 1-hour fire resistance–rated and shall meet the requirements of Chapter 8.

6.1.14.4.3 The minimum fire resistance rating specified in Table 6.1.14.4.1(a) and Table 6.1.14.4.1(b) shall be permitted to be reduced by 1 hour, but in no case shall it be reduced to less than 1 hour, where the building is protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1) and supervised in accordance with 9.7.2, unless prohibited by the double-dagger footnote entries in the tables.

6.1.14.4.4 Occupancy separations shall be vertical, horizontal, or both or, when necessary, of such other form as required to provide complete separation between occupancy divisions in the building.

6.1.14.4.5* Each separated portion of the building shall comply with the requirements for the occupancy therein.

6.1.14.4.6 Where permitted in Chapters 11 through 43, atrium walls shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis, provided all of the following are met:

(1) The atrium is separated from adjacent areas by walls that are smoke partitions in accordance with Section 8.4.
(2) Doors in the smoke partitions required by 6.1.14.4.6(a) are equipped with positive latching hardware.
(3) The atrium meets the provisions of 8.6.7 that are applicable to new atriums.

6.2 Hazard of Contents.

6.2.1 General.

6.2.1.1 For the purpose of this *Code*, the hazard of contents shall be the relative danger of the start and spread of fire, the danger of smoke or gases generated, and the danger of explosion or other occurrence potentially endangering the lives and safety of the occupants of the building or structure.

6.2.1.2 Hazard of contents shall be classified by the registered design professional (RDP) or owner and submitted to the authority having jurisdiction for review and approval on the basis of the character of the contents and the processes or operations conducted in the building or structure.

6.2.1.3* For the purpose of this *Code*, where different degrees of hazard of contents exist in different parts of a building or structure, the most hazardous shall govern the classification, unless hazardous areas are separated or protected as specified in Section 8.7 and the applicable sections of Chapters 11 through 43.

6.2.2 Classification of Hazard of Contents.

6.2.2.1* General. The hazard of contents of any building or structure shall be classified as low, ordinary, or high in accordance with 6.2.2.2, 6.2.2.3, and 6.2.2.4.

6.2.2.2* Low Hazard Contents. Low hazard contents shall be classified as those of such low combustibility that no self-propagating fire therein can occur.

6.2.2.3* Ordinary Hazard Contents. Ordinary hazard contents shall be classified as those that are likely to burn with moderate rapidity or to give off a considerable volume of smoke.

6.2.2.4* High Hazard Contents. High hazard contents shall be classified as those that are likely to burn with extreme rapidity or from which explosions are likely. *(For means of egress requirements, see Section 7.11.)*

Chapter 7 Means of Egress

7.1 General.

7.1.1* Application. Means of egress for both new and existing buildings shall comply with this chapter. *(See also 4.5.3.)*

7.1.2 Definitions.

7.1.2.1 General. For definitions see Chapter 3 Definitions.

7.1.2.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Accessible Area of Refuge.** See 3.3.22.1.
(2) **Accessible Means of Egress.** See 3.3.172.1.
(3) **Area of Refuge.** See 3.3.22.
(4) **Common Path of Travel.** See 3.3.47.
(5) **Electroluminescent.** See 3.3.67.
(6) **Elevator Evacuation System.** See 3.3.68.
(7) **Elevator Lobby.** See 3.3.69.
(8) **Elevator Lobby Door.** See 3.3.62.1.
(9) **Exit.** See 3.3.83.
(10) **Exit Access.** See 3.3.84.
(11) **Exit Discharge.** See 3.3.85.
(12) **Externally Illuminated.** See 3.3.146.1.
(13) **Fire Exit Hardware.** See 3.3.135.1.
(14) **Horizontal Exit.** See 3.3.83.1.
(15) **Internally Illuminated.** See 3.3.146.2.
(16) **Means of Egress.** See 3.3.172.
(17) **Panic Hardware.** See 3.3.135.2.
(18) **Photoluminescent.** See 3.3.209.
(19) **Ramp.** See 3.3.221.
(20) **Self-Luminous.** See 3.3.241.
(21) **Severe Mobility Impairment.** See 3.3.246.
(22) **Smokeproof Enclosure.** See 3.3.257.

7.1.3 Separation of Means of Egress. See also Section 8.2.

7.1.3.1 Exit Access Corridors. Corridors used as exit access and serving an area having an occupant load exceeding 30 shall be separated from other parts of the building by walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to existing buildings, provided that the occupancy classification does not change.
(2) This requirement shall not apply where otherwise provided in Chapters 11 through 43.

7.1.3.2 Exits.

7.1.3.2.1 Where this *Code* requires an exit to be separated from other parts of the building, the separating construction shall meet the requirements of Section 8.2 and the following:

(1)*The separation shall have a minimum 1-hour fire resistance rating where the exit connects three or fewer stories.
(2) The separation specified in 7.1.3.2.1(1), other than an existing separation, shall be supported by construction having not less than a 1-hour fire resistance rating.
(3)*The separation shall have a minimum 2-hour fire resistance rating where the exit connects four or more stories, unless one of the following conditions exists:
   (a) In existing non-high-rise buildings, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.

(b) In existing buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, existing exit stair enclosures shall have a minimum 1-hour fire resistance rating.
(c) The minimum 1-hour enclosures in accordance with 28.2.2.1.2, 29.2.2.1.2, 30.2.2.1.2, and 31.2.2.1.2 shall be permitted as an alternative to the requirement of 7.1.3.2.1(3).

(4) Reserved.
(5) The minimum 2-hour fire resistance–rated separation required by 7.1.3.2.1(3) shall be constructed of an assembly of noncombustible or limited-combustible materials and shall be supported by construction having a minimum 2-hour fire resistance rating, unless otherwise permitted by 7.1.3.2.1(7).
(6)*Structural elements, or portions thereof, that support exit components and either penetrate into a fire resistance–rated assembly or are installed within a fire resistance–rated wall assembly shall be protected, as a minimum, to the fire resistance rating required by 7.1.3.2.1(1) or (3).
(7) In Type III, Type IV, and Type V construction, as defined in NFPA 220, *Standard on Types of Building Construction (see 8.2.1.2)*, fire retardant–treated wood enclosed in noncombustible or limited-combustible materials shall be permitted.
(8) Openings in the separation shall be protected by fire door assemblies equipped with door closers complying with 7.2.1.8.
(9)*Openings in exit enclosures shall be limited to door assemblies from normally occupied spaces and corridors and door assemblies for egress from the enclosure, unless one of the following conditions exists:

(a) Vestibules that separate normally unoccupied spaces from an exit enclosure shall be permitted, provided the vestibule is separated from adjacent spaces by corridor walls and related opening protectives as required for the occupancy involved but not less than a smoke partition in accordance with Section 8.4.
(b) In buildings of Type I or Type II construction, as defined in NFPA 220, *Standard on Types of Building Construction, (see 8.2.1.2)* fire protection–rated door assemblies to normally unoccupied building service equipment support areas as addressed in Section 7.13 shall be permitted, provided the space is separated from the exit enclosure by fire barriers as required by 7.1.3.2.1(3).
(c) Openings in exit passageways in mall buildings as provided in Chapters 36 and 37 shall be permitted.
(d) In buildings of Type I or Type II construction, as defined in NFPA 220, *Standard on Types of Building Construction, (see 8.2.1.2)* existing fire protection–rated door assemblies to interstitial spaces shall be permitted, provided that such spaces meet all of the following criteria:
   i. The space is used solely for distribution of pipes, ducts, and conduits.
   ii. The space contains no storage.
   iii. The space is separated from the exit enclosure in accordance with Section 8.3.
(e) Existing openings to mechanical equipment spaces protected by approved existing fire protection–rated door assemblies shall be permitted, provided that the following criteria are met:
   i. The space is used solely for non-fuel-fired mechanical equipment.
   ii. The space contains no storage of combustible materials.
   iii. The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

(10) Penetrations into, and openings through, an exit enclosure assembly shall be limited to the following:
(a) Door assemblies permitted by 7.1.3.2.1(9)
(b)*Electrical conduit serving the exit enclosure
(c) Required exit door openings
(d) Ductwork and equipment necessary for independent stair pressurization
(e) Water or steam piping necessary for the heating or cooling of the exit enclosure
(f) Sprinkler piping
(g) Standpipes
(h) Existing penetrations protected in accordance with 8.3.5
(i) Penetrations for fire alarm circuits, where the circuits are installed in metal conduit and the penetrations are protected in accordance with 8.3.5

(11) Penetrations or communicating openings shall be prohibited between adjacent exit enclosures.
(12) Membrane penetrations shall be permitted on the exit access side of the exit enclosure and shall be protected in accordance with 8.3.5.6.

7.1.3.2.2 An exit enclosure shall provide a continuous protected path of travel to an exit discharge.

7.1.3.2.3* An exit enclosure shall not be used for any purpose that has the potential to interfere with its use as an exit and, if so designated, as an area of refuge. *(See also 7.2.2.5.3.)*

7.1.4 Interior Finish in Exit Enclosures.

7.1.4.1* Interior Wall and Ceiling Finish in Exit Enclosures. Interior wall and ceiling finish shall be in accordance with Section 10.2. In exit enclosures, interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B.

7.1.4.2* Interior Floor Finish in Exit Enclosures. New interior floor finish in exit enclosures, including stair treads and risers, shall be not less than Class II in accordance with Section 10.2.

7.1.5* Headroom.

7.1.5.1 Means of egress shall be designed and maintained to provide headroom in accordance with other sections of this *Code*, and such headroom shall be not less than 7 ft 6 in. (2285 mm), with projections from the ceiling not less than 6 ft 8 in. (2030 mm) with a tolerance of −¾ in. (−19 mm), above the finished floor, unless otherwise specified by any of the following:

(1) In existing buildings, the ceiling height shall be not less than 7 ft (2135 mm) from the floor, with projections from the ceiling not less than 6 ft 8 in. (2030 mm) nominal above the floor.
(2) Headroom in industrial equipment access areas as provided in 40.2.5.3 shall be permitted.

7.1.5.2 The minimum ceiling height shall be maintained for not less than two-thirds of the ceiling area of any room or space, provided that the ceiling height of the remaining ceiling area is not less than 6 ft 8 in. (2030 mm).

7.1.5.3 Headroom on stairs shall be not less than 6 ft 8 in. (2030 mm) and shall be measured vertically above a plane parallel to, and tangent with, the most forward projection of the stair tread.

7.1.6 Walking Surfaces in the Means of Egress.

7.1.6.1 General.

7.1.6.1.1 Walking surfaces in the means of egress shall comply with 7.1.6.2 through 7.1.6.4.

7.1.6.1.2 Approved existing walking surfaces shall be permitted.

7.1.6.2 Changes in Elevation. Abrupt changes in elevation of walking surfaces shall not exceed ¼ in. (6.3 mm). Changes in elevation exceeding ¼ in. (6.3 mm), but not exceeding ½ in. (13 mm), shall be beveled with a slope of 1 in 2. Changes in elevation exceeding ½ in. (13 mm) shall be considered a change in level and shall be subject to the requirements of 7.1.7.

7.1.6.3 Level.

7.1.6.3.1 Walking surfaces shall comply with all of the following:

(1) Walking surfaces shall be nominally level.
(2) The slope of a walking surface in the direction of travel shall not exceed 1 in 20, unless the ramp requirements of 7.2.5 are met.
(3) The slope perpendicular to the direction of travel shall not exceed 1 in 48.

7.1.6.3.2 Vehicle ramps in parking structures, as permitted in 42.8.2.2.6, and not on an accessible means of egress or other accessible element shall be exempt from the provisions of 7.1.6.3.1.

7.1.6.4* Slip Resistance. Walking surfaces in the means of egress shall be slip resistant under foreseeable conditions.

7.1.7 Changes in Level in Means of Egress.

7.1.7.1 Changes in level in means of egress shall be achieved by an approved means of egress where the elevation difference exceeds 21 in. (535 mm).

7.1.7.2* Changes in level in means of egress not in excess of 21 in. (535 mm) shall be achieved either by a ramp complying with the requirements of 7.2.5 or by a stair complying with the requirements of 7.2.2.

7.1.7.2.1 Where a ramp is used to meet the requirements of 7.1.7.2, the presence and location of ramped portions of walkways shall be readily apparent.

7.1.7.2.2 Where a stair is used to meet the requirements of 7.1.7.2, the tread depth of such stair shall be not less than 13 in. (330 mm).

7.1.7.2.3 Tread depth in industrial equipment access areas as provided in 40.2.5.3 shall be permitted.

7.1.7.2.4 The presence and location of each step shall be readily apparent.

7.1.8* Guards. Guards in accordance with 7.2.2.4 shall be provided at the open sides of means of egress that exceed 30 in. (760 mm) above the floor or the finished ground level below except where guards are specifically exempted by provisions of Chapters 11 through 43.

7.1.9 Impediments to Egress. Any device or alarm installed to restrict the improper use of a means of egress shall be designed and installed so that it cannot, even in case of failure, impede or prevent emergency use of such means of egress, unless otherwise provided in 7.2.1.6 and Chapters 18, 19, 22, and 23.

7.1.10 Means of Egress Reliability.

7.1.10.1* Maintenance. Means of egress shall be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or other emergency.

7.1.10.2 Furnishings and Decorations in Means of Egress.

7.1.10.2.1 No furnishings, decorations, or other objects shall obstruct exits or their access thereto, egress therefrom, or visibility thereof.

7.1.10.2.2 No obstruction by railings, barriers, or gates shall divide the means of egress into sections appurtenant to individual rooms, apartments, or other occupied spaces. Where the authority having jurisdiction finds the required path of travel to be obstructed by furniture or other movable objects, the authority shall be permitted to require that such objects be secured out of the way or shall be permitted to require that railings or other permanent barriers be installed to protect the path of travel against encroachment.

7.1.10.2.3 Mirrors shall not be placed on exit door leaves. Mirrors shall not be placed in or adjacent to any exit in such a manner as to confuse the direction of egress.

7.1.11 Sprinkler System Installation. Where another provision of this chapter requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with the subparts of 9.7.1.1 permitted by the applicable occupancy chapters.

7.2 Means of Egress Components.

7.2.1 Door Openings.

7.2.1.1 General.

7.2.1.1.1 A door assembly in a means of egress shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.1.

7.2.1.1.2 Every door opening and every principal entrance that is required to serve as an exit shall be designed and constructed so that the path of egress travel is obvious and direct. Windows that, because of their physical configuration or design and the materials used in their construction, have the potential to be mistaken for door openings shall be made inaccessible to the occupants by barriers or railings.

7.2.1.1.3 Occupied Building.

7.2.1.1.3.1 For the purposes of Section 7.2, a building shall be considered to be occupied at any time it meets any of the following criteria:

(1) It is open for general occupancy.
(2) It is open to the public.
(3) It is occupied by more than 10 persons.

7.2.1.1.3.2 Where means of egress doors are locked in a building that is not considered occupied, occupants shall not be locked beyond their control in buildings or building spaces, except for lockups in accordance with 22.4.5 and 23.4.5, detention and correctional occupancies, and health care occupancies.

7.2.1.2 Door Leaf Width.

7.2.1.2.1* Measurement of Clear Width.

7.2.1.2.1.1 Swinging Door Assemblies. For swinging door assemblies, clear width shall be measured as follows:

(1) The measurement shall be taken at the narrowest point in the door opening.
(2) The measurement shall be taken between the face of the door leaf and the stop of the frame.
(3) For new swinging door assemblies, the measurement shall be taken with the door leaf open 90 degrees.
(4) For any existing door assembly, the measurement shall be taken with the door leaf in the fully open position.
(5) Projections of not more than 4 in. (100 mm) into the door opening width on the hinge side shall not be considered reductions in clear width, provided that such projections are for purposes of accommodating panic hardware or fire exit hardware and are located not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.
(6) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in clear width.

7.2.1.2.1.2 Other than Swinging Door Assemblies. For other than swinging door assemblies, clear width shall be measured as follows:

(1) The measurement shall be taken at the narrowest point in the door opening.
(2) The measurement shall be taken as the door opening width when the door leaf is in the fully open position.
(3) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in clear width.

7.2.1.2.2* Measurement of Egress Capacity Width.

7.2.1.2.2.1 Swinging Door Assemblies. For swinging door assemblies, egress capacity width shall be measured as follows:

(1) The measurement shall be taken at the narrowest point in the door opening.
(2) The measurement shall be taken between the face of the door leaf and the stop of the frame.
(3) For new swinging doors assemblies, the measurement shall be taken with the door leaf open 90 degrees.
(4) For any existing door assembly, the measurement shall be taken with the door leaf in the fully open position.
(5) Projections not more than 3½ in. (90 mm) at each side of the door openings at a height of not more than 38 in. (965 mm) shall not be considered reductions in egress capacity width.
(6) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in egress capacity width.

7.2.1.2.2.2 Other than Swinging Door Assemblies. For other than swinging door assemblies, egress capacity width shall be measured as follows:

(1) The measurement shall be taken at the narrowest point in the door opening.
(2) The measurement shall be taken as the door opening width when the door leaf is in the fully open position.
(3) Projections not more than 3½ in. (90 mm) at each side of the door openings at a height of not more than 38 in. (965 mm) shall not be considered reductions in egress capacity width.
(4) Projections exceeding 6 ft 8 in. (2030 mm) above the floor shall not be considered reductions in egress capacity width.

7.2.1.2.3 Minimum Door Leaf Width.

7.2.1.2.3.1 For purposes of determining minimum door opening width, the clear width in accordance with 7.2.1.2.1 shall be used, unless door leaf width is specified.

7.2.1.2.3.2 Door openings in means of egress shall be not less than 32 in. (810 mm) in clear width, except under any of the following conditions:

(1) Where a pair of door leaves is provided, one door leaf shall provide not less than a 32 in. (810 mm) clear width opening.
(2)*Exit access door assemblies serving a room not exceeding 70 ft^2 (6.5 m^2) and not required to be accessible to persons with severe mobility impairments shall be not less than 24 in. (610 mm) in door leaf width.
(3)*Door openings serving a building or portion thereof not required to be accessible to persons with severe mobility impairments shall be permitted to be 28 in. (710 mm) in door leaf width.
(4) In existing buildings, the existing door leaf width shall be not less than 28 in. (710 mm).
(5) Door openings in detention and correctional occupancies, as otherwise provided in Chapters 22 and 23, shall not be required to comply with 7.2.1.2.3.
(6) Interior door openings in dwelling units as otherwise provided in Chapter 24 shall not be required to comply with 7.2.1.2.3.
(7) A power-operated door leaf located within a two-leaf opening shall be exempt from the minimum 32 in. (810 mm) single-leaf requirement in accordance with 7.2.1.9.1.5.
(8) Revolving door assemblies, as provided in 7.2.1.10, shall be exempt from the minimum 32 in. (810 mm) width requirement.
(9)*Where a single door opening is provided for discharge from a stairway required to be a minimum of 56 in. (1420 mm) wide in accordance with 7.2.2.2.1.2(B), and such door assembly serves as the sole means of exit discharge from such stairway, the clear width of the door opening, measured in accordance with 7.2.1.2.2, shall be not less than two-thirds the required width of the stairway.

7.2.1.3 Floor Level.

7.2.1.3.1 The elevation of the floor surfaces on both sides of a door opening shall not vary by more than ½ in. (13 mm), unless otherwise permitted by 7.2.1.3.5, 7.2.1.3.6, or 7.2.1.3.7.

7.2.1.3.2 The elevation of the floor surfaces required by 7.2.1.3.1 shall be maintained on both sides of the door openings for a distance not less than the width of the widest leaf.

7.2.1.3.3 Thresholds at door openings shall not exceed ½ in. (13 mm) in height.

7.2.1.3.4 Raised thresholds and floor level changes in excess of ¼ in. (6.3 mm) at door openings shall be beveled with a slope not steeper than 1 in 2.

7.2.1.3.5 In existing buildings, where the door opening discharges to the outside or to an exterior balcony or exterior exit access, the floor level outside the door opening shall be permitted to be one step lower than that of the inside, but shall be not more than 8 in. (205 mm) lower.

7.2.1.3.6 In existing buildings, a door assembly at the top of a stair shall be permitted to open directly at a stair, provided that the door leaf does not swing over the stair and that the door opening serves an area with an occupant load of fewer than 50 persons.

7.2.1.3.7 Where doors serve spaces that are not normally occupied, the floor level shall be permitted to be lower than that of the door opening but shall be not more than 8 in. (205 mm) lower.

7.2.1.4 Swing and Force to Open.

7.2.1.4.1* Swinging-Type Door Assembly Requirement. Any door assembly in a means of egress shall be of the side-hinged or pivoted-swinging type, and shall be installed to be capable of swinging from any position to the full required width of the opening in which it is installed, unless otherwise specified as follows:

(1) Door assemblies in dwelling units, as provided in Chapter 24, shall be permitted.
(2) Door assemblies in residential board and care occupancies, as provided in Chapters 32 and 33, shall be permitted.
(3) Where permitted in Chapters 11 through 43, horizontal-sliding or vertical-rolling security grilles or door assemblies that are part of the required means of egress shall be permitted, provided that all of the following criteria are met:
  (a) Such grilles or door assemblies shall remain secured in the fully open position during the period of occupancy by the general public.
  (b) On or adjacent to the grille or door opening, there shall be a readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows: THIS DOOR TO REMAIN OPEN WHEN THE SPACE IS OCCUPIED.
  (c) Door leaves or grilles shall not be brought to the closed position when the space is occupied.
  (d) Door leaves or grilles shall be operable from within the space without the use of any special knowledge or effort.
  (e) Where two or more means of egress are required, not more than half of the means of egress shall be equipped with horizontal-sliding or vertical-rolling grilles or door assemblies.
(4) Horizontal-sliding door assemblies shall be permitted under any of the following conditions:
  (a) Horizontal-sliding door assemblies in detention and correctional occupancies, as provided in Chapters 22 and 23, shall be permitted.
  (b) Special-purpose horizontally sliding accordion or folding door assemblies complying with 7.2.1.14 shall be permitted.
  (c) Unless prohibited by Chapters 11 through 43, horizontal-sliding door assemblies serving a room or area with an occupant load of fewer than 10 shall be permitted, provided that all of the following criteria are met:
    i. The area served by the door assembly has no high hazard contents.
    ii. The door assembly is readily operable from either side without special knowledge or effort.
    iii. The force required to operate the door assembly in the direction of door leaf travel is not more than 30 lbf (133 N) to set the door leaf in motion and is not more than 15 lbf (67 N) to close the door assembly or open it to the minimum required width.
    iv. The door assembly complies with any required fire protection rating, and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 7.2.1.8 and is installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*
    v. Corridor door assemblies required to be self-latching have a latch or other mechanism that ensures that the door leaf will not rebound into a partially open position if forcefully closed.
  (d) Where private garages, business areas, industrial areas, and storage areas with an occupant load not exceeding 10 contain only low or ordinary hazard contents, door openings to such areas and private garages shall be permitted to be horizontal-sliding door assemblies.
(5) Where private garages, business areas, industrial areas, and storage areas with an occupant load not exceeding 10 contain only low or ordinary hazard contents, door openings to such areas and private garages shall be permitted to be vertical-rolling door assemblies.
(6) Revolving door assemblies complying with 7.2.1.10 shall be permitted.
(7) Existing fusible link–operated horizontal-sliding or vertical-rolling fire door assemblies shall be permitted to be used as provided in Chapters 39, 40, and 42.

7.2.1.4.2 Door Leaf Swing Direction. Door leaves required to be of the side-hinged or pivoted-swinging type shall swing in the direction of egress travel under any of the following conditions:

(1) Where serving a room or area with an occupant load of 50 or more, except under any of the following conditions:
  (a) Door leaves in horizontal exits shall not be required to swing in the direction of egress travel where permitted by 7.2.4.3.8.1 or 7.2.4.3.8.2.
  (b) Door leaves in smoke barriers shall not be required to swing in the direction of egress travel in existing health care occupancies, as provided in Chapter 19.
(2) Where the door assembly is used in an exit enclosure, unless the door opening serves an individual living unit that opens directly into an exit enclosure
(3) Where the door opening serves a high hazard contents area

7.2.1.4.3* Door Leaf Encroachment.

7.2.1.4.3.1 During its swing, any door leaf in a means of egress shall leave not less than one-half of the required width of an aisle, a corridor, a passageway, or a landing unobstructed, unless both of the following conditions are met:

(1) The door opening provides access to a stair in an existing building.
(2) The door opening meets the requirement of 7.2.1.4.3.2.

7.2.1.4.3.2 When fully open, any door leaf in a means of egress shall not project more than 7 in. (180 mm) into the required width of an aisle, a corridor, a passageway, or a landing, unless the door leaf is equipped with an approved self-closing device and is not required by the provisions of 7.2.1.4.2 to swing in the direction of egress travel.

7.2.1.4.3.3 Surface-mounted latch release hardware on the door leaf shall be exempt from being included in the maximum 7 in. (180 mm) projection requirement of 7.2.1.4.3.1, provided that both of the following criteria are met:

(1) The hardware is mounted to the side of the door leaf that faces the aisle, corridor, passageway, or landing when the door leaf is in the open position.
(2) The hardware is mounted not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.

7.2.1.4.4 Screen Door Assemblies and Storm Door Assemblies. Screen door assemblies and storm door assemblies used in a means of egress shall be subject to the requirements for direction of swing that are applicable to other door assemblies used in a means of egress.

7.2.1.4.5 Door Leaf Operating Forces.

7.2.1.4.5.1 The forces required to fully open any door leaf manually in a means of egress shall not exceed 15 lbf (67 N) to release the latch, 30 lbf (133 N) to set the leaf in motion, and 15 lbf (67 N) to open the leaf to the minimum required width, unless otherwise specified as follows:

(1) The opening forces for interior side-hinged or pivoted-swinging door leaves without closers shall not exceed 5 lbf (22 N).
(2) The opening forces for existing door leaves in existing buildings shall not exceed 50 lbf (222 N) applied to the latch stile.
(3) The opening forces for horizontal-sliding door leaves in detention and correctional occupancies shall be as provided in Chapters 22 and 23.
(4) The opening forces for power-operated door leaves shall be as provided in 7.2.1.9.

7.2.1.4.5.2 The forces specified in 7.2.1.4.5 shall be applied to the latch stile.

7.2.1.5 Locks, Latches, and Alarm Devices.

7.2.1.5.1 Door leaves shall be arranged to be opened readily from the egress side whenever the building is occupied.

7.2.1.5.2* The requirement of 7.2.1.5.1 shall not apply to door leaves of listed fire door assemblies after exposure to elevated temperature in accordance with the listing, based on laboratory fire test procedures.

7.2.1.5.3 Locks, if provided, shall not require the use of a key, a tool, or special knowledge or effort for operation from the egress side.

7.2.1.5.4 The requirements of 7.2.1.5.1 and 7.2.1.5.3 shall not apply where otherwise provided in Chapters 18 through 23.

7.2.1.5.5 Key-Operated Locks.

7.2.1.5.5.1* Exterior door assemblies shall be permitted to have key-operated locks from the egress side, provided that all of the following criteria are met:

(1) This alternative is permitted in Chapters 11 through 43 for the specific occupancy.
(2) A readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows is located on or adjacent to the door leaf: THIS DOOR TO REMAIN UNLOCKED WHEN THE BUILDING IS OCCUPIED.
(3) The locking device is of a type that is readily distinguishable as locked.
(4) A key is immediately available to any occupant inside the building when it is locked.

7.2.1.5.5.2 The alternative provisions of 7.2.1.5.5.1 shall be permitted to be revoked by the authority having jurisdiction for cause.

7.2.1.5.6 Electrically Controlled Egress Door Assemblies. Door assemblies in the means of egress shall be permitted to be electrically locked if equipped with approved, listed hardware, provided that all of the following conditions are met:

(1) The hardware for occupant release of the lock is affixed to the door leaf.
(2) The hardware has an obvious method of operation that is readily operated in the direction of egress.
(3) The hardware is capable of being operated with one hand in the direction of egress.
(4) Operation of the hardware interrupts the power supply directly to the electric lock and unlocks the door assembly in the direction of egress.
(5)*Loss of power to the listed releasing hardware automatically unlocks the door assembly in the direction of egress.
(6) Hardware for new installations is listed in accordance with ANSI/UL 294, *Standard for Access Control System Units*.

7.2.1.5.7 Where permitted in Chapters 11 through 43, key operation shall be permitted, provided that the key cannot be removed when the door leaf is locked from the side from which egress is to be made.

7.2.1.5.8* Every door assembly in a stair enclosure serving more than four stories, unless permitted by 7.2.1.5.8.2, shall meet one of the following conditions:

(1) Re-entry from the stair enclosure to the interior of the building shall be provided.
(2) An automatic release that is actuated with the initiation of the building fire alarm system shall be provided to unlock all stair enclosure door assemblies to allow re-entry.
(3) Selected re-entry shall be provided in accordance with 7.2.1.5.8.1.

7.2.1.5.8.1 Door assemblies on stair enclosures shall be permitted to be equipped with hardware that prevents re-entry into the interior of the building, provided that all of the following criteria are met:

(1) There shall be not less than two levels where it is possible to leave the stair enclosure to access another exit.
(2) There shall be not more than four stories intervening between stories where it is possible to leave the stair enclosure to access another exit.
(3) Re-entry shall be possible on the top story or next-to-top story served by the stair enclosure, and such story shall allow access to another exit.
(4) Door assemblies allowing re-entry shall be identified as such on the stair side of the door leaf.
(5) Door assemblies not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door opening, in each direction of travel, that allows re-entry or exit.

7.2.1.5.8.2 The requirements of 7.2.1.5.8, except as provided in 7.2.1.5.8.3, shall not apply to the following:

(1) Existing installations in buildings that are not high-rise buildings as permitted in Chapters 11 through 43
(2) Existing installations in high-rise buildings as permitted in Chapters 11 through 43 where the occupancy is within a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(3) Existing approved stairwell re-entry installations as permitted by Chapters 11 through 43
(4) Stair enclosures serving a building permitted to have a single exit in accordance with Chapters 11 through 43
(5) Stair enclosures in health care occupancies where otherwise provided in Chapter 18
(6) Stair enclosures in detention and correctional occupancies where otherwise provided in Chapter 22

7.2.1.5.8.3 When the provisions of 7.2.1.5.8.2 are used, signage on the stair door leaves shall be required as follows;

(1) Door assemblies allowing re-entry shall be identified as such on the stair side of the door leaf.
(2) Door assemblies not allowing re-entry shall be provided with a sign on the stair side indicating the location of the nearest door opening, in each direction of travel, that allows re-entry or exit.

7.2.1.5.9 If a stair enclosure allows access to the roof of the building, the door assembly to the roof either shall be kept locked or shall allow re-entry from the roof.

7.2.1.5.10* A latch or other fastening device on a door leaf shall be provided with a releasing device that has an obvious method of operation and that is readily operated under all lighting conditions.

7.2.1.5.10.1 The releasing mechanism for any latch shall be located as follows:

(1) Not less than 34 in. (865 mm) above the finished floor for other than existing installations
(2) Not more than 48 in. (1220 mm) above the finished floor

7.2.1.5.10.2 The releasing mechanism shall open the door leaf with not more than one releasing operation, unless otherwise specified in 7.2.1.5.10.3, 7.2.1.5.10.4, or 7.2.1.5.10.6.

7.2.1.5.10.3* Egress door assemblies from individual living units and guest rooms of residential occupancies shall be permitted to be provided with devices, including automatic latching devices, that require not more than one additional releasing operation, provided that such device is operable from the inside without the use of a key or tool and is mounted at a height not exceeding 48 in. (1220 mm) above the finished floor.

7.2.1.5.10.4 Existing security devices permitted by 7.2.1.5.10.3 shall be permitted to have two additional releasing operations.

7.2.1.5.10.5 Existing security devices permitted by 7.2.1.5.10.3, other than automatic latching devices, shall be located not more than 60 in. (1525 mm) above the finished floor.

7.2.1.5.10.6 Two releasing operations shall be permitted for existing hardware on a door leaf serving an area having an occupant load not exceeding three, provided that releasing does not require simultaneous operations.

7.2.1.5.11 Where pairs of door leaves are required in a means of egress, one of the following criteria shall be met:

(1) Each leaf of the pair shall be provided with a releasing device that does not depend on the release of one leaf before the other.
(2) Approved automatic flush bolts shall be used and arranged such that both of the following criteria are met:
    (a) The door leaf equipped with the automatic flush bolts shall have no doorknob or surface-mounted hardware.
    (b) Unlatching of any leaf shall not require more than one operation.

7.2.1.5.12* Devices shall not be installed in connection with any door assembly on which panic hardware or fire exit hardware is required where such devices prevent or are intended to prevent the free use of the leaf for purposes of egress, unless otherwise provided in 7.2.1.6.

7.2.1.6* Special Locking Arrangements.

7.2.1.6.1 Delayed-Egress Locking Systems.

7.2.1.6.1.1 Approved, listed, delayed-egress locking systems shall be permitted to be installed on door assemblies serving low and ordinary hazard contents in buildings protected throughout by an approved, supervised automatic fire detection system in accordance with Section 9.6 or an approved, supervised automatic sprinkler system in accordance with Section 9.7, and where permitted in Chapters 11 through 43, provided that all of the following criteria are met:

(1) The door leaves shall unlock in the direction of egress upon actuation of one of the following:
    (a) Approved, supervised automatic sprinkler system in accordance with Section 9.7
    (b) Not more than one heat detector of an approved, supervised automatic fire detection system in accordance with Section 9.6
    (c) Not more than two smoke detectors of an approved, supervised automatic fire detection system in accordance with Section 9.6
(2) The door leaves shall unlock in the direction of egress upon loss of power controlling the lock or locking mechanism.
(3)*An irreversible process shall release the lock in the direction of egress within 15 seconds, or 30 seconds where approved by the authority having jurisdiction, upon application of a force to the release device required in 7.2.1.5.10 under all of the following conditions:
    (a) The force shall not be required to exceed 15 lbf (67 N).
    (b) The force shall not be required to be continuously applied for more than 3 seconds.
    (c) The initiation of the release process shall activate an audible signal in the vicinity of the door opening.
    (d) Once the lock has been released by the application of force to the releasing device, relocking shall be by manual means only.
(4)*A readily visible, durable sign in letters not less than 1 in. (25 mm) high and not less than ⅛ in. (3.2 mm) in stroke width on a contrasting background shall be located on the door leaf adjacent to the release device in the direction of egress, and shall read as follows:
    (a) PUSH UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN 15 SECONDS, for doors that swing in the direction of egress travel
    (b) PULL UNTIL ALARM SOUNDS, DOOR CAN BE OPENED IN 15 SECONDS, for doors that swing against the direction of egress travel
(5) The egress side of doors equipped with delayed-egress locks shall be provided with emergency lighting in accordance with Section 7.9.

7.2.1.6.1.2 The provisions of 7.2.1.6.2 for access-controlled egress door assemblies shall not apply to door assemblies with delayed-egress locking systems.

7.2.1.6.2* Access-Controlled Egress Door Assemblies. Where permitted in Chapters 11 through 43, door assemblies in the means of egress shall be permitted to be equipped with electrical lock hardware that prevents egress, provided that all of the following criteria are met:

(1) A sensor shall be provided on the egress side, arranged to unlock the door leaf in the direction of egress upon detection of an approaching occupant.

(2) Door leaves shall automatically unlock in the direction of egress upon loss of power to the sensor or to the part of the access control system that locks the door leaves.
(3) Door locks shall be arranged to unlock in the direction of egress from a manual release device complying with all of the following criteria:
   (a) The manual release device shall be located on the egress side, 40 in. to 48 in. (1015 mm to 1220 mm) vertically above the floor, and within 60 in. (1525 mm) of the secured door openings.
   (b) The manual release device shall be readily accessible and clearly identified by a sign that reads as follows: PUSH TO EXIT.
   (c) When operated, the manual release device shall result in direct interruption of power to the lock — independent of the locking system electronics — and the lock shall remain unlocked for not less than 30 seconds.
(4) Activation of the building fire-protective signaling system, if provided, shall automatically unlock the door leaves in the direction of egress, and the door leaves shall remain unlocked until the fire-protective signaling system has been manually reset.
(5) The activation of manual fire alarm boxes that activate the building fire-protective signaling system specified in 7.2.1.6.2(4) shall not be required to unlock the door leaves.
(6) Activation of the building automatic sprinkler or fire detection system, if provided, shall automatically unlock the door leaves in the direction of egress, and the door leaves shall remain unlocked until the fire-protective signaling system has been manually reset.
(7) The egress side of access-controlled egress doors, other than existing access-controlled egress doors, shall be provided with emergency lighting in accordance with Section 7.9.

7.2.1.6.3 Elevator Lobby Exit Access Door Assemblies Locking. Where permitted in Chapters 11 through 43, door assemblies separating the elevator lobby from the exit access required by 7.4.1.6.1 shall be permitted to be electrically locked, provided that all the following criteria are met:

(1) The lock is listed in accordance with ANSI/UL 294, *Standard for Access Control System Units*.
(2) The building is protected throughout by a fire alarm system in accordance with Section 9.6.
(3) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(4) Waterflow in the sprinkler system required by 7.2.1.6.3(3) is arranged to initiate the building fire alarm system.
(5) The elevator lobby is protected by an approved, supervised smoke detection system in accordance with Section 9.6.
(6) Detection of smoke by the detection system required by 7.2.1.6.3(5) is arranged to initiate the building fire alarm system and notify building occupants.
(7) Initiation of the building fire alarm system by other than manual fire alarm boxes unlocks the elevator lobby door assembly.
(8) Loss of power to the elevator lobby electronic lock system unlocks the elevator lobby door assemblies.
(9) Once unlocked, the elevator lobby door assemblies remain unlocked until the building fire alarm system has been manually reset.
(10) Where the elevator lobby door assemblies remain latched after being unlocked, latch-releasing hardware in accordance with 7.2.1.5.10 is affixed to the door leaves.
(11) A two-way communication system is provided for communication between the elevator lobby and a central control point that is constantly staffed.
(12) The central control point staff required by 7.2.1.6.3(11) is capable, trained, and authorized to provide emergency assistance.
(13) The provisions of 7.2.1.6.1 for delayed-egress locking systems are not applied to the elevator lobby door assemblies.
(14)*The provisions of 7.2.1.6.2 for access-controlled egress door assemblies are not applied to the elevator lobby door assemblies.

7.2.1.7 Panic Hardware and Fire Exit Hardware.

7.2.1.7.1 Where a door assembly is required to be equipped with panic or fire exit hardware, such hardware shall meet all of the following criteria:

(1) It shall consist of a cross bar or a push pad, the actuating portion of which extends across not less than one-half of the width of the door leaf.
(2) It shall be mounted as follows:
   (a) New installations shall be not less than 34 in. (865 mm), and not more than 48 in. (1220 mm), above the floor.
   (b) Existing installations shall be not less than 30 in. (760 mm), and not more than 48 in. (1220 mm), above the floor.
(3) It shall be constructed so that a horizontal force not to exceed 15 lbf (66 N) actuates the cross bar or push pad and latches.

7.2.1.7.2* Only approved fire exit hardware shall be used on fire protection-rated door assemblies. New panic hardware and new fire exit hardware shall comply with ANSI/UL 305, *Standard for Safety Panic Hardware*, and ANSI/BHMA A156.3, *Exit Devices*.

7.2.1.7.3 Required panic hardware and fire exit hardware, in other than detention and correctional occupancies as otherwise provided in Chapters 22 and 23, shall not be equipped with any locking device, set screw, or other arrangement that prevents the release of the latch when pressure is applied to the releasing device.

7.2.1.7.4 Devices that hold the latch in the retracted position shall be prohibited on fire exit hardware, unless such devices are listed and approved for such a purpose.

7.2.1.8 Self-Closing Devices.

7.2.1.8.1* A door leaf normally required to be kept closed shall not be secured in the open position at any time and shall be self-closing or automatic-closing in accordance with 7.2.1.8.2, unless otherwise permitted by 7.2.1.8.3.

7.2.1.8.2 In any building of low or ordinary hazard contents, as defined in 6.2.2.2 and 6.2.2.3, or where approved by the authority having jurisdiction, door leaves shall be permitted to be automatic-closing, provided that all of the following criteria are met:

(1) Upon release of the hold-open mechanism, the leaf becomes self-closing.
(2) The release device is designed so that the leaf instantly releases manually and, upon release, becomes self-closing, or the leaf can be readily closed.

(3) The automatic releasing mechanism or medium is activated by the operation of approved smoke detectors installed in accordance with the requirements for smoke detectors for door leaf release service in *NFPA 72, National Fire Alarm and Signaling Code*.
(4) Upon loss of power to the hold-open device, the hold-open mechanism is released and the door leaf becomes self-closing.
(5) The release by means of smoke detection of one door leaf in a stair enclosure results in closing all door leaves serving that stair.

7.2.1.8.3 The elevator car doors, and the associated hoistway enclosure doors, at the floor level designated for recall in accordance with the requirements of 9.4.3 shall be permitted to remain open during Phase I Emergency Recall Operation.

7.2.1.9* Powered Door Leaf Operation.

7.2.1.9.1* General. Where means of egress door leaves are operated by power upon the approach of a person or are provided with power-assisted manual operation, the design shall be such that, in the event of power failure, the leaves open manually to allow egress travel or close when necessary to safeguard the means of egress.

7.2.1.9.1.1 The forces required to manually open the door leaves specified in 7.2.1.9.1 shall not exceed those required in 7.2.1.4.5, except that the force required to set the leaf in motion shall not exceed 50 lbf (222 N).

7.2.1.9.1.2 The door assembly shall be designed and installed so that, when a force is applied to the door leaf on the side from which egress is made, it shall be capable of swinging from any position to provide full use of the required width of the opening in which it is installed. *(See 7.2.1.4.)*

7.2.1.9.1.3 A readily visible, durable sign in letters not less than 1 in. (25 mm) high on a contrasting background that reads as follows shall be located on the egress side of each door opening:

IN EMERGENCY, PUSH TO OPEN

7.2.1.9.1.4 Sliding, power-operated door assemblies in an exit access serving an occupant load of fewer than 50 that manually open in the direction of door leaf travel, with forces not exceeding those required in 7.2.1.4.5, shall not be required to have the swing-out feature required by 7.2.1.9.1.2. The required sign shall be in letters not less than 1 in. (25 mm) high on a contrasting background and shall read as follows:

IN EMERGENCY, SLIDE TO OPEN

7.2.1.9.1.5* In the emergency breakout mode, a door leaf located within a two-leaf opening shall be exempt from the minimum 32 in. (810 mm) single-leaf requirement of 7.2.1.2.3.2(1), provided that the clear width of the single leaf is not less than 30 in. (760 mm).

7.2.1.9.1.6 For a biparting sliding door assembly in the emergency breakout mode, a door leaf located within a multiple-leaf opening shall be exempt from the minimum 32 in. (810 mm) single-leaf requirement of 7.2.1.2.3.2(1) if a clear opening of not less than 32 in. (810 mm) is provided by all leaves broken out.

7.2.1.9.1.7 Door assemblies complying with 7.2.1.14 shall be permitted to be used.

7.2.1.9.1.8 The requirements of 7.2.1.9.1 through 7.2.1.9.1.7 shall not apply in detention and correctional occupancies where otherwise provided in Chapters 22 and 23.

7.2.1.9.2 Self-Closing or Self-Latching Door Leaf Operation. Where door leaves are required to be self-closing or self-latching and are operated by power upon the approach of a person, or are provided with power-assisted manual operation, they shall be permitted in the means of egress where they meet the following criteria:

(1) The door leaves can be opened manually in accordance with 7.2.1.9.1 to allow egress travel in the event of power failure.
(2) New door leaves remain in the closed position, unless actuated or opened manually.
(3) When actuated, new door leaves remain open for not more than 30 seconds.
(4) Door leaves held open for any period of time close — and the power-assist mechanism ceases to function — upon operation of approved smoke detectors installed in such a way as to detect smoke on either side of the door opening in accordance with the provisions of *NFPA 72, National Fire Alarm and Signaling Code*.
(5) Door leaves required to be self-latching are either self-latching or become self-latching upon operation of approved smoke detectors per 7.2.1.9.2(4).
(6) New power-assisted swinging door assemblies comply with BHMA/ANSI A156.19, *American National Standard for Power Assist and Low Energy Power Operated Doors*.

7.2.1.10 Revolving Door Assemblies.

7.2.1.10.1 Revolving door assemblies, whether used or not used in the means of egress, shall comply with all of the following:

(1) Revolving door wings shall be capable of being collapsed into a book-fold position, unless they are existing revolving doors approved by the authority having jurisdiction.
(2) When revolving door wings are collapsed into the book-fold position, the parallel egress paths formed shall provide an aggregate width of 36 in. (915 mm), unless they are approved existing revolving door assemblies.
(3) Revolving door assemblies shall not be used within 10 ft (3050 mm) of the foot or the top of stairs or escalators.
(4) A dispersal area acceptable to the authority having jurisdiction shall be located between stairs or escalators and the revolving door assembly.
(5) The revolutions per minute (rpm) of revolving door wings shall not exceed the values in Table 7.2.1.10.1.
(6) Each revolving door assembly shall have a conforming side-hinged swinging door assembly in the same wall as the revolving door within 10 ft (3050 mm) of the revolving door, unless one of the following conditions applies:
    (a) Revolving door assemblies shall be permitted without adjacent swinging door assemblies, as required by 7.2.1.10.1(6), in street floor elevator lobbies, provided that no stairways or door openings from other parts of the building discharge through the lobby and the lobby has no occupancy other than as a means of travel between the elevators and street.
    (b) The requirement of 7.2.1.10.1(6) shall not apply to existing revolving door assemblies where the number of revolving door assemblies does not exceed the number of swinging door assemblies within 20 ft (6100 mm) of the revolving door assembly.

Table 7.2.1.10.1 Revolving Door Assembly Maximum Speed

Inside Diameter		Power-Driven Speed Control (rpm)	Manual Speed Control (rpm)
ft/in.	mm		
6 ft 6 in.	1980	11	12
7 ft	2135	10	11
7 ft 6 in.	2285	9	11
8 ft	2440	9	10
8 ft 6 in.	2590	8	9
9 ft	2745	8	9
9 ft 6 in.	2895	7	8
10 ft	3050	7	8

7.2.1.10.2 Where permitted in Chapters 11 through 43, revolving door assemblies shall be permitted as a component in a means of egress, provided that all of the following criteria are met:

(1) Revolving door openings shall not be given credit for more than 50 percent of the required egress capacity.
(2) Each revolving door opening shall not be credited with more than a 50-person capacity or, if of not less than a 9 ft (2745 mm) diameter, a revolving door assembly shall be permitted egress capacity based on the clear opening width provided when collapsed into a book-fold position.
(3) Revolving door wings shall be capable of being collapsed into a book-fold position when a force not exceeding 130 lbf (580 N) is applied to the wings within 3 in. (75 mm) of the outer edge.

7.2.1.10.3 Revolving door assemblies not used as a component of a means of egress shall have a collapsing force not exceeding 180 lbf (800 N) applied at a point 3 in. (75 mm) from the outer edge of the outer wing stile and 40 in. (1015 mm) above the floor.

7.2.1.10.4 The requirement of 7.2.1.10.3 shall not apply to revolving door assemblies, provided that the collapsing force is reduced to a force not to exceed 130 lbf (580 N) under all of the following conditions:

(1) Power failure, or removal of power to the device holding the wings in position
(2) Actuation of the automatic sprinkler system, where such a system is provided
(3) Actuation of a smoke detection system that is installed to provide coverage in all areas within the building that are within 75 ft (23 m) of the revolving door assemblies
(4) Actuation of a clearly identified manual control switch in an approved location that reduces the holding force to a force not to exceed 130 lbf (580 N)

7.2.1.11 Turnstiles and Similar Devices.

7.2.1.11.1 Turnstiles or similar devices that restrict travel to one direction or are used to collect fares or admission charges shall not be placed so as to obstruct any required means of egress, unless otherwise specified in 7.2.1.11.1.1, 7.2.1.11.1.2, and 7.2.1.11.1.3.

7.2.1.11.1.1 Approved turnstiles not exceeding 39 in. (990 mm) in height that turn freely in the direction of egress travel shall be permitted where revolving door assemblies are permitted in Chapters 11 through 43.

7.2.1.11.1.2 Where turnstiles are approved by the authority having jurisdiction and permitted in Chapters 11 through 43, each turnstile shall be credited for a capacity of 50 persons, provided that such turnstiles meet all of the following criteria:

(1) They freewheel in the egress direction when primary power is lost, and freewheel in the direction of egress travel upon manual release by an employee assigned in the area.
(2) They are not given credit for more than 50 percent of the required egress width.
(3) They are not in excess of 39 in. (990 mm) in height and have a clear width of not less than 16½ in. (420 mm).

7.2.1.11.1.3* Security access turnstiles that impede travel in the direction of egress utilizing a physical barrier shall be permitted to be considered as a component of the means of egress, where permitted in Chapters 11 through 43, provided that all the following criteria are met:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) Each security access turnstile lane configuration has a minimum clear passage width of 22 in. (560 mm).
(3) Any security access turnstile lane configuration providing a clear passage width of less than 32 in. (810 mm) shall be given an egress capacity of 50 persons.
(4) Any security access turnstile lane configuration providing a clear passage width of 32 in. (810 mm) or more shall be given an egress capacity as calculated in accordance with Section 7.3.
(5) Each secured physical barrier shall automatically retract or swing to an unobstructed open position in the direction of egress, under each of the following conditions:
    (a) Upon loss of power to the turnstile or any part of the access control system that secures the physical barrier
    (b) Upon actuation of a readily accessible and clearly identified manual release device that results in direct interruption of power to each secured physical barrier, remains in the open position for not less than 30 seconds, and is positioned at one of the following locations:
        i. The manual release device is located on the egress side of each security access turnstile lane.
        ii. The manual release device is located at an approved location where it can be actuated by an employee assigned to the area.
    (c) Upon actuation of the building fire-protective signaling system, if provided, and for which the following apply:
        i. The physical barrier remains in the open position until the fire-protective signaling system is manually reset.
        ii. The actuation of manual fire alarm boxes that actuate the building fire-protective signaling system is not required to meet the requirements specified in 7.2.1.11.1.3(5)(c)i.
    (d) Upon actuation of the building automatic sprinkler or fire detection system, and for which the physical barrier remains in the open position until the fire-protective signaling system is manually reset

7.2.1.11.2 Turnstiles exceeding 39 in. (990 mm) in height shall meet the requirements for revolving door assemblies in

7.2.1.10 or the requirements of 7.2.1.11.1.3 for security access turnstiles.

7.2.1.11.3 Turnstiles located in, or furnishing access to, required exits shall provide not less than 16½ in. (420 mm) clear width at and below a height of 39 in. (990 mm) and at least 22 in. (560 mm) clear width at heights above 39 in. (990 mm).

7.2.1.12 Door Openings in Folding Partitions. Where permanently mounted folding or movable partitions divide a room into smaller spaces, a swinging door leaf or open doorway shall be provided as an exit access from each such space, unless otherwise specified in 7.2.1.12.1 and 7.2.1.12.2.

7.2.1.12.1 A door leaf or opening in the folding partition shall not be required, provided that all of the following criteria are met:

(1) The subdivided space is not used by more than 20 persons at any time.
(2) The use of the space is under adult supervision.
(3) The partitions are arranged so that they do not extend across any aisle or corridor used as an exit access to the required exits from the story.
(4) The partitions conform to the interior finish and other requirements of this *Code*.
(5) The partitions are of an approved type, have a simple method of release, and are capable of being opened quickly and easily by experienced persons in case of emergency.

7.2.1.12.2 Where a subdivided space is provided with not less than two means of egress, the swinging door leaf in the folding partition specified in 7.2.1.12 shall not be required, and one such means of egress shall be permitted to be equipped with a horizontal-sliding door assembly complying with 7.2.1.14.

7.2.1.13 Balanced Door Assemblies. If panic hardware is installed on balanced door leaves, the panic hardware shall be of the push-pad type, and the pad shall not extend more than approximately one-half the width of the door leaf, measured from the latch stile. *[See 7.2.1.7.1(1).]*

7.2.1.14 Special-Purpose Horizontally Sliding Accordion or Folding Door Assemblies. Special-purpose horizontally sliding accordion or folding door assemblies shall be permitted in means of egress, provided that all of the following criteria are met:

(1) The door leaf is readily operable from either side without special knowledge or effort.
(2) The force that, when applied to the operating device in the direction of egress, is required to operate the door leaf is not more than 15 lbf (67 N).
(3) The force required to operate the door leaf in the direction of travel is not more than 30 lbf (133 N) to set the leaf in motion and is not more than 15 lbf (67 N) to close the leaf or open it to the minimum required width.
(4) The door leaf is operable using a force of not more than 50 lbf (222 N) when a force of 250 lbf (1100 N) is applied perpendicularly to the leaf adjacent to the operating device, unless the door opening is an existing special-purpose horizontally sliding accordion or folding exit access door assembly serving an area with an occupant load of fewer than 50.
(5) The door assembly complies with the fire protection rating, if required, and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 7.2.1.8 and is installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

7.2.1.15 Inspection of Door Openings.

7.2.1.15.1* Where required by Chapters 11 through 43, the following door assemblies shall be inspected and tested not less than annually in accordance with 7.2.1.15.2 through 7.2.1.15.7:

(1) Door leaves equipped with panic hardware or fire exit hardware in accordance with 7.2.1.7
(2) Door assemblies in exit enclosures
(3) Electrically controlled egress doors
(4) Door assemblies with special locking arrangements subject to 7.2.1.6

7.2.1.15.2* The inspection and testing interval for fire-rated and nonrated door assemblies shall be permitted to exceed 12 months under a written performance-based program.

7.2.1.15.2.1 Goals established under a performance-based program shall provide assurance that the door assembly will perform its intended function.

7.2.1.15.2.2 Technical justification for inspection, testing, and maintenance intervals shall be documented.

7.2.1.15.2.3 The performance-based option shall include historical data.

7.2.1.15.3 A written record of the inspections and testing shall be signed and kept for inspection by the authority having jurisdiction.

7.2.1.15.4 Functional testing of door assemblies shall be performed by individuals who can demonstrate knowledge and understanding of the operating components of the type of door being subjected to testing.

7.2.1.15.5 Door assemblies shall be visually inspected from both sides of the opening to assess the overall condition of the assembly.

7.2.1.15.6 As a minimum, the following items shall be verified:

(1) Floor space on both sides of the openings is clear of obstructions, and door leaves open fully and close freely.
(2) Forces required to set door leaves in motion and move to the fully open position do not exceed the requirements in 7.2.1.4.5.
(3) Latching and locking devices comply with 7.2.1.5.
(4) Releasing hardware devices are installed in accordance with 7.2.1.5.10.1.
(5) Door leaves of paired openings are installed in accordance with 7.2.1.5.11.
(6) Door closers are adjusted properly to control the closing speed of door leaves in accordance with accessibility requirements.
(7) Projection of door leaves into the path of egress does not exceed the encroachment permitted by 7.2.1.4.3.
(8) Powered door openings operate in accordance with 7.2.1.9.
(9) Signage required by 7.2.1.4.1(3), 7.2.1.5.5, 7.2.1.6, and 7.2.1.9 is intact and legible.
(10) Door openings with special locking arrangements function in accordance with 7.2.1.6.
(11) Security devices that impede egress are not installed on openings, as required by 7.2.1.5.12.
(12) Where required by 7.2.2.5.5.7, door hardware marking is present and intact.
(13) Emergency lighting on access-controlled egress doors and doors equipped with delayed-egress locking systems is present and functioning in accordance with Section 7.9.

7.2.1.15.7* Door openings not in proper operating condition shall be repaired or replaced without delay.

7.2.2 Stairs.

7.2.2.1 General.

7.2.2.1.1 Stairs used as a component in the means of egress shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.2, unless otherwise specified in 7.2.2.1.2.

7.2.2.1.2 The requirement of 7.2.2.1.1 shall not apply to the following:

(1) Aisle stairs in assembly occupancies, as provided in Chapters 12 and 13
(2) Approved existing noncomplying stairs

7.2.2.2 Dimensional Criteria.

7.2.2.2.1 Standard Stairs.

7.2.2.2.1.1 Stairs shall meet the following criteria:

(1) New stairs shall be in accordance with Table 7.2.2.2.1.1(a) and 7.2.2.2.1.2.
(2)*Existing stairs shall be permitted to remain in use, provided that they meet the requirements for existing stairs shown in Table 7.2.2.2.1.1(b).
(3) Approved existing stairs shall be permitted to be rebuilt in accordance with the following:
  (a) Dimensional criteria of Table 7.2.2.2.1.1(b)
  (b) Other stair requirements of 7.2.2
(4) The requirements for new and existing stairs shall not apply to stairs located in industrial equipment access areas where otherwise provided in 40.2.5.3.

7.2.2.2.1.2* Minimum New Stair Width. *(See also 7.3.3.)*

(A) Where the total occupant load of all stories served by the stair is fewer than 50, the minimum width clear of all obstructions, except projections not more than 4½ in. (114 mm) at or below handrail height on each side, shall be 36 in. (915 mm).

(B)* Where stairs serve occupant loads exceeding that permitted by 7.2.2.2.1.2(A), the minimum width clear of all obstructions, except projections not more than 4½ in. (114 mm) at or below handrail height on each side, shall be in accordance with Table 7.2.2.2.1.2(B) and the requirements of, 7.2.2.2.1.2(C), 7.2.2.2.1.2(D), 7.2.2.2.1.2(E), and 7.2.2.2.1.2(F).

Table 7.2.2.2.1.1(a) New Stairs

Feature	Dimensional Criteria ft/in.	Dimensional Criteria mm
Minimum width	See 7.2.2.2.1.2.	
Maximum height of risers	7 in.	180
Minimum height of risers	4 in.	100
Minimum tread depth	11 in.	280
Minimum headroom	6 ft 8 in.	2030
Maximum height between landings	12 ft	3660
Landing	See 7.2.1.3, 7.2.1.4.3.1, and 7.2.2.3.2.	

Table 7.2.2.2.1.1(b) Existing Stairs

Feature	Dimensional Criteria ft/in.	Dimensional Criteria mm
Minimum width clear of all obstructions, except projections not more than 4½ in. (114 mm) at or below handrail height on each side	36 in.	915
Maximum height of risers	8 in.	205
Minimum tread depth	9 in.	230
Minimum headroom	6 ft 8 in.	2030
Maximum height between landings	12 ft	3660
Landing	See 7.2.1.3 and 7.2.1.4.3.1.	

Table 7.2.2.2.1.2(B) New Stair Width

Total Cumulative Occupant Load Assigned to the Stair	Width in.	Width mm
<2000 persons	44	1120
≥2000 persons	56	1420

(C) The total cumulative occupant load assigned to a particular stair shall be that stair's prorated share of the total occupant load, as stipulated in 7.2.2.2.1.2(D) and 7.2.2.2.1.2(E), calculated in proportion to the stair width.

(D) For downward egress travel, stair width shall be based on the total number of occupants from stories above the level where the width is measured.

(E) For upward egress travel, stair width shall be based on the total number of occupants from stories below the level where the width is measured.

(F) The clear width of door openings discharging from stairways required to be a minimum of 56 in. (1420 mm) wide in accordance with 7.2.2.2.1.2(B) shall be in accordance with 7.2.1.2.3.2(9).

7.2.2.2.2 Curved Stairs.

7.2.2.2.2.1 New curved stairs shall be permitted as a component in a means of egress, provided that the depth of tread is not less than 11 in. (280 mm) at a point 12 in. (305 mm) from the narrower end of the tread and the smallest radius is not less than twice the stair width.

7.2.2.2.2.2 Existing curved stairs shall be permitted as a component in a means of egress, provided that the depth of tread is not less than 10 in. (255 mm) at a point 12 in. (305 mm) from the narrower end of the tread and the smallest radius is not less than twice the stair width.

7.2.2.2.3 Spiral Stairs.

7.2.2.2.3.1 Where specifically permitted for individual occupancies by Chapters 11 through 43, spiral stairs shall be permitted as a component in a means of egress in accordance with 7.2.2.2.3.2 through 7.2.2.2.3.4.

7.2.2.2.3.2 Spiral stairs shall be permitted, provided that all of the following criteria are met:

(1) Riser heights shall not exceed 7 in. (180 mm).
(2) The stairway shall have a tread depth of not less than 11 in. (280 mm) for a portion of the stairway width sufficient to provide egress capacity for the occupant load served in accordance with 7.3.3.1.
(3) At the outer side of the stairway, an additional 10½ in. (265 mm) of width shall be provided clear to the other handrail, and this width shall not be included as part of the required egress capacity.
(4) Handrails complying with 7.2.2.4 shall be provided on both sides of the spiral stairway.
(5) The inner handrail shall be located within 24 in. (610 mm), measured horizontally, of the point where a tread depth of not less than 11 in. (280 mm) is provided.
(6) The turn of the stairway shall be such that the outer handrail is at the right side of descending users.

7.2.2.2.3.3 Where the occupant load served does not exceed three, spiral stairs shall be permitted, provided that all of the following criteria are met:

(1) The clear width of the stairs shall be not less than 26 in. (660 mm).
(2) The height of risers shall not exceed 9½ in. (240 mm).
(3) The headroom shall be not less than 6 ft 6 in. (1980 mm).
(4) Treads shall have a depth not less than 7½ in. (190 mm) at a point 12 in. (305 mm) from the narrower edge.
(5) All treads shall be identical.
(6) Handrails shall be provided on both sides of the stairway.

7.2.2.2.3.4 Where the occupant load served does not exceed five, existing spiral stairs shall be permitted, provided that the requirements of 7.2.2.2.3.3(1) through (5) are met.

7.2.2.2.4* Winders.

7.2.2.2.4.1 Where specified in Chapters 11 through 43, winders shall be permitted in stairs, provided that they meet the requirements of 7.2.2.2.4.2 and 7.2.2.2.4.3.

7.2.2.2.4.2 New winders shall have a tread depth of not less than 6 in. (150 mm) and a tread depth of not less than 11 in. (280 mm) at a point 12 in. (305 mm) from the narrowest edge.

7.2.2.2.4.3 Existing winders shall be permitted to be continued in use, provided that they have a tread depth of not less than 6 in. (150 mm) and a tread depth of not less than 9 in. (230 mm) at a point 12 in. (305 mm) from the narrowest edge.

7.2.2.3 Stair Details.

7.2.2.3.1 Construction.

7.2.2.3.1.1 All stairs serving as required means of egress shall be of permanent fixed construction, unless they are stairs serving seating that is designed to be repositioned in accordance with Chapters 12 and 13.

7.2.2.3.1.2 Each stair, platform, and landing, not including handrails and existing stairs, in buildings required in this *Code* to be of Type I or Type II construction shall be of noncombustible material throughout.

7.2.2.3.2 Landings.

7.2.2.3.2.1 Stairs shall have landings at door openings, except as permitted in 7.2.2.3.2.5.

7.2.2.3.2.2 Stairs and intermediate landings shall continue with no decrease in width along the direction of egress travel.

7.2.2.3.2.3 In new buildings, every landing shall have a dimension, measured in the direction of travel, that is not less than the width of the stair.

7.2.2.3.2.4 Landings shall not be required to exceed 48 in. (1220 mm) in the direction of travel, provided that the stair has a straight run.

7.2.2.3.2.5 In existing buildings, a door assembly at the top of a stair shall be permitted to open directly to the stair, provided that the door leaf does not swing over the stair and the door opening serves an area with an occupant load of fewer than 50 persons.

7.2.2.3.3 Tread and Landing Surfaces.

7.2.2.3.3.1 Stair treads and landings shall be solid, without perforations, unless otherwise permitted in 7.2.2.3.3.5.

7.2.2.3.3.2* Stair treads and landings shall be free of projections or lips that could trip stair users.

7.2.2.3.3.3* Stair treads and landings within the same stairway shall have consistent surface traction.

7.2.2.3.3.4 If not vertical, risers on other than existing stairs shall be permitted to slope under the tread at an angle not to exceed 30 degrees from vertical, provided that the projection of the nosing does not exceed 1½ in. (38 mm).

7.2.2.3.3.5 The requirement of 7.2.2.3.3.1 shall not apply to noncombustible grated stair treads and landings in the following occupancies:

(1) Assembly occupancies as otherwise provided in Chapters 12 and 13
(2) Detention and correctional occupancies as otherwise provided in Chapters 22 and 23
(3) Industrial occupancies as otherwise provided in Chapter 40
(4) Storage occupancies as otherwise provided in Chapter 42

7.2.2.3.4* Tread and Landing Slope. The tread and landing slope shall not exceed ¼ in./ft (21 mm/m) (a slope of 1 in 48).

7.2.2.3.5* Riser Height and Tread Depth. Riser height shall be measured as the vertical distance between tread nosings. Tread depth shall be measured horizontally, between the vertical planes of the foremost projection of adjacent treads and at a right angle to the tread's leading edge, but shall not include beveled or rounded tread surfaces that slope more than 20 degrees (a slope of 1 in 2.75). At tread nosings, such beveling or rounding shall not exceed ½ in. (13 mm) in horizontal dimension.

7.2.2.3.6* Dimensional Uniformity.

7.2.2.3.6.1 Variation in excess of 3⁄16 in. (4.8 mm) in the sizes of adjacent tread depths or in the height of adjacent risers shall be prohibited, unless otherwise permitted in 7.2.2.3.6.3.

7.2.2.3.6.2 The variation between the sizes of the largest and smallest riser or between the largest and smallest tread depths shall not exceed ⅜ in. (9.5 mm) in any flight.

7.2.2.3.6.3 Where the bottom or top riser adjoins a sloping public way, walk, or driveway having an established finished ground level and serves as a landing, the bottom or top riser shall be permitted to have a variation in height of not more than 1 in. in every 12 in. (25 mm in every 305 mm) of stairway width.

7.2.2.3.6.4 The size of the variations addressed by 7.2.2.3.6.1, 7.2.2.3.6.2, and 7.2.2.3.6.3 shall be based on the nosing-to-nosing dimensions of the tread depths and riser heights, consistent with the measurement details set out in 7.2.2.3.5.

7.2.2.3.6.5* All tread nosings of stairs utilizing the provision of 7.2.2.3.6.3 shall be marked in accordance with 7.2.2.5.4.3. Those portions of the marking stripe at locations where the riser height below the nosing is inconsistent by more than 3⁄16 in. (4.8 mm), relative to other risers in the stair flight, shall be distinctively colored or patterned, incorporating safety yellow, to warn descending users of the inconsistent geometry relative to other steps in the flight.

7.2.2.3.6.6 The variation in the horizontal projection of all nosings, including the projection of the landing nosing, shall not exceed 3⁄8 in. (9.5 mm) within each stair flight and, for other than existing nosings, shall not exceed 3⁄16 in. (4.8 mm) between adjacent nosings.

7.2.2.4 Guards and Handrails.

7.2.2.4.1 Handrails.

7.2.2.4.1.1 Stairs and ramps shall have handrails on both sides, unless otherwise permitted in 7.2.2.4.1.5 or 7.2.2.4.1.6.

7.2.2.4.1.2 In addition to the handrails required at the sides of stairs by 7.2.2.4.1.1, both of the following provisions shall apply:

(1) For new stairs, handrails shall be provided within 30 in. (760 mm) of all portions of the required egress width.
(2) For existing stairs, handrails shall meet the following criteria:
    (a) They shall be provided within 44 in. (1120 mm) of all portions of the required egress width.
    (b) Such stairs shall not have their egress capacity adjusted to a higher occupant load than permitted by the capacity factor in Table 7.3.3.1 if the stair's clear width between handrails exceeds 60 in. (1525 mm).

7.2.2.4.1.3 Where new intermediate handrails are provided in accordance with 7.2.2.4.1.2, the minimum clear width between handrails shall be 20 in. (510 mm).

7.2.2.4.1.4* The required egress width shall be provided along the natural path of travel.

7.2.2.4.1.5 If a single step or a ramp is part of a curb that separates a sidewalk from a vehicular way, it shall not be required to have a handrail.

7.2.2.4.1.6 Existing stairs, existing ramps, stairs within dwelling units and within guest rooms, and ramps within dwelling units and guest rooms shall be permitted to have a handrail on one side only.

7.2.2.4.2 Continuity. Required guards and handrails shall continue for the full length of each flight of stairs. At turns of new stairs, inside handrails shall be continuous between flights at landings.

7.2.2.4.3 Projections. The design of guards and handrails and the hardware for attaching handrails to guards, balusters, or walls shall be such that there are no projections that might engage loose clothing. Openings in guards shall be designed to prevent loose clothing from becoming wedged in such openings.

7.2.2.4.4 Direction. For standard stairs, at least one handrail shall be installed at a right angle to the leading edge of the stair treads.

7.2.2.4.5* Handrail Details.

7.2.2.4.5.1 New handrails on stairs shall be not less than 34 in. (865 mm), and not more than 38 in. (965 mm), above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.

7.2.2.4.5.2 Existing required handrails shall be not less than 30 in. (760 mm), and not more than 38 in. (965 mm), above the surface of the tread, measured vertically to the top of the rail from the leading edge of the tread.

7.2.2.4.5.3 The height of required handrails that form part of a guard shall be permitted to exceed 38 in. (965 mm), but shall not exceed 42 in. (1065 mm), measured vertically to the top of the rail from the leading edge of the tread.

7.2.2.4.5.4* Additional handrails that are lower or higher than the main handrail shall be permitted.

7.2.2.4.5.5 New handrails shall be installed to provide a clearance of not less than 2¼ in. (57 mm) between the handrail and the wall to which it is fastened.

7.2.2.4.5.6 Handrails shall include one of the following features:

(1) Circular cross section with an outside diameter of not less than 1¼ in. (32 mm) and not more than 2 in. (51 mm)
(2)*Shape that is other than circular with a perimeter dimension of not less than 4 in. (100 mm), but not more than 6¼ in. (160 mm), and with the largest cross-sectional dimension not more than 2¼ in. (57 mm), provided that graspable edges are rounded so as to provide a radius of not less than 1⁄8 in. (3.2 mm)

7.2.2.4.5.7 New handrails shall be continuously graspable along their entire length.

7.2.2.4.5.8 Handrail brackets or balusters attached to the bottom surface of the handrail shall not be considered to be obstructions to graspability, provided that both of the following criteria are met:

(1) They do not project horizontally beyond the sides of the handrail within 1½ in. (38 mm) of the bottom of the handrail and provided that, for each additional ½ in. (13 mm) of handrail perimeter dimension greater than 4 in. (100 mm), the vertical clearance dimension of 1½ in. (38 mm) is reduced by 1⁄8 in. (3.2 mm).
(2) They have edges with a radius of not less than 0.01 in. (0.25 mm).

7.2.2.4.5.9 New handrail ends shall be returned to the wall or floor or shall terminate at newel posts.

7.2.2.4.5.10 In other than dwelling units, new handrails that are not continuous between flights shall extend horizontally, at the required height, not less than 12 in. (305 mm) beyond the top riser and continue to slope for a depth of one tread beyond the bottom riser.

7.2.2.4.5.11 Within dwelling units, handrails shall extend, at the required height, to at least those points that are directly above the top and bottom risers.

7.2.2.4.6 Guard Details. See 7.1.8 for guard requirements.

7.2.2.4.6.1 The height of guards required in 7.1.8 shall be measured vertically to the top of the guard from the surface adjacent thereto.

7.2.2.4.6.2 Guards shall be not less than 42 in. (1065 mm) high, except as permitted by one of the following:

(1) Existing guards within dwelling units shall be permitted to be not less than 36 in. (915 mm) high.
(2) The requirement of 7.2.2.4.6.2 shall not apply in assembly occupancies where otherwise provided in Chapters 12 and 13.
(3)*Existing guards on existing stairs shall be permitted to be not less than 30 in. (760 mm) high.

7.2.2.4.6.3* Open guards, other than approved existing open guards, shall have intermediate rails or an ornamental pattern such that a sphere 4 in. (100 mm) in diameter is not able to pass through any opening up to a height of 34 in. (865 mm), and the following also shall apply:

(1) The triangular openings formed by the riser, tread, and bottom element of a guardrail at the open side of a stair shall be of such size that a sphere 6 in. (150 mm) in diameter is not able to pass through the triangular opening.
(2) In detention and correctional occupancies, in industrial occupancies, and in storage occupancies, the clear distance between intermediate rails, measured at right angles to the rails, shall not exceed 21 in. (535 mm).

7.2.2.5 Enclosure and Protection of Stairs.

7.2.2.5.1 Enclosures.

7.2.2.5.1.1 All inside stairs serving as an exit or exit component shall be enclosed in accordance with 7.1.3.2.

7.2.2.5.1.2 Inside stairs, other than those serving as an exit or exit component, shall be protected in accordance with Section 8.6.

7.2.2.5.1.3 In existing buildings, where a two-story exit enclosure connects the story of exit discharge with an adjacent story, the exit shall be permitted to be enclosed only on the story of exit discharge, provided that not less than 50 percent of the number and capacity of exits on the story of exit discharge are independent of such enclosures.

7.2.2.5.2* Exposures.

7.2.2.5.2.1 Where nonrated walls or unprotected openings enclose the exterior of a stairway, other than an existing stairway, and the walls or openings are exposed by other parts of the building at an angle of less than 180 degrees, the building enclosure walls within 10 ft (3050 mm) horizontally of the nonrated wall or unprotected opening shall be constructed as required for stairway enclosures, including opening protectives.

7.2.2.5.2.2 Construction shall extend vertically from the finished ground level to a point 10 ft (3050 mm) above the topmost landing of the stairs or to the roofline, whichever is lower.

7.2.2.5.2.3 The fire resistance rating of the separation extending 10 ft (3050 mm) from the stairs shall not be required to exceed 1 hour where openings have a minimum ¾-hour fire protection rating.

7.2.2.5.3* Usable Space. Enclosed, usable spaces within exit enclosures shall be prohibited, including under stairs, unless otherwise permitted by 7.2.2.5.3.2.

7.2.2.5.3.1 Open space within the exit enclosure shall not be used for any purpose that has the potential to interfere with egress.

7.2.2.5.3.2 Enclosed, usable space shall be permitted under stairs, provided that both of the following criteria are met:

(1) The space shall be separated from the stair enclosure by the same fire resistance as the exit enclosure.
(2) Entrance to the enclosed, usable space shall not be from within the stair enclosure. *(See also 7.1.3.2.3.)*

7.2.2.5.4* Stairway Identification.

7.2.2.5.4.1 New enclosed stairs serving three or more stories and existing enclosed stairs, other than those addressed in 7.2.2.5.4.1(P), serving five or more stories shall comply with 7.2.2.5.4.1(A) through 7.2.2.5.4.1(O).

(A) The stairs shall be provided with special signage within the enclosure at each floor landing.

(B) The signage shall indicate the floor level.

(C) The signage shall indicate the terminus of the top and bottom of the stair enclosure.

(D) The signage shall indicate the identification of the stair enclosure.

(E) The signage shall indicate the floor level of, and the direction to, exit discharge.

(F) The signage shall be located inside the stair enclosure.

(G) The bottom of the signage shall be located a minimum of 48 in. (1220 mm) above the floor landing, and the top of the signage shall be located a maximum of 84 in. (2135 mm) above the floor landing

(H) The signage shall be in a position that is visible when the door is in the open or closed position.

(I) The signage shall comply with 7.10.8.1 and 7.10.8.2 of this *Code*.

(J) The floor level designation shall also be tactile in accordance with ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*.

(K) The signage shall be painted or stenciled on the wall or on a separate sign securely attached to the wall.

(L) The stairway identification shall be located at the top of the sign in minimum 1 in. (25 mm) high lettering and shall be in accordance with 7.10.8.2.

(M)* Signage that reads NO ROOF ACCESS shall designate stairways that do not provide roof access. Lettering shall be a minimum of 1 in. (25 mm) high and shall be in accordance with 7.10.8.2.

(N) The floor level number shall be located below the stairway identifier in minimum 5 in. (125 mm) high numbers and shall be in accordance with 7.10.8.2. Mezzanine levels shall have the letter "M" or other appropriate identification letter preceding the floor number, while basement levels shall have the letter "B" or other appropriate identification letter preceding the floor level number.

(O) Identification of the lower and upper terminus of the stairway shall be on the sign in minimum 1 in. (25 mm) high letters or numbers and shall be in accordance with 7.10.8.2.

(P) Previously approved, existing signage shall not be required to comply with 7.2.2.5.4.1(L) through (O).

7.2.2.5.4.2 Wherever an enclosed stair requires travel in an upward direction to reach the level of exit discharge, special signs with directional indicators showing the direction to the level of exit discharge shall be provided at each floor level landing from which upward direction of travel is required, unless otherwise provided in 7.2.2.5.4.2(A) and 7.2.2.5.4.2(B), and both of the following also shall apply:

(1) Such signage shall comply with 7.10.8.1 and 7.10.8.2.
(2) Such signage shall be visible when the door leaf is in the open or closed position.

(A) The requirement of 7.2.2.5.4.2 shall not apply where signs required by 7.2.2.5.4.1 are provided.

(B) The requirement of 7.2.2.5.4.2 shall not apply to stairs extending not more than one story below the level of exit discharge where the exit discharge is clearly obvious.

7.2.2.5.4.3* Stairway Tread Marking. Where new contrasting marking is applied to stairs, such marking shall comply with all of the following:

(1) The marking shall include a continuous strip as a coating on, or as a material integral with, the full width of the leading edge of each tread.
(2) The marking shall include a continuous strip as a coating on, or as a material integral with, the full width of the leading edge of each landing nosing.
(3) The marking strip width, measured horizontally from the leading vertical edge of the nosing, shall be consistent at all nosings.
(4) The marking strip width shall be 1 in. to 2 in. (25 mm to 51 mm).

7.2.2.5.4.4* Where new contrast marking is provided for stairway handrails, it shall be applied to, or be part of, at least the upper surface of the handrail; have a minimum width of ½ in. (13 mm); and extend the full length of each handrail. After marking, the handrail shall comply with 7.2.2.4.5. Where handrails or handrail extensions bend or turn corners, the stripe shall be permitted to have a gap of not more than 4 in. (100 mm).

7.2.2.5.5 Exit Stair Path Markings. Where exit stair path markings are required in Chapters 11 through 43, such markings shall be installed in accordance with 7.2.2.5.5.1 through 7.2.2.5.5.11.

7.2.2.5.5.1* Exit Stair Treads. Exit stair treads shall incorporate a marking stripe that is applied as a paint/coating or be a material that is integral with the nosing of each step.

(A) The marking stripe shall be installed along the horizontal leading edge of the step and shall extend the full width of the step.

(B) The marking stripe shall also meet all of the following requirements:

(1) The marking stripe shall be not more than ½ in. (13 mm) from the leading edge of each step and shall not overlap the leading edge of the step by more than ½ in. (13 mm) down the vertical face of the step.
(2) The marking stripe shall have a minimum horizontal width of 1 in. (25 mm) and a maximum width of 2 in. (51 mm).
(3) The dimensions and placement of the marking stripe shall be uniform and consistent on each step throughout the exit enclosure.
(4) Surface-applied marking stripes using adhesive-backed tapes shall not be used.

7.2.2.5.5.2 Exit Stair Landings. The leading edge of exit stair landings shall be marked with a solid and continuous marking stripe consistent with the dimensional requirements for stair treads and shall be the same length as, and consistent with, the stripes on the steps.

7.2.2.5.5.3 Exit Stair Handrails. All handrails and handrail extensions shall be marked with a solid and continuous marking stripe and meet all of the following requirements:

(1) The marking stripe shall be applied to the upper surface of the handrail or be a material integral with the upper surface of the handrail for the entire length of the handrail, including extensions.
(2) Where handrails or handrail extensions bend or turn corners, the marking stripe shall be permitted to have a gap of not more than 4 in. (100 mm).
(3) The marking stripe shall have a minimum horizontal width of 1 in. (25 mm), which shall not apply to outlining stripes listed in accordance with ANSI/UL 1994, *Standard for Luminous Egress Path Marking Systems.*
(4) The dimensions and placement of the marking stripe shall be uniform and consistent on each handrail throughout the exit enclosure.

7.2.2.5.5.4 Perimeter Demarcation Marking. Stair landings, exit passageways, and other parts of the floor areas within the exit enclosure shall be provided with a solid and continuous perimeter demarcation marking stripe on the floor or on the walls or a combination of both. The marking stripe shall also meet all of the following requirements:

(1) The marking stripe shall have a minimum horizontal width of 1 in. (25 mm) and a maximum width of 2 in. (51 mm), with interruptions not exceeding 4 in. (100 mm).
(2) The minimum marking stripe width of 1 in. (25 mm) shall not apply to outlining stripes listed in accordance with ANSI/UL 1994, *Standard for Luminous Egress Path Marking Systems.*
(3) The dimensions and placement of the perimeter demarcation marking stripe shall be uniform and consistent throughout the exit enclosure.
(4) Surface-applied marking stripes using adhesive-backed tapes shall not be used.

(A) Perimeter floor demarcation lines shall comply with all of the following:

(1) They shall be placed within 4 in. (100 mm) of the wall and extend to within 2 in. (51 mm) of the markings on the leading edge of landings.
(2) They shall continue across the floor in front of all doors.
(3) They shall not extend in front of exit doors leading out of an exit enclosure and through which occupants must travel to complete the egress path.

(B) Perimeter wall demarcation lines shall comply with all of the following:

(1) They shall be placed on the wall with the bottom edge of the stripe not more than 4 in. (100 mm) above the finished floor.

(2) At the top or bottom of the stairs, they shall drop vertically to the floor within 2 in. (51 mm) of the step or landing edge.
(3) They shall transition vertically to the floor and then extend across the floor where a line on the floor is the only practical method of outlining the path.
(4) Where the wall line is broken by a door, they shall continue across the face of the door or transition to the floor and extend across the floor in front of such door.
(5) They shall not extend in front of doors leading out of an exit enclosure and through which occupants must travel to complete the egress path.
(6) Where a wall-mounted demarcation line transitions to a floor-mounted demarcation line, or vice versa, the wall-mounted demarcation line shall drop vertically to the floor to meet a complementary extension of the floor-mounted demarcation line, thus forming a continuous marking.

7.2.2.5.5.5* Obstacles. Obstacles that are in the exit enclosure at or below 6 ft 6 in. (1980 mm) in height, and that project more than 4 in. (100 mm) into the egress path, shall be identified with markings not less than 1 in. (25 mm) in horizontal width comprised of a pattern of alternating equal bands of luminescent material and black; and with the alternating bands not more than 2 in. (51 mm) in horizontal width and angled at 45 degrees.

7.2.2.5.5.6 Doors Serving Exit Enclosure. All doors serving the exit enclosure that swing out from the enclosure in the direction of egress travel shall be provided with a marking stripe on the top and sides of the door(s) frame(s). The marking stripe shall also meet all of the following requirements:

(1) The marking stripe shall have a minimum horizontal width of 1 in. (25 mm) and a maximum width of 2 in. (51 mm).
(2) Gaps shall be permitted in the continuity of door frame markings where a line is fitted into a corner or bend, but shall be as small as practicable, and in no case shall gaps be greater than 1 in. (25 mm).
(3) Where the door molding does not provide enough flat surface on which to locate the marking stripe, the marking stripe shall be located on the wall surrounding the frame.
(4) The dimensions and placement of the marking stripe shall be uniform and consistent on all doors in the exit enclosure.

7.2.2.5.5.7 Door Hardware Marking.

(A) The door hardware for the doors serving the exit enclosure that swing out from the enclosure in the direction of egress travel shall be provided with a marking stripe.

(B) The marking stripe shall also meet the following requirements:

(1)*The door hardware necessary to release the latch shall be outlined with an approved marking stripe having a minimum width of 1 in. (25 mm).
(2) Where panic hardware is installed, both of the following criteria shall be met:
   (a) The marking stripe shall have a minimum width of 1 in. (25 mm) and be applied to the entire length of the actuating bar or touch pad.
   (b) The placement of the marking stripe shall not interfere with viewing of any instructions on the actuating bar or touch pad.

7.2.2.5.5.8 Emergency Exit Symbol. An emergency exit symbol with a luminescent background shall be applied on all doors serving the exit enclosure that swing out from the enclosure in the direction of egress travel. The emergency exit symbol shall also meet both of the following requirements:

(1) The emergency exit symbol shall meet the requirements of NFPA 170, *Standard for Fire Safety and Emergency Symbols*.
(2) The emergency exit symbol applied on the door shall be a minimum of 4 in. (100 mm) in height and shall be applied on the door, centered horizontally, with the top of the symbol not higher than 18 in. (455 mm) above the finished floor.

7.2.2.5.5.9 Uniformity. Placement and dimensions of the marking stripes shall be consistent and uniform throughout the same exit enclosure.

7.2.2.5.5.10 Materials. Exit stair path markings shall be made of any material, including paint, provided that an electrical charge is not required to maintain the required luminescence. Such materials shall include, but shall not be limited to, self-luminous materials and photoluminescent materials. Materials shall comply with one of the following:

(1) ASTM E 2072, *Standard Specification for Photoluminescent (Phosphorescent) Safety Markings*, with the following exceptions:
   (a) The charging source shall be 1 ft-candle (10.8 lux) of fluorescent illumination for 60 minutes.
   (b) The minimum luminance shall be 5 millicandelas/m^2 after 90 minutes.
(2) ANSI/UL 1994, *Standard for Luminous Egress Path Marking Systems*

7.2.2.5.5.11 Exit Stair Illumination. Exit enclosures where photoluminescent materials are installed shall comply with all of the following:

(1) The exit enclosure shall be continuously illuminated for at least 60 minutes prior to periods when the building is occupied.
(2) The illumination shall remain on when the building is occupied.
(3) Lighting control devices provided for illumination within the exit enclosure shall meet all of the following requirements:
   (a) Lighting control devices that automatically turn exit enclosure lighting on and off, based on occupancy, shall be permitted, provided that they turn on illumination for charging photoluminescent materials for at least 60 minutes prior to periods when the building is occupied.
   (b) Lighting used to charge photoluminescent materials shall not be controlled by motion sensors.
   (c) Lighting control devices that dim the lighting levels within the exit enclosure shall not be installed unless they provide a minimum of 1 ft-candle (10.8 lux) of illumination within the exit enclosure measured at the walking surface.

7.2.2.6 Special Provisions for Outside Stairs.

7.2.2.6.1 Access. Where approved by the authority having jurisdiction, outside stairs shall be permitted to lead to roofs of other sections of a building or an adjoining building where the construction is fire resistive and there is a continuous and safe means of egress from the roof. *(See also 7.7.6.)*

7.2.2.6.2* Visual Protection. Outside stairs shall be arranged to avoid any impediments to their use by persons having a fear of high places. Outside stairs more than 36 ft (11 m) above the finished ground level, other than previously approved existing stairs, shall be provided with an opaque visual obstruction not less than 48. in. (1220 mm) in height.

7.2.2.6.3 Separation and Protection of Outside Stairs.

7.2.2.6.3.1* Outside stairs shall be separated from the interior of the building by construction with the fire resistance rating required for enclosed stairs with fixed or self-closing opening protectives, except as follows:

(1) Outside stairs serving an exterior exit access balcony that has two remote outside stairways or ramps shall be permitted to be unprotected.
(2) Outside stairs serving two or fewer adjacent stories, including the story where the exit discharges, shall be permitted to be unprotected where there is a remotely located second exit.
(3) In existing buildings, existing outside stairs serving three or fewer adjacent stories, including the story where the exit discharges, shall be permitted to be unprotected where there is a remotely located second exit.
(4) The fire resistance rating of a separation extending 10 ft (3050 mm) from the stairs shall not be required to exceed 1 hour where openings have a minimum ¾-hour fire protection rating.
(5) Outside stairs in existing buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall be permitted to be unprotected.

7.2.2.6.3.2 Wall construction required by 7.2.2.6.3.1 shall extend as follows:

(1) Vertically from the finished ground level to a point 10 ft (3050 mm) above the topmost landing of the stairs or to the roofline, whichever is lower
(2) Horizontally for not less than 10 ft (3050 mm)

7.2.2.6.3.3 Roof construction required by 7.2.2.6.3.1 shall meet both of the following criteria:

(1) It shall provide protection beneath the stairs.
(2) It shall extend horizontally to each side of the stair for not less than 10 ft (3050 mm).

7.2.2.6.4 Protection of Openings. All openings below an outside stair shall be protected with an assembly having a minimum ¾-hour fire protection rating as follows:

(1) Where located in an enclosed court *(see 3.3.50.1)*, the smallest dimension of which does not exceed one-third its height
(2) Where located in an alcove having a width that does not exceed one-third its height and a depth that does not exceed one-fourth its height

7.2.2.6.5* Water Accumulation. Outside stairs and landings, other than existing outside stairs and landings, shall be designed to minimize water accumulation on their surfaces.

7.2.2.6.6 Openness. Outside stairs, other than existing outside stairs, shall be not less than 50 percent open on one side. Outside stairs shall be arranged to restrict the accumulation of smoke.

7.2.3 Smokeproof Enclosures.

7.2.3.1 General. Where smokeproof enclosures are required in other sections of this *Code,* they shall comply with 7.2.3, unless they are approved existing smokeproof enclosures.

7.2.3.2 Performance Design. An appropriate design method shall be used to provide a system that meets the definition of *smokeproof enclosure (see 3.3.257).* The smokeproof enclosure shall be permitted to be created by using natural ventilation, by using mechanical ventilation incorporating a vestibule, or by pressurizing the stair enclosure.

7.2.3.3 Enclosure.

7.2.3.3.1 A smokeproof enclosure shall be continuously enclosed by barriers having a 2-hour fire resistance rating from the highest point to the level of exit discharge, except as otherwise permitted in 7.2.3.3.3.

7.2.3.3.2 Where a vestibule is used, it shall be within the 2-hour-rated enclosure and shall be considered part of the smokeproof enclosure.

7.2.3.3.3 A smokeproof enclosure comprised of an enclosed stair and serving floors below the level of exit discharge shall not be required to comply with 7.2.3.3.1 where the portion of the stairway below is separated from the stairway enclosure at the level of exit discharge by barriers with a 1-hour fire resistance rating.

7.2.3.4 Vestibule. Where a vestibule is provided, the door opening into the vestibule shall be protected with an approved fire door assembly having a minimum 1½-hour fire protection rating, and the fire door assembly from the vestibule to the smokeproof enclosure shall have a minimum 20-minute fire protection rating. Door leaves shall be designed to minimize air leakage and shall be self-closing or shall be automatic-closing by actuation of a smoke detector within 10 ft (3050 mm) of the vestibule door opening. New door assemblies shall be installed in accordance with NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives.*

7.2.3.5 Discharge.

7.2.3.5.1 Every smokeproof enclosure shall discharge into a public way, into a yard or court having direct access to a public way, or into an exit passageway. Such exit passageways shall be without openings, other than the entrance to the smokeproof enclosure and the door opening to the outside yard, court, or public way. The exit passageway shall be separated from the remainder of the building by a 2-hour fire resistance rating.

7.2.3.5.2 The smokeproof enclosure shall be permitted to discharge through interior building areas, provided that all of the following criteria are met:

(1) The building shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) The discharge from the smokeproof enclosure shall lead to a free and unobstructed way to an exterior exit, and such way shall be readily visible and identifiable from the point of discharge from the smokeproof enclosure.
(3) Not more than 50 percent of the required number and capacity of exits comprised of smokeproof enclosures shall discharge through interior building areas in accordance with 7.7.2.

7.2.3.6 Access. For smokeproof enclosures other than those consisting of a pressurized enclosure complying with 7.2.3.9, access to the smokeproof enclosure shall be by way of a vestibule or by way of an exterior balcony.

7.2.3.7 Natural Ventilation. Smokeproof enclosures using natural ventilation shall comply with 7.2.3.3 and all of the following:

(1) Where access to the enclosure is by means of an open exterior balcony, the door assembly to the enclosure shall have a minimum 1½-hour fire protection rating and shall be self-closing or shall be automatic-closing by actuation of a smoke detector.
(2) Openings adjacent to the exterior balcony specified in 7.2.3.7(1) shall be protected in accordance with 7.2.2.6.4.
(3) Every vestibule shall have a net area of not less than 16 ft^2 (1.5 m^2) of opening in an exterior wall facing an exterior court, yard, or public space not less than 20 ft (6100 mm) in width.
(4) Every vestibule shall have a minimum dimension of not less than the required width of the corridor leading to it and a dimension of not less than 6 ft (1830 mm) in the direction of travel.

7.2.3.8 Mechanical Ventilation. Smokeproof enclosures using mechanical ventilation shall comply with 7.2.3.3 and the requirements of 7.2.3.8.1 through 7.2.3.8.4.

7.2.3.8.1 Vestibules shall have a dimension of not less than 44 in. (1120 mm) in width and not less than 6 ft (1830 mm) in the direction of travel.

7.2.3.8.2 The vestibule shall be provided with not less than one air change per minute, and the exhaust shall be 150 percent of the supply. Supply air shall enter and exhaust air shall discharge from the vestibule through separate tightly constructed ducts used only for such purposes. Supply air shall enter the vestibule within 6 in. (150 mm) of the floor level. The top of the exhaust register shall be located not more than 6 in. (150 mm) below the top of the trap and shall be entirely within the smoke trap area. Door leaves, when in the open position, shall not obstruct duct openings. Controlling dampers shall be permitted in duct openings if needed to meet the design requirements.

7.2.3.8.3 To serve as a smoke and heat trap and to provide an upward-moving air column, the vestibule ceiling shall be not less than 20 in. (510 mm) higher than the door opening into the vestibule. The height shall be permitted to be decreased where justified by engineering design and field testing.

7.2.3.8.4 The stair shall be provided with a dampered relief opening at the top and supplied mechanically with sufficient air to discharge at least 2500 ft^3/min (70.8 m^3/min) through the relief opening while maintaining a positive pressure of not less than 0.10 in. water column (25 N/m^2) in the stair, relative to the vestibule with all door leaves closed.

7.2.3.9 Enclosure Pressurization.

7.2.3.9.1* Smokeproof enclosures using pressurization shall use an approved engineered system with a design pressure difference across the barrier of not less than 0.05 in. water column (12.5 N/m^2) in sprinklered buildings, or 0.10 in. water column (25 N/m^2) in nonsprinklered buildings, and shall be capable of maintaining these pressure differences under likely conditions of stack effect or wind. The pressure difference across door openings shall not exceed that which allows the door leaves to begin to be opened by a force of 30 lbf (133 N) in accordance with 7.2.1.4.5.

7.2.3.9.2 Equipment and ductwork for pressurization shall be located in accordance with one of the following specifications:

(1) Exterior to the building and directly connected to the enclosure by ductwork enclosed in noncombustible construction
(2) Within the enclosure with intake and exhaust air vented directly to the outside or through ductwork enclosed by a 2-hour fire-resistive rating
(3) Within the building under the following conditions:
    (a) Where the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by a 2-hour fire-resistive rating
    (b) Where the building, including the enclosure, is protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.7, and the equipment and ductwork are separated from the remainder of the building, including other mechanical equipment, by not less than a 1-hour fire-resistive rating

7.2.3.9.3 In all cases specified by 7.2.3.9.2(1) through (3), openings into the required fire resistance–rated construction shall be limited to those needed for maintenance and operation and shall be protected by self-closing fire protection–rated devices in accordance with 8.3.4.

7.2.3.10 Activation of Mechanical Ventilation and Pressurized Enclosure Systems.

7.2.3.10.1 For both mechanical ventilation and pressurized enclosure systems, the activation of the systems shall be initiated by a smoke detector installed in an approved location within 10 ft (3050 mm) of each entrance to the smokeproof enclosure.

7.2.3.10.2 The required mechanical system shall operate upon the activation of the smoke detectors specified in 7.2.3.10.1 and by manual controls accessible to the fire department. The required system also shall be initiated by the following, if provided:

(1) Waterflow signal from a complete automatic sprinkler system
(2) General evacuation alarm signal *(see 9.6.3.6)*

7.2.3.11 Door Leaf Closers. The activation of an automatic-closing device on any door leaf in the smokeproof enclosure shall activate all other automatic-closing devices on door leaves in the smokeproof enclosure.

7.2.3.12 Emergency Power Supply System (EPSS). Power shall be provided as follows:

(1) A Type 60, Class 2, Level 2 EPSS for new mechanical ventilation equipment shall be provided in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems.*
(2) A previously approved existing standby power generator installation with a fuel supply adequate to operate the equipment for 2 hours shall be permitted in lieu of 7.2.3.12(1).
(3) The generator shall be located in a room separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.

7.2.3.13 Testing. Before the mechanical equipment is accepted by the authority having jurisdiction, it shall be tested to confirm that it is operating in compliance with the requirements of 7.2.3. All operating parts of the system shall be tested semiannually by approved personnel, and a log shall be kept of the results.

7.2.4 Horizontal Exits.

7.2.4.1 General.

7.2.4.1.1 Where horizontal exits are used in the means of egress, they shall conform to the general requirements of Section 7.1 and the special requirements of 7.2.4.

7.2.4.1.2* Horizontal exits shall be permitted to be substituted for other exits where the total egress capacity and the total number of the other exits (stairs, ramps, door openings leading outside the building) is not less than half that required for the entire area of the building or connected buildings, and provided that none of the other exits is a horizontal exit, unless otherwise permitted by 7.2.4.1.3.

7.2.4.1.3 The requirement of 7.2.4.1.2 shall not apply to the following:

(1) Health care occupancies as otherwise provided in Chapters 18 and 19
(2) Detention and correctional occupancies as otherwise provided in Chapters 22 and 23

7.2.4.2 Fire Compartments.

7.2.4.2.1 Every fire compartment for which credit is permitted in connection with a horizontal exit(s) also shall have at least one additional exit, but not less than 50 percent of the required number and capacity of exits, that is not a horizontal exit, unless otherwise provided in 7.2.4.2.1.2.

7.2.4.2.1.1 Any fire compartment not having an exit leading outside shall be considered as part of an adjoining compartment with an exit leading to the outside.

7.2.4.2.1.2 The requirement of 7.2.4.2.1 shall not apply to the following:

(1) Health care occupancies as otherwise provided in Chapters 18 and 19
(2) Detention and correctional occupancies as otherwise provided in Chapters 22 and 23

7.2.4.2.2 Every horizontal exit for which credit is permitted shall be arranged so that there are continuously available paths of travel leading from each side of the exit to stairways or other means of egress leading to outside the building.

7.2.4.2.3 Wherever either side of a horizontal exit is occupied, the door leaves used in connection with the horizontal exit shall be unlocked from the egress side, unless otherwise permitted for the following:

(1) Health care occupancies as provided in Chapters 18 and 19
(2) Detention and correctional occupancies as provided in Chapters 22 and 23

7.2.4.2.4 The floor area on either side of a horizontal exit shall be sufficient to hold the occupants of both floor areas and shall provide at least 3 ft^2 (0.28 m^2) clear floor area per person, unless otherwise permitted for the following:

(1) Health care occupancies as provided in Chapters 18 and 19
(2) Detention and correctional occupancies as provided in Chapters 22 and 23

7.2.4.3 Fire Barriers.

7.2.4.3.1* Fire barriers separating buildings or areas between which there are horizontal exits shall meet both of the following requirements:

(1) The barrier shall have a minimum 2-hour fire resistance rating, unless otherwise provided in 7.2.4.4.1.
(2) The barrier shall provide a separation that is continuous to the finished ground level, unless otherwise provided in 7.2.4.3.2. *(See also Section 8.3.)*

7.2.4.3.2* The separation required by 7.2.4.3.1(2) shall not be required to extend below the lowest level providing discharge to the exterior where both of the following are met:

(1) Stories below the lowest level providing discharge to the exterior do not have a horizontal exit.
(2) Stories below the lowest level providing discharge to the exterior are separated from the level above by a minimum of 2-hour fire resistance–rated construction.

7.2.4.3.3 Where a fire barrier provides a horizontal exit in any story of a building, such fire barrier shall not be required on other stories, provided that all of the following criteria are met:

(1) The stories on which the fire barrier is omitted are separated from the story with the horizontal exit by construction having a fire resistance rating at least equal to that of the horizontal exit fire barrier.
(2) Vertical openings between the story with the horizontal exit and the open fire area story are enclosed with construction having a fire resistance rating at least equal to that of the horizontal exit fire barrier.
(3) All required exits, other than horizontal exits, discharge directly to the outside.

7.2.4.3.4 Where fire barriers serving horizontal exits, other than existing horizontal exits, terminate at outside walls, and the outside walls are at an angle of less than 180 degrees for a distance of 10 ft (3050 mm) on each side of the horizontal exit, the outside walls shall be protected by one of the following methods:

(1) The outside walls shall have a minimum 1-hour fire resistance rating, with opening protectives having a minimum ¾-hour fire protection rating, for a distance of 10 ft (3050 mm) on each side of the horizontal exit.
(2) One of the outside walls shall have a 2-hour fire resistance rating with opening protectives having a minimum 1½-hour fire protection rating, for a distance of 10 ft (3050 mm) from intersection with the horizontal exit.

7.2.4.3.5* Fire barriers forming horizontal exits shall not be penetrated by ducts, unless one of the following criteria is met:

(1) The ducts are existing penetrations protected by approved and listed fire dampers.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(3) The duct penetrations are those permitted in detention and correctional occupancies as otherwise provided in Chapters 22 and 23 and are protected by combination fire dampers/smoke leakage–rated dampers that meet the smoke damper actuation requirements of 8.5.5.

7.2.4.3.6 Any opening in the fire barriers specified in 7.2.4.3.5 shall be protected as provided in 8.3.4.

7.2.4.3.7 Door assemblies in horizontal exits shall comply with 7.2.1.4, unless they are sliding door assemblies in industrial or storage occupancies as otherwise provided in Chapters 40 and 42.

7.2.4.3.8 Unless otherwise specified in 7.2.4.3.8.1 and 7.2.4.3.8.2, swinging fire door assemblies shall be permitted in horizontal exits, provided that the criteria of both 7.2.4.3.8(1) and (2), or the criteria of both 7.2.4.3.8(1) and (3), are met as follows:

(1) The door leaves shall swing in the direction of egress travel.
(2) In other than sleeping room areas in detention and correctional occupancies, where a horizontal exit serves areas on both sides of a fire barrier, adjacent openings with swinging door leaves that open in opposite directions shall be provided, with signs on each side of the fire barrier identifying the door leaf that swings with the travel from that side.
(3) The door assemblies shall be of any other approved arrangement, provided that the door leaves always swing with any possible egress travel.

7.2.4.3.8.1 The requirements of 7.2.4.3.8 shall not apply to horizontal exit door leaf swing as provided in Chapters 19 and 23.

7.2.4.3.8.2 The requirements of 7.2.4.3.8 shall not apply to horizontal exit door assemblies in corridors not more than 6 ft (1830 mm) wide in existing buildings.

7.2.4.3.9 Door leaves in horizontal exits shall be designed and installed to minimize air leakage. New door assemblies in horizontal exits shall be installed in accordance with NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives.*

7.2.4.3.10* All fire door assemblies in horizontal exits shall be self-closing or automatic-closing in accordance with 7.2.1.8.

7.2.4.3.11 Horizontal exit door assemblies located across a corridor, other than approved existing door assemblies, shall be automatic-closing in accordance with 7.2.1.8.2.

7.2.4.4 Bridges Serving Horizontal Exits Between Buildings. The provisions of 7.2.4.4 shall apply to bridges serving horizontal exits between buildings and to the associated horizontal exit fire barrier.

7.2.4.4.1 The minimum 2-hour fire resistance–rated barrier required by 7.2.4.3.1 shall extend as follows:

(1) Vertically from the ground to a point 10 ft (3050 mm) above the bridge or to the roofline, whichever is lower
(2) Horizontally for not less than 10 ft (3050 mm) to each side of the bridge

7.2.4.4.2 Any opening in the fire barrier addressed in 7.2.4.4.1 shall be protected with fire door assemblies or fixed fire window assemblies having a ¾-hour fire protection rating, unless otherwise provided in 7.2.4.4.3.

7.2.4.4.3 The requirement of 7.2.4.4.2 shall not apply to approved existing bridges.

7.2.4.4.4 Where the bridge serves as a horizontal exit in one direction, the horizontal exit door leaf shall be required to swing only in the direction of egress travel, unless the door leaf complies with the swing requirements for the following:

(1) Existing health care occupancies in Chapter 19
(2) Existing detention and correctional occupancies in Chapter 23

7.2.4.4.5 Where the bridge serves as a horizontal exit in both directions, door leaves shall be provided in pairs that swing in opposite directions, with only the door leaf swinging in the direction of egress travel included when determining egress capacity, unless otherwise provided in 7.2.4.4.5.1 through 7.2.4.4.5.3.

7.2.4.4.5.1 Approved existing door assemblies on both ends of the bridge shall be permitted to swing out from the building.

7.2.4.4.5.2 The requirement of 7.2.4.4.5 shall not apply to existing bridges if the bridge has sufficient floor area to accommodate the occupant load of either connected building or fire area based on 3 ft^2 (0.28 m^2) per person.

7.2.4.4.5.3 The requirement of 7.2.4.4.5 shall not apply to horizontal exit door leaf swing as provided for the following:

(1) Existing health care occupancies in Chapter 19
(2) Existing detention and correctional occupancies in Chapter 23

7.2.4.4.6 Every bridge shall be not less than the width of the door opening to which it leads and shall be not less than 44 in. (1120 mm) wide for new construction.

7.2.4.4.7 In climates subject to the accumulation of snow and ice, the bridge floor shall be protected to prevent the accumulation of snow and ice.

7.2.4.4.8 In existing buildings, one step not exceeding 8 in. (205 mm) shall be permitted below the level of the inside floor.

7.2.5 Ramps.

7.2.5.1 General. Every ramp used as a component in a means of egress shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.5.

7.2.5.2 Vehicle Ramps. Vehicle ramps in parking structures, as permitted in 42.8.2.2.6, and not an accessible means of egress or other accessible element, shall be exempt from the provisions of 7.2.5.

7.2.5.3 Dimensional Criteria. The following dimensional criteria shall apply to ramps:

(1) New ramps shall be in accordance with Table 7.2.5.3(a), unless otherwise permitted by the following:
   (a) Table 7.2.5.3(a) shall not apply to industrial equipment access areas as provided in 40.2.5.3.
   (b) The maximum slope requirement shall not apply to ramps in assembly occupancies as provided in Chapter 12.
   (c) The maximum slope or maximum rise for a single ramp run shall not apply to ramps providing access to vehicles, vessels, mobile structures, and aircraft.
(2) Existing ramps shall be permitted to remain in use or be rebuilt, provided that they meet the requirements shown in Table 7.2.5.3(b), unless otherwise permitted by any of the following:
   (a) The requirements of Table 7.2.5.3(b) shall not apply to industrial equipment access areas as provided in 40.2.5.3.
   (b) The maximum slope or maximum height between landings for a single ramp run shall not apply to ramps providing access to vehicles, vessels, mobile structures, and aircraft.
   (c) Approved existing ramps with slopes not steeper than 1 in 6 shall be permitted to remain in use.
   (d) Existing ramps with slopes not steeper than 1 in 10 shall not be required to be provided with landings.

Table 7.2.5.3(a) New Ramps

Feature	Dimensional Criteria in.	Dimensional Criteria mm
Minimum width clear of all obstructions, except projections not more than 4½ in. (114 mm) at or below handrail height on each side	44	1120
Maximum slope	1 in 12	
Maximum cross slope	1 in 48	
Maximum rise for a single ramp run	30	760

Table 7.2.5.3(b) Existing Ramps

Feature	Dimensional Criteria ft/in.	Dimensional Criteria mm
Minimum width	30 in.	760
Maximum slope	1 in 8	
Maximum height between landings	12 ft	3660

7.2.5.4 Ramp Details.

7.2.5.4.1 Construction. Ramp construction shall be as follows:

(1) All ramps serving as required means of egress shall be of permanent fixed construction.
(2) Each ramp in buildings required by this *Code* to be of Type I or Type II construction shall be any combination of noncombustible or limited-combustible material or fire-retardant–treated wood.
(3) Ramps constructed with fire-retardant–treated wood shall be not more than 30 in. (760 mm) high, shall have an area of not more than 3000 ft^2 (277 m^2), and shall not occupy more than 50 percent of the room area.
(4) The ramp floor and landings shall be solid and without perforations.

7.2.5.4.2 Landings. Ramp landings shall be as follows:

(1) Ramps shall have landings located at the top, at the bottom, and at door leaves opening onto the ramp.
(2) The slope of the landing shall be not steeper than 1 in 48.
(3) Every landing shall have a width not less than the width of the ramp.
(4) Every landing, except as otherwise provided in 7.2.5.4.2(5), shall be not less than 60 in. (1525 mm) long in the direction of travel, unless the landing is an approved existing landing.
(5) Where the ramp is not part of an accessible route, the ramp landings shall not be required to exceed 48 in. (1220 mm) in the direction of travel, provided that the ramp has a straight run.
(6) Any changes in travel direction shall be made only at landings, unless the ramp is an existing ramp.
(7) Ramps and intermediate landings shall continue with no decrease in width along the direction of egress travel.

7.2.5.4.3 Drop-Offs. Ramps and landings with drop-offs shall have curbs, walls, railings, or projecting surfaces that prevent people from traveling off the edge of the ramp. Curbs or barriers shall be not less than 4 in. (100 mm) in height.

7.2.5.5 Guards and Handrails.

7.2.5.5.1 Guards complying with 7.2.2.4 shall be provided for ramps, unless otherwise provided in 7.2.5.5.4.

7.2.5.5.2 Handrails complying with 7.2.2.4 shall be provided along both sides of a ramp run with a rise greater than 6 in. (150 mm), unless otherwise provided in 7.2.5.5.4.

7.2.5.5.3 The height of handrails and guards shall be measured vertically to the top of the guard or rail from the walking surface adjacent thereto.

7.2.5.5.4 The requirements of 7.2.5.5.1 and 7.2.5.5.2 shall not apply to guards and handrails provided for ramped aisles in assembly occupancies as otherwise provided in Chapters 12 and 13.

7.2.5.6 Enclosure and Protection of Ramps. Ramps in a required means of egress shall be enclosed or protected as a stair in accordance with 7.2.2.5 and 7.2.2.6.

7.2.5.7 Special Provisions for Outside Ramps.

7.2.5.7.1* Visual Protection. Outside ramps shall be arranged to avoid any impediments to their use by persons having a fear of high places. Outside ramps more than 36 ft (11 m) above the finished ground level shall be provided with an opaque visual obstruction not less than 48 in. (1220 mm) in height.

7.2.5.7.2* Water Accumulation. Outside ramps and landings shall be designed to minimize water accumulation on their surfaces.

7.2.6* Exit Passageways.

7.2.6.1* General. Exit passageways used as exit components shall conform to the general requirements of Section 7.1 and to the special requirements of 7.2.6.

7.2.6.2 Enclosure. An exit passageway shall be separated from other parts of the building as specified in 7.1.3.2, and the following alternatives shall be permitted:

(1) Fire windows in accordance with 8.3.3 shall be permitted to be installed in the separation in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) Existing fixed wired glass panels in steel sash shall be permitted to be continued in use in the separation in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

7.2.6.3 Stair Discharge. An exit passageway that serves as a discharge from a stair enclosure shall have not less than the same fire resistance rating and opening protective fire protection rating as those required for the stair enclosure.

7.2.6.4 Width.

7.2.6.4.1 The width of an exit passageway shall be sized to accommodate the aggregate required capacity of all exits that discharge through it, unless one of the following conditions applies:

(1)*Where an exit passageway serves occupants of the level of exit discharge as well as other stories, the capacity shall not be required to be aggregated.

(2) As provided in Chapters 36 and 37, an exit passageway in a mall building shall be permitted to accommodate occupant loads independently from the mall and the tenant spaces. *(See 36.2.2.7.2 and 37.2.2.7.2.)*

7.2.6.4.2 In new construction, the minimum width of any exit passageway into which an exit stair discharges, or that serves as a horizontal transfer within an exit stair system, shall meet the following criteria:

(1) The minimum width of the exit passageway shall be not less than two-thirds of the width of the exit stair.
(2) Where stairs are credited with egress capacity in accordance with 7.3.3.2, the exit passageway width shall be sized to accommodate the same capacity as the stair, with such capacity determined by use of the capacity factors in Table 7.3.3.1.

7.2.6.5 Floor. The floor shall be solid and without perforations.

7.2.7 Escalators and Moving Walks. Escalators and moving walks shall not constitute a part of the required means of egress, unless they are previously approved existing escalators and moving walks.

7.2.8 Fire Escape Stairs.

7.2.8.1 General.

7.2.8.1.1 Where permitted in Chapters 11 through 43, fire escape stairs shall comply with the provisions of 7.2.8, unless they are approved existing fire escape stairs.

7.2.8.1.2 Fire escape stairs shall not constitute any of the required means of egress, unless otherwise provided in 7.2.8.1.2.1 and 7.2.8.1.2.2.

7.2.8.1.2.1 Fire escape stairs shall be permitted on existing buildings as provided in Chapters 11 through 43 but shall not constitute more than 50 percent of the required means of egress.

7.2.8.1.2.2 New fire escape stairs shall be permitted to be erected on existing buildings only where the authority having jurisdiction has determined that outside stairs are impractical. *(See 7.2.2.)*

7.2.8.1.2.3 New fire escape stairs permitted by 7.2.8.1.2.2 shall not incorporate ladders or access windows, regardless of occupancy classification or occupant load served.

7.2.8.1.3 Fire escape stairs of the return-platform type with superimposed runs, or of the straight-run type with a platform that continues in the same direction, shall be permitted. Either type shall be permitted to be parallel to, or at right angles to, buildings. Either type shall be permitted to be attached to buildings or erected independently of buildings and connected by walkways.

7.2.8.2 Protection of Openings. Fire escape stairs shall be exposed to the smallest possible number of window and door openings, and each opening shall be protected with approved fire door or fire window assemblies where the opening or any portion of the opening is located as follows:

(1) Horizontally, within 15 ft (4570 mm) of any balcony, platform, or stairway constituting a component of the fire escape stair
(2) Below, within three stories or 36 ft (11 m) of any balcony, platform, walkway, or stairway constituting a component of the fire escape stair, or within two stories or 24 ft (7320 mm) of a platform or walkway leading from any story to the fire escape stair
(3) Above, within 10 ft (3050 mm) of any balcony, platform, or walkway, as measured vertically, or within 10 ft (3050 mm) of any stair tread surface, as measured vertically
(4) Facing a court served by a fire escape stair, where the least dimension of the court does not exceed one-third of the height to the uppermost platform of the fire escape stair, measured from the finished ground level
(5) Facing an alcove served by a fire escape stair, where the width of the alcove does not exceed one-third, or the depth of the alcove does not exceed one-fourth, of the height to the uppermost platform of the fire escape stair, measured from the finished ground level

7.2.8.2.1 The requirements of 7.2.8.2 shall not apply to openings located on the top story where stairs do not lead to the roof.

7.2.8.2.2 The requirements of 7.2.8.2 shall be permitted to be modified by the authority having jurisdiction where automatic sprinkler protection is provided, where the occupancy is limited to low hazard contents, or where other special conditions exist.

7.2.8.2.3 The requirements of 7.2.8.2 for the protection of window openings shall not apply where such window openings are necessary for access to existing fire escape stairs.

7.2.8.3 Access.

7.2.8.3.1 Access to fire escape stairs shall be in accordance with 7.2.8.4 and 7.5.1.1.1 through 7.5.1.2.2.

7.2.8.3.2 Where access is permitted by way of windows, the windows shall be arranged and maintained so as to be easily opened. Screening or storm windows that restrict free access to the fire escape stair shall be prohibited.

7.2.8.3.3 Fire escape stairs shall extend to the roof in all cases where the roof is subject to occupancy or provides an area of safe refuge, unless otherwise provided in 7.2.8.3.4.

7.2.8.3.4 Where a roof has a pitch that does not exceed 1 to 6, fire escape ladders in accordance with 7.2.9 or alternating tread devices in accordance with 7.2.11 shall be permitted to provide access to the roof.

7.2.8.3.5 Access to a fire escape stair shall be directly to a balcony, landing, or platform; shall not exceed the floor or windowsill level; and shall not be more than 8 in. (205 mm) below the floor level or 18 in. (455 mm) below the windowsill level.

7.2.8.4 Stair Details. Fire escape stairs shall comply with the requirements of Table 7.2.8.4(a). Replacement of fire escape stairs shall comply with the requirements of Table 7.2.8.4(b).

7.2.8.5 Guards, Handrails, and Visual Enclosures.

7.2.8.5.1 All fire escape stairs shall have walls or guards and handrails on both sides in accordance with 7.2.2.4.

7.2.8.5.2 Replacement fire escape stairs in occupancies serving more than 10 occupants shall have visual enclosures to avoid any impediments to their use by persons having a fear of high places. Fire escape stairs more than 36 ft (11 m) above the finished ground level shall be provided with an opaque visual obstruction not less than 48 in. (1220 mm) in height.

7.2.8.6 Materials and Strength.

7.2.8.6.1 Noncombustible materials shall be used for the construction of all components of fire escape stairs.

Table 7.2.8.4(a) Fire Escape Stairs

Feature	Serving More Than 10 Occupants	Serving 10 or Fewer Occupants
Minimum widths	22 in. (560 mm) clear between rails	18 in. (455 mm) clear between rails
Minimum horizontal dimension of any landing or platform	22 in. (560 mm) clear	18 in. (455 mm) clear
Maximum riser height	9 in. (230 mm)	12 in. (305 mm)
Minimum tread, exclusive of nosing	9 in. (230 mm)	6 in. (150 mm)
Minimum nosing or projection	1 in. (25 mm)	No requirement
Tread construction	Solid ½ in. (13 mm) diameter perforations permitted	Flat metal bars on edge or square bars secured against turning, spaced 1¼ in. (32 mm) maximum on centers
Winders	None	Permitted subject to capacity penalty
Risers	None	No requirement
Spiral	None	Permitted subject to capacity penalty
Maximum height between landings	12 ft (3660 mm)	No requirement
Minimum headroom	6 ft 8 in. (2030 mm)	6 ft 8 in. (2030 mm)
Access to escape	Door or casement windows, 24 in. × 6 ft 8 in. (610 mm × 1980 mm); or double-hung windows, 30 in. × 36 in. (760 mm × 915 mm) clear opening	Windows providing a clear opening of at least 20 in. (510 mm) in width, 24 in. (610 mm) in height, and 5.7 ft^2 (0.53 m^2) in area
Level of access opening	Not over 12 in. (305 mm) above floor; steps if higher	Not over 12 in. (305 mm) above floor; steps if higher
Discharge to the finished ground level	Swinging stair section permitted if approved by authority having jurisdiction	Swinging stair, or ladder if approved by authority having jurisdiction
Capacity	½ in. (13 mm) per person, if access by door; 1 in. (25 mm) per person, if access by climbing over windowsill	10 persons; if winders or ladder from bottom balcony, 5 persons; if both, 1 person

Table 7.2.8.4(b) Replacement Fire Escape Stairs

Feature	Serving More Than 10 Occupants	Serving 10 or Fewer Occupants
Minimum widths	22 in. (560 mm) clear between rails	22 in. (560 mm) clear between rails
Minimum horizontal dimension of any landing or platform	22 in. (560 mm)	22 in. (560 mm)
Maximum riser height	9 in. (230 mm)	9 in. (230 mm)
Minimum tread, exclusive of nosing	10 in. (255 mm)	10 in. (255 mm)
Tread construction	Solid, ½ in. (13 mm) diameter perforations permitted	Solid, ½ in. (13 mm) diameter perforations permitted
Winders	None	Permitted subject to 7.2.2.2.4
Spiral	None	Permitted subject to 7.2.2.2.3
Risers	None	None
Maximum height between landings	12 ft (3660 mm)	12 ft (3660 mm)
Minimum headroom	6 ft 8 in. (2030 mm)	6 ft 8 in. (2030 mm)
Access to escape	Door or casement windows, 24 in. × 6 ft 8 in. (610 mm × 1980 mm); or double-hung windows, 30 in. × 36 in. (760 mm × 915 mm) clear opening	Windows providing a clear opening of at least 20 in. (510 mm) in width, 24 in. (610 mm) in height, and 5.7 ft^2 (0.53 m^2) in area
Level of access opening	Not over 12 in. (305 mm) above floor; steps if higher	Not over 12 in. (305 mm) above floor; steps if higher
Discharge to the finished ground level	Swinging stair section permitted if approved by authority having jurisdiction	Swinging stair section permitted if approved by authority having jurisdiction
Capacity	½ in. (13 mm) per person, if access by door; 1 in. (25 mm) per person, if access by climbing over windowsill	10 persons

7.2.8.6.2 The authority having jurisdiction shall be permitted to approve any existing fire escape stair that has been shown by load test or other satisfactory evidence to have adequate strength.

7.2.8.7* Swinging Stairs.

7.2.8.7.1 A single swinging stair section shall be permitted to terminate fire escape stairs over sidewalks, alleys, or driveways where it is impractical to make the termination with fire escape stairs.

7.2.8.7.2 Swinging stair sections shall not be located over doors, over the path of travel from any other exit, or in any locations where there are likely to be obstructions.

7.2.8.7.3 The width of swinging stair sections shall be at least that of the fire escape stairs above.

7.2.8.7.4 The pitch of swinging stair sections shall not exceed the pitch of the fire escape stairs above.

7.2.8.7.5 Guards and handrails shall be provided in accordance with 7.2.2.4 and shall be similar in height and construction to those used with the fire escape stairs above. Guards and handrails shall be designed to prevent any possibility of injury to persons where stairs swing downward. The clearance between moving sections and any other portion of the stair system where hands have the potential to be caught shall be not less than 4 in. (100 mm).

7.2.8.7.6 If the distance from the lowest platform to the finished ground level is not less than 12 ft (3660 mm), an intermediate balcony not more than 12 ft (3660 mm) from the finished ground level and not less than 7 ft (2135 mm) in the clear underneath shall be provided, with width not less than that of the stairs and length not less than 48 in. (1220 mm).

7.2.8.7.7 Swinging stairs shall be counterbalanced about a pivot, and cables shall not be used. A weight of 150 lb (68 kg) located one step from the pivot shall not cause the stairs to swing downward, and a weight of 150 lb (68 kg) located one-quarter of the length of the swinging stairs from the pivot shall cause the stairs to swing down.

7.2.8.7.8 The pivot for swinging stairs shall be of a corrosion-resistant assembly or shall have clearances to prevent sticking due to corrosion.

7.2.8.7.9* Devices shall not be installed to lock a swinging stair section in the up position.

7.2.8.8 Intervening Spaces.

7.2.8.8.1 Where approved by the authority having jurisdiction, fire escape stairs shall be permitted to lead to an adjoining roof that is crossed before continuing downward travel. The direction of travel shall be clearly marked, and walkways with guards and handrails complying with 7.2.2.4 shall be provided.

7.2.8.8.2 Where approved by the authority having jurisdiction, fire escape stairs shall be permitted to be used in combination with inside or outside stairs complying with 7.2.2, provided that a continuous safe path of travel is maintained.

7.2.9 Fire Escape Ladders.

7.2.9.1 General. Fire escape ladders complying with 7.2.9.2 and 7.2.9.3 shall be permitted in the means of egress only where providing one of the following:

(1) Access to unoccupied roof spaces as permitted in 7.2.8.3.4
(2) Second means of egress from storage elevators as permitted in Chapter 42
(3) Means of egress from towers and elevated platforms around machinery or similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder
(4) Secondary means of egress from boiler rooms or similar spaces subject to occupancy not to exceed three persons who are all capable of using the ladder
(5) Access to the finished ground level from the lowest balcony or landing of a fire escape stair for small buildings as permitted in 7.2.8.4 where approved by the authority having jurisdiction

7.2.9.2 Construction and Installation.

7.2.9.2.1 Fire escape ladders shall comply with ANSI A14.3, *Safety Requirements for Fixed Ladders*, unless one of the following criteria is met:

(1) Approved existing ladders complying with the edition of this *Code* that was in effect when the ladders were installed shall be permitted.
(2) Industrial stairs complying with the minimum requirements for fixed stairs of ANSI/ASSE A1264.1, *Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrail Systems*, shall be permitted where fire escape ladders are permitted in accordance with Chapter 40.

7.2.9.2.2 Ladders shall be installed with a pitch that exceeds 75 degrees.

7.2.9.3 Access. The lowest rung of any ladder shall not be more than 12 in. (305 mm) above the level of the surface beneath it.

7.2.10 Slide Escapes.

7.2.10.1 General.

7.2.10.1.1 A slide escape shall be permitted as a component in a means of egress where permitted in Chapters 11 through 43.

7.2.10.1.2 Each slide escape shall be of an approved type.

7.2.10.2 Capacity.

7.2.10.2.1 Slide escapes, where permitted as a required means of egress, shall be rated at a capacity of 60 persons.

7.2.10.2.2 Slide escapes shall not constitute more than 25 percent of the required egress capacity from any building or structure or any individual story thereof, unless otherwise provided for industrial occupancies in Chapter 40.

7.2.11* Alternating Tread Devices.

7.2.11.1 Alternating tread devices complying with 7.2.11.2 shall be permitted in the means of egress only where providing one of the following:

(1) Access to unoccupied roof spaces as permitted in 7.2.8.3.4
(2) Second means of egress from storage elevators as permitted in Chapter 42
(3) Means of egress from towers and elevated platforms around machinery or similar spaces subject to occupancy not to exceed three persons who are all capable of using the alternating tread device
(4) Secondary means of egress from boiler rooms or similar spaces subject to occupancy not to exceed three persons who are all capable of using the alternating tread device

7.2.11.2 Alternating tread devices shall comply with all of the following:

(1) Handrails shall be provided on both sides of alternating tread devices in accordance with 7.2.2.4.4, except as provided in 7.2.11.3.
(2) The clear width between handrails shall be not less than 17 in. (430 mm) and not more than 24 in. (610 mm).
(3) Headroom shall be not less than 6 ft 8 in. (2030 mm).
(4) The angle of the device shall be between 50 degrees and 68 degrees to horizontal.
(5) The height of the riser shall not exceed 9½ in. (240 mm).
(6) Treads shall have a projected tread depth of not less than 5⅝ in. (145 mm), measured in accordance with 7.2.2, with each tread providing 9½ in. (240 mm) of depth, including tread overlap.
(7) A distance of not less than 6 in. (150 mm) shall be provided between the alternating tread device handrail and any other object.
(8) The initial tread of the alternating tread device shall begin at the same elevation as the platform, landing, or floor surface.
(9) The alternating treads shall not be laterally separated by a distance of more than 2 in. (51 mm).
(10) The occupant load served shall not exceed three.

7.2.11.3 Handrails of alternating tread devices shall comply with the following:

(1) The handrail height of alternating tread devices, measured above tread nosings, shall be uniform, not less than 30 in. (760 mm), and not more than 34 in. (865 mm).
(2) Handrails for alternating tread devices shall be permitted to terminate at a location vertically above the top and bottom risers.
(3) Handrails for alternating tread devices shall not be required to be continuous between flights or to extend beyond the top or bottom risers.
(4) Alternating tread device guards, with a top rail that also serves as a handrail, shall have a height of not less than 30 in. (760 mm), and not more than 34 in. (865 mm), measured vertically from the leading edge of the device tread nosing.
(5) Open guards of alternating tread devices shall have rails such that a sphere 21 in. (535 mm) in diameter is not able to pass through any opening.

7.2.12 Areas of Refuge.

7.2.12.1 General.

7.2.12.1.1 An area of refuge used as part of a required accessible means of egress in accordance with 7.5.4; consisting of a story in a building that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7; and having an accessible story that is one or more stories above or below a story of exit discharge shall meet the following criteria:

(1) Each elevator landing shall be provided with a two-way communication system for communication between the elevator landing and the fire command center or a central control point approved by the authority having jurisdiction.
(2) Directions for the use of the two-way communication system, instructions for summoning assistance via the two-way communication system, and written identification of the location shall be posted adjacent to the two-way communication system.
(3) The two-way communication system shall include both audible and visible signals.

7.2.12.1.2 An area of refuge used as part of a required accessible means of egress in accordance with 7.5.4 in other than a building that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall meet both of the following criteria:

(1) The area of refuge shall meet the general requirements of Section 7.1.
(2) The area of refuge shall meet the requirements of 7.2.12.2 and 7.2.12.3.

7.2.12.2 Accessibility.

7.2.12.2.1 Required portions of an area of refuge shall be accessible from the space they serve by an accessible means of egress.

7.2.12.2.2 Required portions of an area of refuge shall have access to a public way via an exit or an elevator without requiring return to the building spaces through which travel to the area of refuge occurred.

7.2.12.2.3* Where the exit providing egress from an area of refuge to a public way that is in accordance with 7.2.12.2.2 includes stairs, the clear width of landings and stair flights, measured between handrails and at all points below handrail height, shall be not less than 48 in. (1220 mm), unless otherwise permitted by the following:

(1) The minimum 48 in. (1220 mm) clear width shall not be required where the area of refuge is separated from the remainder of the story by a horizontal exit meeting the requirements of 7.2.4. *(See also 7.2.12.3.4.)*
(2) Existing stairs and landings that provide a clear width of not less than 37 in. (940 mm), measured at and below handrail height, shall be permitted.

7.2.12.2.4* Where an elevator provides access from an area of refuge to a public way that is in accordance with 7.2.12.2.2, all of the following criteria shall be met:

(1) The elevator shall be approved for fire fighters' emergency operations as provided in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.
(2) The power supply shall be protected against interruption from fire occurring within the building but outside the area of refuge.
(3) The elevator shall be located in a shaft system meeting the requirements for smokeproof enclosures in accordance with 7.2.3, unless otherwise provided in 7.2.12.2.4.1 and 7.2.12.2.4.2.

7.2.12.2.4.1 The smokeproof enclosure specified in 7.2.12.2.4(3) shall not be required for areas of refuge that are more than 1000 ft^2 (93 m^2) and that are created by a horizontal exit meeting the requirements of 7.2.4.

7.2.12.2.4.2 The smokeproof enclosure specified in 7.2.12.2.4(3) shall not be required for elevators complying with 7.2.13.

7.2.12.2.5 The area of refuge shall be provided with a two-way communication system for communication between the area of refuge and a central control point. The door opening to the stair enclosure or the elevator door and the associated portion of the area of refuge that the stair enclosure door opening or elevator door serves shall be identified by signage. *(See 7.2.12.3.5.)*

7.2.12.2.6* Instructions for summoning assistance, via the two-way communication system, and written identification of the area of refuge location shall be posted adjacent to the two-way communication system.

7.2.12.3 Details.

7.2.12.3.1* Each area of refuge shall be sized to accommodate one wheelchair space of 30 in. × 48 in. (760 mm × 1220 mm) for every 200 occupants, or portion thereof, based on the occupant load served by the area of refuge. Such wheelchair spaces shall maintain the width of a means of egress to not less than that required for the occupant load served and to not less than 36 in. (915 mm).

7.2.12.3.2* For any area of refuge that does not exceed 1000 ft^2 (93 m^2), it shall be demonstrated by calculation or test that tenable conditions are maintained within the area of refuge for a period of 15 minutes when the exposing space on the other side of the separation creating the area of refuge is subjected to the maximum expected fire conditions.

7.2.12.3.3 Access to any designated wheelchair space in an area of refuge shall not pass through more than one adjoining wheelchair space.

7.2.12.3.4* Each area of refuge shall be separated from the remainder of the story by a barrier having a minimum 1-hour fire resistance rating, unless one of the following criteria applies:

(1) A greater rating is required in other provisions of this *Code*.
(2) The barrier is an existing barrier with a minimum 30-minute fire resistance rating.

7.2.12.3.4.1 New fire door assemblies serving an area of refuge shall be smoke leakage–rated in accordance with 8.2.2.4.

7.2.12.3.4.2 The barriers specified in 7.2.12.3.4, and any openings in them, shall minimize air leakage and resist the passage of smoke.

7.2.12.3.4.3 Door assemblies in the barriers specified in 7.2.12.3.4 shall have not less than a 20-minute fire protection rating, unless a greater rating is required in other provisions of this *Code*, and shall be either self-closing or automatic-closing in accordance with 7.2.1.8.

7.2.12.3.4.4 Ducts shall be permitted to penetrate the barrier specified in 7.2.12.3.4, unless prohibited in other provisions of this *Code*, and shall be provided with smoke-actuated dampers or other approved means to resist the transfer of smoke into the area of refuge.

7.2.12.3.5 Each area of refuge shall be identified by a sign that reads as the follows:

AREA OF REFUGE

7.2.12.3.5.1 The sign required by 7.2.12.3.5 shall conform to the requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, for such signage and shall display the international symbol of accessibility. Signs also shall be located as follows:

(1) At each door opening providing access to the area of refuge
(2) At all exits not providing an accessible means of egress, as defined in 3.3.172.1
(3) Where necessary to indicate clearly the direction to an area of refuge

7.2.12.3.5.2 Signs required by 7.2.12.3.5 shall be illuminated as required for special signs in accordance with 7.10.8.1.

7.2.12.3.6 Tactile signage complying with ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, shall be located at each door opening to an area of refuge.

7.2.13 Elevators in Towers.

7.2.13.1* General. An elevator complying with the requirements of Section 9.4 and 7.2.13 shall be permitted to be used as a second means of egress from a tower, as defined in 3.3.281, provided that all of the following criteria are met:

(1) The tower and any attached structure shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) The tower shall be subject to occupancy not to exceed 90 persons.
(3) Primary egress discharges shall be directly to the outside.
(4) No high hazard content areas shall exist in the tower or attached structure.
(5) One hundred percent of the egress capacity shall be provided independent of the elevators.
(6) An evacuation plan that specifically includes the elevator shall be implemented, and staff personnel shall be trained in operations and procedures for elevator emergency use in normal operating mode prior to fire fighter recall.
(7) The tower shall not be used by the general public.

7.2.13.2 Elevator Evacuation System Capacity.

7.2.13.2.1 The elevator car shall have a capacity of not less than eight persons.

7.2.13.2.2 The elevator lobby shall have a capacity of not less than 50 percent of the occupant load of the area served by the lobby. The capacity shall be calculated based on 3 ft^2 (0.28 m^2) per person and shall also include one wheelchair space of 30 in. × 48 in. (760 mm × 1220 mm) for every 50 persons, or portion thereof, of the total occupant load served by that lobby.

7.2.13.3 Elevator Lobby. Every floor served by the elevator shall have an elevator lobby. Barriers forming the elevator lobby shall have a minimum 1-hour fire resistance rating and shall be arranged as a smoke barrier in accordance with Section 8.5.

7.2.13.4 Elevator Lobby Door Assemblies. Elevator lobby door assemblies shall have a minimum 1-hour fire protection rating. The transmitted temperature end point shall not exceed 450°F Δ (250°C Δ) above ambient at the end of 30 minutes of the fire exposure specified in the test method referenced in 8.3.3.2. Elevator lobby door leaves shall be self-closing or automatic-closing in accordance with 7.2.1.8.

7.2.13.5 Door Leaf Activation. The elevator lobby door leaves shall close in response to a signal from a smoke detector located directly outside the elevator lobby adjacent to or on each door opening. Elevator lobby door leaves shall be permitted to close in response to a signal from the building fire alarm system. Where one elevator lobby door leaf closes by means of a smoke detector or a signal from the building fire alarm system, all elevator lobby door leaves serving that elevator evacuation system shall close.

7.2.13.6* Water Protection. Building elements shall be used to restrict water exposure of elevator equipment.

7.2.13.7* Power and Control Wiring. Elevator equipment, elevator communications, elevator machine room cooling, and elevator controller cooling shall be supplied by both normal and standby power. Wiring for power and control shall be located and properly protected to ensure a minimum 1 hour of operation in the event of a fire.

7.2.13.8* Communications. Two-way communication systems shall be provided between elevator lobbies and a central control point and between elevator cars and a central control point. Communications wiring shall be protected to ensure a minimum 1 hour of operation in the event of fire.

7.2.13.9* Elevator Operation. Elevators shall be provided with fire fighters' emergency operations in accordance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

7.2.13.10 Maintenance. Where an elevator lobby is served by only one elevator car, the elevator evacuation system shall have a program of scheduled maintenance during times of building shutdown or low building activity. Repairs shall be performed within 24 hours of breakdown.

7.2.13.11 Earthquake Protection. Elevators shall have the capability of orderly shutdowns during earthquakes at locations where such shutdowns are an option of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

7.2.13.12 Signage. Signage shall comply with 7.10.8.4.

7.3 Capacity of Means of Egress.

7.3.1 Occupant Load.

7.3.1.1 Sufficient Capacity.

7.3.1.1.1 The total capacity of the means of egress for any story, balcony, tier, or other occupied space shall be sufficient for the occupant load thereof.

7.3.1.1.2 For other than existing means of egress, where more than one means of egress is required, the means of egress shall be of such width and capacity that the loss of any one means of egress leaves available not less than 50 percent of the required capacity.

7.3.1.2* Occupant Load Factor. The occupant load in any building or portion thereof shall be not less than the number of persons determined by dividing the floor area assigned to that use by the occupant load factor for that use as specified in Table 7.3.1.2, Figure 7.3.1.2(a), and Figure 7.3.1.2(b). Where both gross and net area figures are given for the same occupancy, calculations shall be made by applying the gross area figure to the gross area of the portion of the building devoted to the use for which the gross area figure is specified and by applying the net area figure to the net area of the portion of the building devoted to the use for which the net area figure is specified.

7.3.1.3 Occupant Load Increases.

7.3.1.3.1 The occupant load in any building or portion thereof shall be permitted to be increased from the occupant load established for the given use in accordance with 7.3.1.2 where all other requirements of this *Code* are also met, based on such increased occupant load.

Table 7.3.1.2 Occupant Load Factor

Use	(ft^2/person)[a]	(m^2/person)[a]
Assembly Use		
Concentrated use, without fixed seating	7 net	0.65 net
Less concentrated use, without fixed seating	15 net	1.4 net
Bench-type seating	1 person/ 18 linear in.	1 person/ 455 linear mm
Fixed seating	Use number of fixed seats	Use number of fixed seats
Waiting spaces	See 12.1.7.2 and 13.1.7.2.	See 12.1.7.2 and 13.1.7.2.
Kitchens	100	9.3
Library stack areas	100	9.3
Library reading rooms	50 net	4.6 net
Swimming pools	50 (water surface)	4.6 (water surface)
Swimming pool decks	30	2.8
Exercise rooms with equipment	50	4.6
Exercise rooms without equipment	15	1.4
Stages	15 net	1.4 net
Lighting and access catwalks, galleries, gridirons	100 net	9.3 net
Casinos and similar gaming areas	11	1
Skating rinks	50	4.6
Business Use (other than below)	100	9.3
Concentrated Business Use[f]	50	4.6
Air traffic control tower observation levels	40	3.7
Day-Care Use	35 net	3.3 net
Detention and Correctional Use	120	11.1
Educational Use		
Classrooms	20 net	1.9 net
Shops, laboratories, vocational rooms	50 net	4.6 net
Health Care Use		
Inpatient treatment departments	240	22.3
Sleeping departments	120	11.1
Ambulatory health care	150	13
Industrial Use		
General and high hazard industrial	100	9.3
Special-purpose industrial	NA	NA
Mercantile Use		
Sales area on street floor[b,c]	30	2.8
Sales area on two or more street floors[c]	40	3.7
Sales area on floor below street floor[c]	30	2.8

(continues)

Table 7.3.1.2 ***Continued***

Use	(ft²/person)[a]	(m²/person)[a]
Sales area on floors above street floor[c]	60	5.6
Floors or portions of floors used only for offices	See business use.	See business use.
Floors or portions of floors used only for storage, receiving, and shipping, and not open to general public	300	27.9
Mall buildings[d]	Per factors applicable to use of space[e]	
Residential Use		
Hotels and dormitories	200	18.6
Apartment buildings	200	18.6
Board and care, large	200	18.6
Storage Use		
In storage occupancies	NA	NA
In mercantile occupancies	300	27.9
In other than storage and mercantile occupancies	500	46.5

NA: Not applicable. The occupant load is the maximum probable number of occupants present at any time.

[a]All factors are expressed in gross area unless marked "net."

[b]For the purpose of determining occupant load in mercantile occupancies where, due to differences in the finished ground level of streets on different sides, two or more floors directly accessible from streets (not including alleys or similar back streets) exist, each such floor is permitted to be considered a street floor. The occupant load factor is one person for each 40 ft² (3.7 m²) of gross floor area of sales space.

[c]For the purpose of determining occupant load in mercantile occupancies with no street floor, as defined in 3.3.271, but with access directly from the street by stairs or escalators, the floor at the point of entrance to the mercantile occupancy is considered the street floor.

[d]For any food court or other assembly use areas located in the mall that are not included as a portion of the gross leasable area of the mall building, the occupant load is calculated based on the occupant load factor for that use as specified in Table 7.3.1.2. The remaining mall area is not required to be assigned an occupant load.

[e]The portions of the mall that are considered a pedestrian way and not used as gross leasable area are not required to be assessed an occupant load based on Table 7.3.1.2. However, means of egress from a mall pedestrian way are required to be provided for an occupant load determined by dividing the gross leasable area of the mall building (not including anchor stores) by the appropriate lowest whole number occupant load factor from Figure 7.3.1.2(a) or Figure 7.3.1.2(b).

Each individual tenant space is required to have means of egress to the outside or to the mall based on occupant loads calculated by using the appropriate occupant load factor from Table 7.3.1.2.

Each individual anchor store is required to have means of egress independent of the mall.

[f]See A.7.3.1.2.

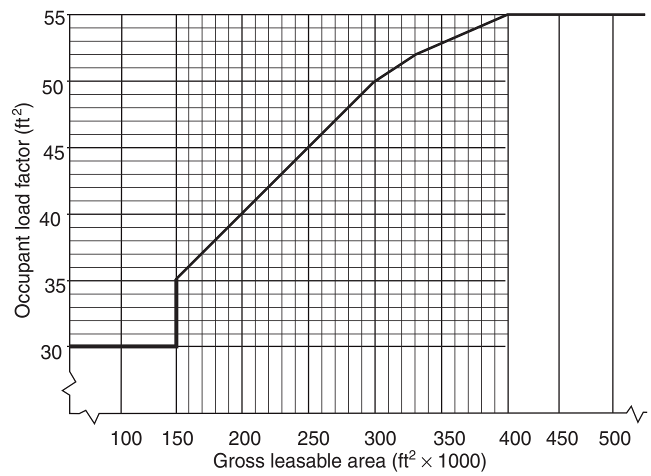


FIGURE 7.3.1.2(a) Mall Building Occupant Load Factors (U.S. Customary Units).

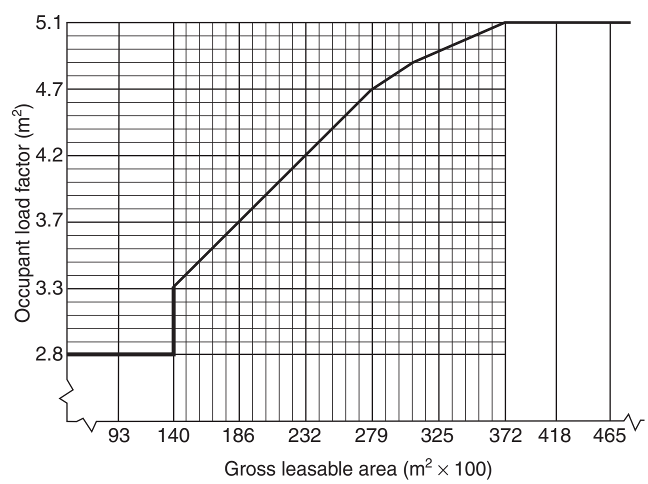


FIGURE 7.3.1.2(b) Mall Building Occupant Load Factors (SI Units).

7.3.1.3.2 The authority having jurisdiction shall be permitted to require an approved aisle, seating, or fixed equipment diagram to substantiate any increase in occupant load and shall be permitted to require that such a diagram be posted in an approved location.

7.3.1.4 Exits Serving More than One Story. Where an exit serves more than one story, only the occupant load of each story considered individually shall be used in computing the required capacity of the exit at that story, provided that the required egress capacity of the exit is not decreased in the direction of egress travel.

7.3.1.5 Capacity from a Point of Convergence. Where means of egress from a story above and a story below converge at an intermediate story, the capacity of the means of egress from the point of convergence shall be not less than the sum of the required capacity of the two means of egress.

7.3.1.6 Egress Capacity from Balconies and Mezzanines. Where any required egress capacity from a balcony or mezzanine passes through the room below, that required capacity shall be added to the required egress capacity of the room in which it is located.

7.3.2 Measurement of Means of Egress.

7.3.2.1 The width of means of egress shall be measured in the clear at the narrowest point of the egress component under consideration, unless otherwise provided in 7.3.2.2 or 7.3.2.3.

7.3.2.2 Projections within the means of egress of not more than 4½ in. (114 mm) on each side shall be permitted at a height of 38 in. (965 mm) and below. In the case of stair and landing handrails forming part of a guard, in accordance with 7.2.2.4.5.3, such projections shall be permitted at a height of 42 in. (1065 mm) and below.

7.3.2.3 In health care and ambulatory health care occupancies, projections shall be permitted in corridors in accordance with Chapters 18 through 21.

7.3.3* Egress Capacity.

7.3.3.1 Egress capacity for approved components of means of egress shall be based on the capacity factors shown in Table 7.3.3.1, unless otherwise provided in 7.3.3.2.

Table 7.3.3.1 Capacity Factors

	Stairways (width/person)		Level Components and Ramps (width/person)	
Area	**in.**	**mm**	**in.**	**mm**
Board and care	0.4	10	0.2	5
Health care, sprinklered	0.3	7.6	0.2	5
Health care, nonsprinklered	0.6	15	0.5	13
High hazard contents	0.7	18	0.4	10
All others	0.3	7.6	0.2	5

7.3.3.2* For stairways wider than 44 in. (1120 mm) and subject to the 0.3 in. (7.6 mm) width per person capacity factor, the capacity shall be permitted to be increased using the following equation:

$$C = 146.7 + \left(\frac{Wn - 44}{0.218}\right) \qquad \textbf{[7.3.3.2]}$$

where:

C = capacity, in persons, rounded to the nearest integer

Wn = nominal width of the stair as permitted by 7.3.2.2 (in.)

7.3.3.3 The required capacity of a corridor shall be the occupant load that utilizes the corridor for exit access divided by the required number of exits to which the corridor connects, but the corridor capacity shall be not less than the required capacity of the exit to which the corridor leads.

7.3.4 Minimum Width.

7.3.4.1 The width of any means of egress, unless otherwise provided in 7.3.4.1.1 through 7.3.4.1.3, shall be as follows:

(1) Not less than that required for a given egress component in this chapter or Chapters 11 through 43
(2) Not less than 36 in. (915 mm) where another part of this chapter and Chapters 11 through 43 do not specify a minimum width

7.3.4.1.1* The width of exit access serving not more than six people and having a length not exceeding 50 ft (15 m) shall meet both of the following criteria:

(1) The width shall be not less than 18 in. (455 mm), at and below a height of 38 in. (965 mm), and not less than 28 in. (710 mm) above a height of 38 in. (965 mm).
(2) A width of not less than 36 in. (915 mm) for new exit access, and not less than 28 in. (710 mm) for existing exit access, shall be capable of being provided without moving permanent walls.

7.3.4.1.2 In existing buildings, the width of exit access shall be permitted to be not less than 28 in. (710 mm).

7.3.4.1.3 The requirement of 7.3.4.1 shall not apply to the following:

(1) Doors as otherwise provided for in 7.2.1.2
(2) Aisles and aisle accessways in assembly occupancies as otherwise provided in Chapters 12 and 13
(3) Industrial equipment access as otherwise provided in 40.2.5.3

7.3.4.2 Where a single exit access leads to an exit, its capacity in terms of width shall be not less than the required capacity of the exit to which it leads.

7.3.4.3 Where more than one exit access leads to an exit, each shall have a width adequate for the number of persons it accommodates.

7.4* Number of Means of Egress.

7.4.1 General.

7.4.1.1 The number of means of egress from any balcony, mezzanine, story, or portion thereof shall be not less than two, except under one of the following conditions:

(1) A single means of egress shall be permitted where permitted in Chapters 11 through 43.
(2) A single means of egress shall be permitted for a mezzanine or balcony where the common path of travel limitations of Chapters 11 through 43 are met.

7.4.1.2 The number of means of egress from any story or portion thereof, other than for existing buildings as permitted in Chapters 11 through 43, shall be as follows:

(1) Occupant load more than 500 but not more than 1000 — not less than 3
(2) Occupant load more than 1000 — not less than 4

7.4.1.3 Accessible means of egress in accordance with 7.5.4 that do not utilize elevators shall be permitted to serve as any or all of the required minimum number of means of egress.

7.4.1.4 The occupant load of each story considered individually shall be required to be used in computing the number of means of egress at each story, provided that the required number of means of egress is not decreased in the direction of egress travel.

7.4.1.5 Doors other than the hoistway door; the elevator car door; and doors that are readily openable from the car side without a key, a tool, special knowledge, or special effort shall be prohibited at the point of access to an elevator car.

7.4.1.6 Elevator Landing and Lobby Exit Access.

7.4.1.6.1 Each elevator landing and lobby shall have access to at least one exit.

7.4.1.6.2 The elevator landing and lobby exit access required by 7.4.1.6.1 shall not require the use of a key, a tool, special knowledge, or special effort, unless permitted by 7.4.1.6.3.

7.4.1.6.3 Doors separating the elevator lobby from the exit access required by 7.4.1.6.1 shall be permitted to be electronically locked in accordance with 7.2.1.6.3.

7.4.2 Spaces About Electrical Equipment.

7.4.2.1 600 Volts, Nominal, or Less. The minimum number of means of egress for working space about electrical equipment, other than existing electrical equipment, shall be in accordance with *NFPA 70*, *National Electrical Code*, Section 110.26(C).

7.4.2.2 Over 600 Volts, Nominal. The minimum number of means of egress for working space about electrical equipment, other than existing electrical equipment, shall be in accordance with *NFPA 70*, *National Electrical Code*, Section 110.33(A).

7.5 Arrangement of Means of Egress.

7.5.1 General.

7.5.1.1 Exits shall be located, and exit access shall be arranged, so that exits are readily accessible at all times.

7.5.1.1.1* Where exits are not immediately accessible from an open floor area, continuous passageways, aisles, or corridors leading directly to every exit shall be maintained and shall be arranged to provide access for each occupant to not less than two exits by separate ways of travel, unless otherwise provided in 7.5.1.1.3 and 7.5.1.1.4.

7.5.1.1.2 Exit access corridors shall provide access to not less than two approved exits, unless otherwise provided in 7.5.1.1.3 and 7.5.1.1.4.

7.5.1.1.3 The requirements of 7.5.1.1.1 and 7.5.1.1.2 shall not apply where a single exit is permitted in Chapters 11 through 43.

7.5.1.1.4 Where common paths of travel are permitted for an occupancy in Chapters 11 through 43, such common paths of travel shall be permitted but shall not exceed the limit specified.

7.5.1.2 Corridors shall provide exit access without passing through any intervening rooms other than corridors, lobbies, and other spaces permitted to be open to the corridor, unless otherwise provided in 7.5.1.2.1 and 7.5.1.2.2.

7.5.1.2.1 Approved existing corridors that require passage through a room to access an exit shall be permitted to continue to be used, provided that all of the following criteria are met:

(1) The path of travel is marked in accordance with Section 7.10.
(2) Doors to such rooms comply with 7.2.1.
(3) Such arrangement is not prohibited by the applicable occupancy chapter.

7.5.1.2.2 Corridors that are not required to be fire resistance rated shall be permitted to discharge into open floor plan areas.

7.5.1.3 Remoteness shall be provided in accordance with 7.5.1.3.1 through 7.5.1.3.7.

7.5.1.3.1 Where more than one exit, exit access, or exit discharge is required from a building or portion thereof, such exits, exit accesses, or exit discharges shall be remotely located from each other and be arranged to minimize the possibility that more than one has the potential to be blocked by any one fire or other emergency condition.

7.5.1.3.2* Where two exits, exit accesses, or exit discharges are required, they shall be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area to be served, measured in a straight line between the nearest edge of the exits, exit accesses, or exit discharges, unless otherwise provided in 7.5.1.3.3 through 7.5.1.3.5.

7.5.1.3.3 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, the minimum separation distance between two exits, exit accesses, or exit discharges, measured in accordance with 7.5.1.3.2, shall be not less than one-third the length of the maximum overall diagonal dimension of the building or area to be served.

7.5.1.3.4* In other than high-rise buildings, where exit enclosures are provided as the required exits specified in 7.5.1.3.2 or 7.5.1.3.3 and are interconnected by not less than a 1-hour fire resistance–rated corridor, exit separation shall be measured along the shortest line of travel within the corridor.

7.5.1.3.5 In existing buildings, where more than one exit, exit access, or exit discharge is required, such exits, exit accesses, or exit discharges shall be exempt from the diagonal measurement separation distance criteria of 7.5.1.3.2 and 7.5.1.3.3, provided that such exits, exit accesses, or exit discharges are remotely located in accordance with 7.5.1.3.1.

7.5.1.3.6 In other than existing buildings, where more than two exits, exit accesses, or exit discharges are required, at least two of the required exits, exit accesses, or exit discharges shall be arranged to comply with the minimum separation distance requirement.

7.5.1.3.7 The balance of the exits, exit accesses, or exit discharges specified in 7.5.1.3.6 shall be located so that, if one becomes blocked, the others are available.

7.5.1.4 Interlocking or scissor stairs shall comply with 7.5.1.4.1 and 7.5.1.4.2.

7.5.1.4.1 New interlocking or scissor stairs shall be permitted to be considered only as a single exit.

7.5.1.4.2* Existing interlocking or scissor stairs shall be permitted to be considered separate exits, provided that they meet all of the following criteria:

(1) They are enclosed in accordance with 7.1.3.2.
(2) They are separated from each other by 2-hour fire resistance–rated noncombustible construction.
(3) No protected or unprotected penetrations or communicating openings exist between the stair enclosures.

7.5.1.5* Exit access shall be arranged so that there are no dead ends in corridors, unless permitted by, and limited to the lengths specified in, Chapters 11 through 43.

7.5.1.6 Exit access from rooms or spaces shall be permitted to be through adjoining or intervening rooms or areas, provided that such rooms or areas are accessory to the area served. Foyers, lobbies, and reception rooms constructed as required for corridors shall not be construed as intervening rooms. Exit access shall be arranged so that it is not necessary to pass through any area identified under Protection from Hazards in Chapters 11 through 43.

7.5.2 Impediments to Egress. See also 7.1.9 and 7.2.1.5.

7.5.2.1* Access to an exit shall not be through kitchens, storerooms other than as provided in Chapters 36 and 37, restrooms, closets, bedrooms or similar spaces, or other rooms or spaces subject to locking, unless passage through such rooms or spaces is permitted for the occupancy by Chapter 18, 19, 22, or 23.

7.5.2.2* Exit access and exit doors shall be designed and arranged to be clearly recognizable.

7.5.2.2.1 Hangings or draperies shall not be placed over exit doors or located so that they conceal or obscure any exit, unless otherwise provided in 7.5.2.2.2.

7.5.2.2.2 Curtains shall be permitted across means of egress openings in tent walls, provided that all of the following criteria are met:

(1) They are distinctly marked in contrast to the tent wall so as to be recognizable as means of egress.
(2) They are installed across an opening that is at least 6 ft (1830 mm) in width.
(3) They are hung from slide rings or equivalent hardware so as to be readily moved to the side to create an unobstructed opening in the tent wall that is of the minimum width required for door openings.

7.5.3 Exterior Ways of Exit Access.

7.5.3.1 Exit access shall be permitted to be by means of any exterior balcony, porch, gallery, or roof that conforms to the requirements of this chapter.

7.5.3.2 The long side of the balcony, porch, gallery, or similar space shall be at least 50 percent open and shall be arranged to restrict the accumulation of smoke.

7.5.3.3 Exterior exit access balconies shall be separated from the interior of the building by walls and opening protectives as required for corridors, unless the exterior exit access balcony is served by at least two remote stairs that can be accessed without any occupant traveling past an unprotected opening to reach one of the stairs, or unless dead ends on the exterior exit access do not exceed 20 ft (6100 mm).

7.5.3.4 Exterior exit access shall be arranged so that there are no dead ends in excess of those permitted for dead-end corridors in Chapters 11 through 43.

7.5.4 Accessible Means of Egress.

7.5.4.1* Areas accessible to people with severe mobility impairment, other than in existing buildings, shall have not less than two accessible means of egress, unless otherwise provided in 7.5.4.1.2 through 7.5.4.1.4.

7.5.4.1.1 Access within the allowable travel distance shall be provided to not less than one accessible area of refuge or one accessible exit providing an accessible route to an exit discharge.

7.5.4.1.2 A single accessible means of egress shall be permitted from buildings or areas of buildings permitted to have a single exit.

7.5.4.1.3 Accessible means of egress shall not be required in health care occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

7.5.4.1.4 Exit access travel along the accessible means of egress shall be permitted to be common for the distances permitted as common paths of travel.

7.5.4.2 Where two accessible means of egress are required, the exits serving such means of egress shall be located at a distance from one another not less than one-half the length of the maximum overall diagonal dimension of the building or area to be served. This distance shall be measured in a straight line between the nearest edge of the exit doors or exit access doors, unless otherwise provided in 7.5.4.2.1 through 7.5.4.2.3.

7.5.4.2.1 Where exit enclosures are provided as the required exits specified in 7.5.4.2 and are interconnected by not less than a 1-hour fire resistance–rated corridor, exit separation shall be permitted to be measured along the line of travel within the corridor.

7.5.4.2.2 The requirement of 7.5.4.2 shall not apply to buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

7.5.4.2.3 The requirement of 7.5.4.2 shall not apply where the physical arrangement of means of egress prevents the possibility that access to both accessible means of egress will be blocked by any one fire or other emergency condition as approved by the authority having jurisdiction.

7.5.4.3 Each required accessible means of egress shall be continuous from each accessible occupied area to a public way or area of refuge in accordance with 7.2.12.2.2.

7.5.4.4 Where an exit stair is used in an accessible means of egress, it shall comply with 7.2.12 and either shall incorporate an area of refuge within an enlarged story-level landing or shall be accessed from an area of refuge.

7.5.4.5 To be considered part of an accessible means of egress, an elevator shall be in accordance with 7.2.12.2.4.

7.5.4.6 To be considered part of an accessible means of egress, a smoke barrier in accordance with Section 8.5 with not less than a 1-hour fire resistance rating, or a horizontal exit in accordance with 7.2.4, shall discharge to an area of refuge in accordance with 7.2.12.

7.5.4.7 Accessible stories that are four or more stories above or below a story of exit discharge shall have not less than one elevator complying with 7.5.4.5, except as modified in 7.5.4.8.

7.5.4.8 Where elevators are required by 7.5.4.7, the smokeproof enclosure required by 7.2.12.2.4 shall not be required in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.5.4.9 An area of refuge used as part of a required accessible means of egress shall be in accordance with 7.2.12.

7.6* Measurement of Travel Distance to Exits.

7.6.1* The travel distance to an exit shall be measured on the floor or other walking surface as follows:

(1) Along the centerline of the natural path of travel, starting from the most remote point subject to occupancy
(2) Curving around any corners or obstructions, with a 12 in. (305 mm) clearance therefrom

(3) Terminating at one of the following:
   (a) Center of the doorway
   (b) Other point at which the exit begins
   (c) Smoke barrier in an existing detention and correctional occupancy as provided in Chapter 23

7.6.2 Where outside stairs that are not separated from the building are permitted as required exits, the travel distance shall be measured from the most remote point subject to occupancy to the leading nosing of the stair landing at the floor level under consideration.

7.6.3* Where open stairways or ramps are permitted as a path of travel to required exits, the distance shall include the travel on the stairway or ramp and the travel from the end of the stairway or ramp to an outside door or other exit in addition to the distance traveled to reach the stairway or ramp.

7.6.4 Where any part of an exterior exit is within 10 ft (3050 mm) of horizontal distance of any unprotected building opening, as permitted by 7.2.2.6.3 for outside stairs, the travel distance to the exit shall include the length of travel to the finished ground level.

7.6.5 Where measurement includes stairs, the measurement shall be taken in the plane of the tread nosing.

7.6.6 The travel distance in any occupied space to not less than one exit, measured in accordance with 7.6.1 through 7.6.5, shall not exceed the limits specified in this *Code. (See 7.6.7.)*

7.6.7 Travel distance limitations shall be as provided in Chapters 11 through 43 and, for high hazard areas, shall be in accordance with Section 7.11.

7.7 Discharge from Exits.

7.7.1* Exit Termination. Exits shall terminate directly, at a public way or at an exterior exit discharge, unless otherwise provided in 7.7.1.2 through 7.7.1.4.

7.7.1.1 Yards, courts, open spaces, or other portions of the exit discharge shall be of the required width and size to provide all occupants with a safe access to a public way.

7.7.1.2 The requirement of 7.7.1 shall not apply to interior exit discharge as otherwise provided in 7.7.2.

7.7.1.3 The requirement of 7.7.1 shall not apply to rooftop exit discharge as otherwise provided in 7.7.6.

7.7.1.4 Means of egress shall be permitted to terminate in an exterior area for detention and correctional occupancies as otherwise provided in Chapters 22 and 23.

7.7.2 Exit Discharge Through Interior Building Areas. Exits shall be permitted to discharge through interior building areas, provided that all of the following are met:

(1) Not more than 50 percent of the required number of exit stairs serving normally occupied areas of each floor, and not more than 50 percent of the exit stair capacity required for normally occupied areas of each floor, shall discharge through areas on any level of discharge, except as otherwise permitted by one of the following:
   (a) One hundred percent of the exits shall be permitted to discharge through areas on any level of discharge in detention and correctional occupancies as otherwise provided in Chapters 22 and 23.
   (b) In existing buildings, the 50 percent limit on egress capacity shall not apply if the 50 percent limit on the required number of exits is met.
(2) Each level of discharge shall discharge directly outside at the finished ground level or discharge directly outside and provide access to the finished ground level by outside stairs or outside ramps.
(3) The interior exit discharge shall lead to a free and unobstructed way to the exterior of the building, and such way shall be readily visible and identifiable from the point of discharge from the exit
(4) The interior exit discharge shall be protected by one of the following methods:
   (a) The level of discharge shall be protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, or the portion of the level of discharge used for interior exit discharge shall be protected by an approved automatic sprinkler system in accordance with Section 9.7 and shall be separated from the nonsprinklered portion of the floor by fire barriers with a fire resistance rating meeting the requirements for the enclosure of exits. *(See 7.1.3.2.1.)*
   (b) The interior exit discharge area shall be in a vestibule or foyer that meets all of the following criteria:
      i. The depth from the exterior of the building shall be not more than 10 ft (3050 mm), and the length shall be not more than 30 ft (9.1 m).
      ii. The foyer shall be separated from the remainder of the level of discharge by fire barriers with a minimum 1-hour fire resistance rating, and existing installations of wired glass in steel frames shall be permitted to be continued in use.
      iii. The foyer shall serve only as means of egress and shall include an exit directly to the outside.
(5) The entire area on the level of discharge shall be separated from areas below by construction having a fire resistance rating not less than that required for the exit enclosure, unless otherwise provided in 7.7.2(6).
(6) Levels below the level of discharge in an atrium shall be permitted to be open to the level of discharge where such level of discharge is protected in accordance with 8.6.7.

7.7.3 Arrangement and Marking of Exit Discharge.

7.7.3.1 Where more than one exit discharge is required, exit discharges shall be arranged to meet the remoteness criteria of 7.5.1.3.

7.7.3.2 The exit discharge shall be arranged and marked to make clear the direction of egress travel from the exit discharge to a public way.

7.7.3.3* Stairs and ramps that continue more than one-half story beyond the level of discharge shall be provided with an approved means to prevent or dissuade occupants from traveling past the level of discharge during emergency building evacuation.

7.7.4 Components of Exit Discharge. Doors, stairs, ramps, corridors, exit passageways, bridges, balconies, escalators, moving walks, and other components of an exit discharge shall comply with the detailed requirements of this chapter for such components.

7.7.5 Signs. See 7.2.2.5.4.

7.7.6 Discharge to Roofs. Where approved by the authority having jurisdiction, exits shall be permitted to discharge to roofs or other sections of the building or an adjoining building where all of the following criteria are met:

(1) The roof/ceiling assembly construction has a fire resistance rating not less than that required for the exit enclosure.
(2) A continuous and safe means of egress from the roof is available.

7.8 Illumination of Means of Egress.

7.8.1 General.

7.8.1.1* Illumination of means of egress shall be provided in accordance with Section 7.8 for every building and structure where required in Chapters 11 through 43. For the purposes of this requirement, exit access shall include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading to an exit. For the purposes of this requirement, exit discharge shall include only designated stairs, aisles, corridors, ramps, escalators, walkways, and exit passageways leading to a public way.

7.8.1.2 Illumination of means of egress shall be continuous during the time that the conditions of occupancy require that the means of egress be available for use, unless otherwise provided in 7.8.1.2.2.

7.8.1.2.1 Artificial lighting shall be employed at such locations and for such periods of time as are necessary to maintain the illumination to the minimum criteria values herein specified.

7.8.1.2.2* Unless prohibited by Chapters 11 through 43, automatic lighting control devices shall be permitted to temporarily turn off the illumination within the means of egress, provided that each lighting control device complies with all of the following:

(1) In new installations, the lighting control device is listed.
(2) The lighting control device is equipped to automatically energize the controlled lights upon loss of normal power and is evaluated for this purpose.
(3) Illumination timers are provided and are set for a minimum 15-minute duration.
(4) The lighting control device is activated by any occupant movement in the area served by the lighting units.
(5) In new installations, the lighting control device is activated by activation of the building fire alarm system, if provided.
(6) The lighting control device does not turn off any lights relied upon for activation of photoluminescent exit signs or path markers.
(7) The lighting control device does not turn off any battery-equipped emergency luminaires, unit equipment, or exit signs.

7.8.1.2.3* Energy-saving sensors, switches, timers, or controllers shall be approved and shall not compromise the continuity of illumination of the means of egress required by 7.8.1.2.

7.8.1.3 The floors and other walking surfaces within an exit and within the portions of the exit access and exit discharge designated in 7.8.1.1 shall be illuminated as follows:

(1) During conditions of stair use, the minimum illumination for new stairs shall be at least 10 ft-candle (108 lux), measured at the walking surfaces.
(2) The minimum illumination for floors and other walking surfaces, other than new stairs during conditions of stair use, shall be to values of at least 1 ft-candle (10.8 lux), measured at the floor.
(3) In assembly occupancies, the illumination of the walking surfaces of exit access shall be at least 0.2 ft-candle (2.2 lux) during periods of performances or projections involving directed light.
(4)*The minimum illumination requirements shall not apply where operations or processes require low lighting levels.

7.8.1.4* Required illumination shall be arranged so that the failure of any single lighting unit does not result in an illumination level of less than 0.2 ft-candle (2.2 lux) in any designated area.

7.8.1.5 The equipment or units installed to meet the requirements of Section 7.10 also shall be permitted to serve the function of illumination of means of egress, provided that all requirements of Section 7.8 for such illumination are met.

7.8.2 Sources of Illumination.

7.8.2.1 Illumination of means of egress shall be from a source considered reliable by the authority having jurisdiction.

7.8.2.2 Battery-operated electric lights and other types of portable lamps or lanterns shall not be used for primary illumination of means of egress. Battery-operated electric lights shall be permitted to be used as an emergency source to the extent permitted under Section 7.9.

7.9 Emergency Lighting.

7.9.1 General.

7.9.1.1* Emergency lighting facilities for means of egress shall be provided in accordance with Section 7.9 for the following:

(1) Buildings or structures where required in Chapters 11 through 43
(2) Underground and limited access structures as addressed in Section 11.7
(3) High-rise buildings as required by other sections of this *Code*
(4) Doors equipped with delayed-egress locks
(5) Stair shafts and vestibules of smokeproof enclosures, for which the following also apply:
    (a) The stair shaft and vestibule shall be permitted to include a standby generator that is installed for the smokeproof enclosure mechanical ventilation equipment.
    (b) The standby generator shall be permitted to be used for the stair shaft and vestibule emergency lighting power supply.
(6) New access-controlled egress doors in accordance with 7.2.1.6.2

7.9.1.2 For the purposes of 7.9.1.1, exit access shall include only designated stairs, aisles, corridors, ramps, escalators, and passageways leading to an exit. For the purposes of 7.9.1.1, exit discharge shall include only designated stairs, ramps, aisles, walkways, and escalators leading to a public way.

7.9.1.3 Where maintenance of illumination depends on changing from one energy source to another, a delay of not more than 10 seconds shall be permitted.

7.9.2 Performance of System.

7.9.2.1 Emergency illumination shall be provided for a minimum of 1½ hours in the event of failure of normal lighting.

7.9.2.1.1 Emergency lighting facilities shall be arranged to provide initial illumination that is not less than an average of

1 ft-candle (10.8 lux) and, at any point, not less than 0.1 ft-candle (1.1 lux), measured along the path of egress at floor level.

7.9.2.1.2 Illumination levels shall be permitted to decline to not less than an average of 0.6 ft-candle (6.5 lux) and, at any point, not less than 0.06 ft-candle (0.65 lux) at the end of 1½ hours.

7.9.2.1.3 The maximum-to-minimum illumination shall not exceed a ratio of 40 to 1.

7.9.2.2 New emergency power systems for emergency lighting shall be at least Type 10, Class 1.5, Level 1, in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems.*

7.9.2.3* The emergency lighting system shall be arranged to provide the required illumination automatically in the event of any interruption of normal lighting due to any of the following:

(1) Failure of a public utility or other outside electrical power supply
(2) Opening of a circuit breaker or fuse
(3) Manual act(s), including accidental opening of a switch controlling normal lighting facilities

7.9.2.4 Emergency generators providing power to emergency lighting systems shall be installed, tested, and maintained in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems.* Stored electrical energy systems, where required in this *Code*, other than battery systems for emergency luminaires in accordance with 7.9.2.5, shall be installed and tested in accordance with NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems.*

7.9.2.5 Unit equipment and battery systems for emergency luminaires shall be listed to ANSI/UL 924, *Standard for Emergency Lighting and Power Equipment.*

7.9.2.6 Existing battery-operated emergency lights shall use only reliable types of rechargeable batteries provided with suitable facilities for maintaining them in properly charged condition. Batteries used in such lights or units shall be approved for their intended use and shall comply with *NFPA 70, National Electrical Code.*

7.9.2.7 The emergency lighting system shall be either continuously in operation or shall be capable of repeated automatic operation without manual intervention.

7.9.3 Periodic Testing of Emergency Lighting Equipment.

7.9.3.1 Required emergency lighting systems shall be tested in accordance with one of the three options offered by 7.9.3.1.1, 7.9.3.1.2, or 7.9.3.1.3.

7.9.3.1.1 Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Functional testing shall be conducted monthly, with a minimum of 3 weeks and a maximum of 5 weeks between tests, for not less than 30 seconds, except as otherwise permitted by 7.9.3.1.1(2).
(2)*The test interval shall be permitted to be extended beyond 30 days with the approval of the authority having jurisdiction.
(3) Functional testing shall be conducted annually for a minimum of 1½ hours if the emergency lighting system is battery powered.
(4) The emergency lighting equipment shall be fully operational for the duration of the tests required by 7.9.3.1.1(1) and (3).
(5) Written records of visual inspections and tests shall be kept by the owner for inspection by the authority having jurisdiction.

7.9.3.1.2 Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.
(2) Not less than once every 30 days, self-testing/self-diagnostic battery-operated emergency lighting equipment shall automatically perform a test with a duration of a minimum of 30 seconds and a diagnostic routine.
(3) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall indicate failures by a status indicator.
(4) A visual inspection shall be performed at intervals not exceeding 30 days.
(5) Functional testing shall be conducted annually for a minimum of 1½ hours.
(6) Self-testing/self-diagnostic battery-operated emergency lighting equipment shall be fully operational for the duration of the 1½-hour test.
(7) Written records of visual inspections and tests shall be kept by the owner for inspection by the authority having jurisdiction.

7.9.3.1.3 Testing of required emergency lighting systems shall be permitted to be conducted as follows:

(1) Computer-based, self-testing/self-diagnostic battery-operated emergency lighting equipment shall be provided.
(2) Not less than once every 30 days, emergency lighting equipment shall automatically perform a test with a duration of a minimum of 30 seconds and a diagnostic routine.
(3) The emergency lighting equipment shall automatically perform annually a test for a minimum of 1½ hours.
(4) The emergency lighting equipment shall be fully operational for the duration of the tests required by 7.9.3.1.3(2) and (3).
(5) The computer-based system shall be capable of providing a report of the history of tests and failures at all times.

7.10 Marking of Means of Egress.

7.10.1 General.

7.10.1.1 Where Required. Means of egress shall be marked in accordance with Section 7.10 where required in Chapters 11 through 43.

7.10.1.2 Exits.

7.10.1.2.1* Exits, other than main exterior exit doors that obviously and clearly are identifiable as exits, shall be marked by an approved sign that is readily visible from any direction of exit access.

7.10.1.2.2* Horizontal components of the egress path within an exit enclosure shall be marked by approved exit or directional exit signs where the continuation of the egress path is not obvious.

7.10.1.3 Exit Door Tactile Signage. Tactile signage shall be provided to meet all of the following criteria, unless otherwise provided in 7.10.1.4:

(1) Tactile signage shall be located at each exit door requiring an exit sign.
(2) Tactile signage shall read as follows: EXIT.

(3) Tactile signage shall comply with ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*.

7.10.1.4 Existing Exemption. The requirements of 7.10.1.3 shall not apply to existing buildings, provided that the occupancy classification does not change.

7.10.1.5 Exit Access.

7.10.1.5.1 Access to exits shall be marked by approved, readily visible signs in all cases where the exit or way to reach the exit is not readily apparent to the occupants.

7.10.1.5.2* New sign placement shall be such that no point in an exit access corridor is in excess of the rated viewing distance or 100 ft (30 m), whichever is less, from the nearest sign.

7.10.1.6* Floor Proximity Exit Signs. Where floor proximity exit signs are required in Chapters 11 through 43, such signs shall comply with 7.10.3, 7.10.4, 7.10.5, and 7.10.6 for externally illuminated signs and 7.10.7 for internally illuminated signs. Such signs shall be located near the floor level in addition to those signs required for doors or corridors. The bottom of the sign shall be not less than 6 in. (150 mm), but not more than 18 in. (455 mm), above the floor. For exit doors, the sign shall be mounted on the door or adjacent to the door, with the nearest edge of the sign within 4 in. (100 mm) of the door frame.

7.10.1.7* Floor Proximity Egress Path Marking. Where floor proximity egress path marking is required in Chapters 11 through 43, an approved floor proximity egress path marking system that is internally illuminated shall be installed within 18 in. (455 mm) of the floor. Floor proximity egress path marking systems shall be listed in accordance with ANSI/UL 1994, *Standard for Luminous Egress Path Marking Systems*. The system shall provide a visible delineation of the path of travel along the designated exit access and shall be essentially continuous, except as interrupted by doorways, hallways, corridors, or other such architectural features. The system shall operate continuously or at any time the building fire alarm system is activated. The activation, duration, and continuity of operation of the system shall be in accordance with 7.9.2. The system shall be maintained in accordance with the product manufacturing listing.

7.10.1.8* Visibility. Every sign required in Section 7.10 shall be located and of such size, distinctive color, and design that it is readily visible and shall provide contrast with decorations, interior finish, or other signs. No decorations, furnishings, or equipment that impairs visibility of a sign shall be permitted. No brightly illuminated sign (for other than exit purposes), display, or object in or near the line of vision of the required exit sign that could detract attention from the exit sign shall be permitted.

7.10.1.9 Mounting Location. The bottom of new egress markings shall be located at a vertical distance of not more than 6 ft 8 in. (2030 mm) above the top edge of the egress opening intended for designation by that marking. Egress markings shall be located at a horizontal distance of not more than the required width of the egress opening, as measured from the edge of the egress opening intended for designation by that marking to the nearest edge of the marking.

7.10.2 Directional Signs.

7.10.2.1 A sign complying with 7.10.3, with a directional indicator showing the direction of travel, shall be placed in every location where the direction of travel to reach the nearest exit is not apparent.

7.10.2.2 Directional exit signs shall be provided within horizontal components of the egress path within exit enclosures as required by 7.10.1.2.2.

7.10.3* Sign Legend.

7.10.3.1 Signs required by 7.10.1 and 7.10.2 shall read as follows in plainly legible letters, or other appropriate wording shall be used:

EXIT

7.10.3.2* Where approved by the authority having jurisdiction, pictograms in compliance with NFPA 170, *Standard for Fire Safety and Emergency Symbols*, shall be permitted.

7.10.4* Power Source. Where emergency lighting facilities are required by the applicable provisions of Chapters 11 through 43 for individual occupancies, the signs, other than approved self-luminous signs and listed photoluminescent signs in accordance with 7.10.7.2, shall be illuminated by the emergency lighting facilities. The level of illumination of the signs shall be in accordance with 7.10.6.3 or 7.10.7 for the required emergency lighting duration as specified in 7.9.2.1. However, the level of illumination shall be permitted to decline to 60 percent at the end of the emergency lighting duration.

7.10.5 Illumination of Signs.

7.10.5.1* General. Every sign required by 7.10.1.2, 7.10.1.5, or 7.10.8.1, other than where operations or processes require low lighting levels, shall be suitably illuminated by a reliable light source. Externally and internally illuminated signs shall be legible in both the normal and emergency lighting mode.

7.10.5.2* Continuous Illumination.

7.10.5.2.1 Every sign required to be illuminated by 7.10.6.3, 7.10.7, and 7.10.8.1 shall be continuously illuminated as required under the provisions of Section 7.8, unless otherwise provided in 7.10.5.2.2.

7.10.5.2.2* Illumination for signs shall be permitted to flash on and off upon activation of the fire alarm system.

7.10.6 Externally Illuminated Signs.

7.10.6.1* Size of Signs.

7.10.6.1.1 Externally illuminated signs required by 7.10.1 and 7.10.2, other than approved existing signs, unless otherwise provided in 7.10.6.1.2, shall read EXIT or shall use other appropriate wording in plainly legible letters sized as follows:

(1) For new signs, the letters shall be not less than 6 in. (150 mm) high, with the principal strokes of letters not less than ¾ in. (19 mm) wide.
(2) For existing signs, the required wording shall be permitted to be in plainly legible letters not less than 4 in. (100 mm) high.
(3) The word EXIT shall be in letters of a width not less than 2 in. (51 mm), except the letter I, and the minimum spacing between letters shall be not less than ⅜ in. (9.5 mm).
(4) Sign legend elements larger than the minimum established in 7.10.6.1.1(1) through (3) shall use letter widths, strokes, and spacing in proportion to their height.

7.10.6.1.2 The requirements of 7.10.6.1.1 shall not apply to marking required by 7.10.1.3 and 7.10.1.7.

7.10.6.2* Size and Location of Directional Indicator.

7.10.6.2.1 Directional indicators, unless otherwise provided in 7.10.6.2.2, shall comply with all of the following:

(1) The directional indicator shall be located outside of the EXIT legend, not less than 3⁄8 in. (9.5 mm) from any letter.
(2) The directional indicator shall be of a chevron type, as shown in Figure 7.10.6.2.1.
(3) The directional indicator shall be identifiable as a directional indicator at a distance of 40 ft (12 m).
(4) A directional indicator larger than the minimum established for compliance with 7.10.6.2.1(3) shall be proportionately increased in height, width, and stroke.
(5) The directional indicator shall be located at the end of the sign for the direction indicated.

FIGURE 7.10.6.2.1 Chevron-Type Indicator.

7.10.6.2.2 The requirements of 7.10.6.2.1 shall not apply to approved existing signs.

7.10.6.3* Level of Illumination. Externally illuminated signs shall be illuminated by not less than 5 ft-candles (54 lux) at the illuminated surface and shall have a contrast ratio of not less than 0.5.

7.10.7 Internally Illuminated Signs.

7.10.7.1 Listing. Internally illuminated signs shall be listed in accordance with ANSI/UL 924, *Standard for Emergency Lighting and Power Equipment*, unless they meet one of the following criteria:

(1) They are approved existing signs.
(2) They are existing signs having the required wording in legible letters not less than 4 in. (100 mm) high.
(3) They are signs that are in accordance with 7.10.1.3 and 7.10.1.6.

7.10.7.2* Photoluminescent Signs. The face of a photoluminescent sign shall be continually illuminated while the building is occupied. The illumination levels on the face of the photoluminescent sign shall be in accordance with its listing. The charging illumination shall be a reliable light source, as determined by the authority having jurisdiction. The charging light source, shall be of a type specified in the product markings.

7.10.8 Special Signs.

7.10.8.1 Sign Illumination.

7.10.8.1.1* Where required by other provisions of this *Code*, special signs shall be illuminated in accordance with 7.10.5, 7.10.6.3, and 7.10.7.

7.10.8.1.2 Where emergency lighting facilities are required by the applicable provisions of Chapters 11 through 43, the required illumination of special signs shall additionally be provided under emergency lighting conditions.

7.10.8.2 Characters. Special signs, where required by other provisions of this *Code*, shall comply with the visual character requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*.

7.10.8.3* No Exit.

7.10.8.3.1 Any door, passage, or stairway that is neither an exit nor a way of exit access and that is located or arranged so that it is likely to be mistaken for an exit shall be identified by a sign that reads as follows:

NO

EXIT

7.10.8.3.2 The NO EXIT sign shall have the word NO in letters 2 in. (51 mm) high, with a stroke width of 3⁄8 in. (9.5 mm), and the word EXIT in letters 1 in. (25 mm) high, with the word EXIT below the word NO, unless such sign is an approved existing sign.

7.10.8.4 Elevator Signs. Elevators that are a part of a means of egress *(see 7.2.13.1)* shall have both of the following signs with a minimum letter height of 5⁄8 in. (16 mm) posted in every elevator lobby:

(1)*Signs that indicate that the elevator can be used for egress, including any restrictions on use
(2)*Signs that indicate the operational status of elevators

7.10.8.5* Evacuation Diagram. Where a posted floor evacuation diagram is required in Chapters 11 through 43, floor evacuation diagrams reflecting the actual floor arrangement and exit locations shall be posted and oriented in a location and manner acceptable to the authority having jurisdiction.

7.10.9 Testing and Maintenance.

7.10.9.1 Inspection. Exit signs shall be visually inspected for operation of the illumination sources at intervals not to exceed 30 days or shall be periodically monitored in accordance with 7.9.3.1.3.

7.10.9.2 Testing. Exit signs connected to, or provided with, a battery-operated emergency illumination source, where required in 7.10.4, shall be tested and maintained in accordance with 7.9.3.

7.11 Special Provisions for Occupancies with High Hazard Contents. See Section 6.2.

7.11.1* Where the contents are classified as high hazard, exits shall be provided and arranged to allow all occupants to escape from the building or structure, or from the hazardous area thereof, to the outside or to a place of safety with a travel distance of not more than 75 ft (23 m), measured as required in 7.6.1, unless otherwise provided in 7.11.2.

7.11.2 The requirement of 7.11.1 shall not apply to storage occupancies as otherwise provided in Chapter 42.

7.11.3 Egress capacity for high hazard contents areas shall be based on 0.7 in./person (18 mm/person) for stairs or 0.4 in./person (10 mm/person) for level components and ramps in accordance with 7.3.3.1.

7.11.4 Not less than two means of egress shall be provided from each building or hazardous area thereof, unless all of the following criteria are met:

(1) Rooms or spaces do not exceed 200 ft^2 (18.6 m^2).
(2) Rooms or spaces have an occupant load not exceeding three persons.

(3) Rooms or spaces have a travel distance to the room door not exceeding 25 ft (7620 mm).

7.11.5 Means of egress, for rooms or spaces other than those that meet the criteria of 7.11.4(1) through (3), shall be arranged so that there are no dead ends in corridors.

7.11.6 Doors serving high hazard contents areas with occupant loads in excess of five shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7.

7.12 Mechanical Equipment Rooms, Boiler Rooms, and Furnace Rooms.

7.12.1 Mechanical equipment rooms, boiler rooms, furnace rooms, and similar spaces shall be arranged to limit common path of travel to a distance not exceeding 50 ft (15 m), unless otherwise permitted by the following:

(1) A common path of travel not exceeding 100 ft (30 m) shall be permitted in the following locations:
   (a) In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
   (b) In mechanical equipment rooms with no fuel-fired equipment
   (c) In existing buildings
(2) In an existing building, a common path of travel not exceeding 150 ft (46 m) shall be permitted, provided that all of the following criteria are met:
   (a) The building is protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.7.
   (b) No fuel-fired equipment is within the space.
   (c) The egress path is readily identifiable.
(3) The requirement of 7.12.1 shall not apply to rooms or spaces in existing health care occupancies complying with the arrangement of means of egress provisions of 19.2.5 and the travel distance limits of 19.2.6.

7.12.2 Stories used exclusively for mechanical equipment, furnaces, or boilers shall be permitted to have a single means of egress where the travel distance to an exit on that story is not in excess of the common path of travel limitations of 7.12.1.

7.13 Normally Unoccupied Building Service Equipment Support Areas.

7.13.1* Hazard of Contents.

7.13.1.1 Unless prohibited by Chapters 11 through 43, the provisions of Section 7.13 shall apply, in lieu of the provisions of Sections 7.1 through 7.12, to normally unoccupied building service equipment support areas where such areas do not contain high hazard contents or operations.

7.13.1.2 Building service equipment support areas shall not contain fuel-fired equipment or be used for the storage of combustibles.

7.13.2 Egress Doors.

7.13.2.1* Egress from normally unoccupied building service equipment support areas shall be provided by doors complying with 7.2.1 where the normally unoccupied building service equipment support area exceeds 45,000 ft^2 (4180 m^2) in buildings not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.13.2.2 Egress from normally unoccupied building service equipment support areas shall be provided by doors complying with 7.2.1 where the normally unoccupied building service equipment support area exceeds 90,000 ft^2 (8370 m^2) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.13.2.3 The absence of sprinklers in the normally unoccupied building service equipment support area, as permitted by an exemption of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not cause a building to be classified as nonsprinklered for purposes of applying the provisions of 7.13.2.2.

7.13.3 Means of Egress Path.

7.13.3.1 A designated means of egress path shall be provided within the normally unoccupied building service equipment support area where the normally unoccupied area exceeds 45,000 ft^2 (4180 m^2) in buildings not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.13.3.2 A designated means of egress path shall be provided within the normally unoccupied building service equipment support area where the normally unoccupied area exceeds 90,000 ft^2 (8370 m^2) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.13.3.3 The absence of sprinklers in the normally unoccupied building service equipment support area, as permitted by an exemption of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not cause a building to be classified as nonsprinklered for purposes of applying the provisions of 7.13.3.2.

7.13.3.4 Where a means of egress path is required, the path shall be a minimum of 28 in. (710 mm) clear width.

7.13.3.5 Where a means of egress path is required, minimum headroom shall be 6 ft 8 in. (2030 mm) along the entire designated means of egress path.

7.13.3.6 Exit signage shall not be required along the means of egress path within normally unoccupied building service equipment support areas.

7.13.3.7 Where two means of egress are required, the means of egress path shall connect the two required means of egress.

7.13.3.8 The designated means of egress path shall be within 25 ft (7.6 m) of any portion of the space where the only available access requires crossing over or under obstructions, unless the space is completely inaccessible.

7.13.4 Illumination.

7.13.4.1 The minimum illumination of means of egress along the required means of egress path shall be 0.2 ft-candle (2.2 lux), except as otherwise provided in 7.13.4.2.

7.13.4.2 Illumination of means of egress shall not be required in normally unoccupied building service equipment support areas where illumination of means of egress is not required by the applicable occupancy chapter for the remainder of the building.

7.13.5 Number of Means of Egress.

7.13.5.1 Two remotely located means of egress shall be provided within the normally unoccupied building service equipment suport area where the normally unoccupied area exceeds 45,000 ft^2 (4180 m^2) in buildings not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.13.5.2 Two remotely located means of egress shall be provided within the normally unoccupied building service equipment support area where the normally unoccupied area exceeds 90,000 ft^2 (8370 m^2) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

7.13.5.3 The absence of sprinklers in the normally unoccupied building service equipment support area, as permitted by an exemption of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not cause a building to be classified as nonsprinklered for purposes of applying the provisions of 7.13.5.2.

7.14 Occupant Evacuation Elevators.

7.14.1 General.

7.14.1.1* Where passenger elevators for general public use are permitted to be used for occupant evacuation prior to Phase I Emergency Recall Operation mandated by the firefighters' emergency operation provisions of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, the elevator system shall also comply with this section, except as otherwise permitted by 7.14.1.2.

7.14.1.2 The provisions of Section 7.14 shall not apply where the limited or supervised use of elevators for evacuation is part of a formal or informal evacuation strategy, including the relocation or evacuation of patients in health care occupancies and the relocation or evacuation of occupants with disabilities in other occupancies.

7.14.1.3* The occupant evacuation elevators shall be in accordance with the occupant evacuation operation (OEO) requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* and the building emergency action plan required by 7.14.3.1.

7.14.1.4 Occupant evacuation elevators in accordance with Section 7.14 shall not be permitted to satisfy requirements of this *Code* applicable to the following:

(1) Number of means of egress
(2) Capacity of means of egress
(3) Arrangement of means of egress

7.14.2 Reserved.

7.14.3 Information Features.

7.14.3.1* An emergency action plan approved by the authority having jurisdiction shall be implemented, specifically including the procedures for occupant evacuation using the exit stairs and the occupant evacuation elevators.

7.14.3.2 Occupant evacuation elevators shall be marked with signage indicating the elevators are suitable for use by building occupants for evacuation during fires.

7.14.3.3 Conditions for Safe Continued Operation.

7.14.3.3.1 Conditions necessary for the continued safe operation of the occupant evacuation elevators and the associated elevator lobbies and elevator machine rooms shall be continuously monitored and displayed at the building fire command center by a standard emergency service interface system meeting the requirements of *NFPA 72, National Fire Alarm and Signaling Code*, and NEMA SB 30, *Fire Service Annunciator and Interface.*

7.14.3.3.2 The monitoring and display required by 7.14.3.3.1 shall include all of the following:

(1) Floor location of each elevator car
(2) Direction of travel of each elevator car
(3) Status of each elevator car with respect to whether it is occupied
(4) Status of normal power to the elevator equipment, elevator controller cooling equipment, and elevator machine room ventilation and cooling equipment
(5) Status of standby or emergency power system that provides backup power to the elevator equipment, elevator controller cooling equipment, and elevator machine/control room or machinery/control space ventilation and cooling equipment
(6) Activation of any fire alarm–initiating device in any elevator lobby, elevator machine/control room or machinery/control space, or elevator hoistway

7.14.3.4 The building fire command center location specified in 7.14.3.3.1 shall be provided with a means to override normal elevator operation and to initiate manually a Phase I emergency recall operation of the occupant evacuation elevators in accordance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators.*

7.14.4 Fire Detection, Alarm, and Communication.

7.14.4.1 The building shall be protected throughout by an approved fire alarm system in accordance with Section 9.6.

7.14.4.2* The fire alarm system shall include an emergency voice/alarm communication system in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, with the ability to provide voice directions on a selective basis to any building floor.

7.14.4.3* The emergency voice/alarm communication system shall be arranged so that intelligible voice instructions are audible in the elevator lobbies under conditions where the elevator lobby doors are in the closed position.

7.14.4.4 Two-way Communication System. A two-way communication system shall be provided in each occupant evacuation elevator lobby for the purpose of initiating communication with the fire command center or an alternative location approved by the fire department.

7.14.4.4.1 Design and Installation. The two-way communication system shall include audible and visible signals and shall be designed and installed in accordance with the requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities.*

7.14.4.4.2 Instructions.

7.14.4.4.2.1 Instructions for the use of the two-way communication system, along with the location of the station, shall be permanently located adjacent to each station.

7.14.4.4.2.2 Signage for instructions shall comply with the requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, for visual characters.

7.14.5 Sprinklers.

7.14.5.1 The building shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), except as otherwise specified in 7.14.5.1.1 through 7.14.5.3.

7.14.5.1.1 A sprinkler control valve and a waterflow device shall be provided for each floor.

7.14.5.1.2 The sprinkler control valves and waterflow devices required by 7.14.5.1.1 shall be monitored by the building fire alarm system.

7.14.5.2* Sprinklers shall not be installed in elevator machine/control rooms and machinery/control spaces serving occupant evacuation elevators, and such prohibition shall not cause an otherwise fully sprinklered building to be classified as nonsprinklered.

7.14.5.3* Where a hoistway serves occupant evacuation elevators, sprinklers shall not be installed at the top of the elevator hoistway or at other points in the hoistway more than 24 in. (610 mm) above the pit floor, and such prohibition shall not cause the building to be classified as nonsprinklered.

7.14.6 Elevator Installation.

7.14.6.1 Except as modified by 7.14.6.2 and 7.14.6.3, occupant evacuation elevators shall be installed in accordance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* including the provisions for occupant evacuation operation, as required by 7.14.1.3.

7.14.6.2* Shunt breakers shall not be installed on elevator systems used for occupant evacuation.

7.14.6.3 Occupant evacuation elevators shall be limited to passenger elevators that are located in noncombustible hoistways and for which the car enclosure materials meet the requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

7.14.7 Elevator Machine/Control Rooms and Machinery/Control Spaces.

7.14.7.1* Elevator machine/control rooms and machinery/control spaces associated with occupant evacuation elevators shall be separated from all building areas, other than elevator hoistways, by minimum 2-hour fire resistance–rated construction.

7.14.7.2* Elevator machine/control rooms and machinery/control spaces associated with occupant evacuation elevators shall be used for no purpose other than elevator machine/control rooms and machinery/control spaces.

7.14.8 Electrical Power and Control Wiring.

7.14.8.1 The following features associated with occupant evacuation elevators shall be supplied by both normal power and Type 60, Class 2, Level 1 standby power:

(1) Elevator equipment
(2) Ventilation and cooling equipment for elevator machine/control rooms and machinery/control spaces
(3) Elevator car lighting

7.14.8.2 Wires or cables that are located outside elevator hoistways, machine/control rooms, and machinery/control spaces, and that provide normal power, standby power, control signals, communication with the cars, lighting, heating, air-conditioning, ventilation, and fire detecting systems to occupant evacuation elevators shall be protected by one of the following means, except as otherwise provided in 7.14.8.3:

(1) The wiring shall utilize Type CI cable with a minimum 2-hour fire resistance rating.
(2) The wiring shall be enclosed in a minimum 2-hour fire resistance construction.
(3) The wiring shall be wiring that is approved as providing a 2-hour performance alternative.

7.14.8.3* Control signaling wiring and cables that do not serve Phase II emergency in-car service shall not be required to be protected.

7.14.9 Occupant Evacuation Shaft System.

7.14.9.1 Occupant evacuation elevators shall be provided with an occupant evacuation shaft system consisting of all of the following:

(1) Elevator hoistway
(2) Enclosed elevator lobby outside the bank or group of hoistway doors on each floor served by the elevators, with the exception that elevator lobbies not be required to be enclosed where located either on the street floor or level of exit discharge
(3) Enclosed exit stair with doors to all floors, at and above grade level, served by the elevators

7.14.9.2* Elevator Lobby Size.

7.14.9.2.1 Occupant evacuation elevator lobbies shall have minimum floor area, except as otherwise provided in 7.14.9.2.2, as follows:

(1) The elevator lobby floor area shall accommodate, at 3 ft^2 (0.28 m^2) per person, a minimum of 25 percent of the occupant load of the floor area served by the lobby.
(2) The elevator lobby floor area also shall accommodate one wheelchair space of 30 in. × 48 in. (760 mm × 1220 mm) for each 50 persons, or portion thereof, of the occupant load of the floor area served by the lobby.

7.14.9.2.2 The size of lobbies serving multiple banks of elevators shall be exempt from the requirement of 7.14.9.2.1(1), provided that the area of such lobbies is approved on an individual basis and is consistent with the building's emergency action plan.

7.14.9.3 Access to the exit stair required by 7.14.9.1(3) shall be directly from the enclosed elevator lobby on each floor.

7.14.9.4 The occupant evacuation shaft system shall be enclosed and separated from the remainder of the building by walls complying with the following:

(1) The shaft system walls shall be smoke barriers in accordance with Section 8.5.
(2) The shaft system walls separating the elevator lobby from the remainder of the building shall have a minimum 1-hour fire resistance rating and minimum ¾-hour fire protection–rated opening protectives.
(3) The shaft system walls separating the elevator hoistway from the remainder of the building shall have a minimum 2-hour fire resistance rating and minimum 1½-hour fire protection–rated opening protectives.
(4) The shaft system walls separating the enclosed exit stair from the remainder of the building shall have a minimum 2-hour fire resistance rating and minimum 1½-hour fire protection–rated opening protectives.

7.14.9.5 Occupant evacuation shaft system enclosures shall be constructed to provide a minimum of classification Level 2 in accordance with ASTM C 1629/C 1629M, *Standard Classification for Abuse-Resistant Nondecorated Interior Gypsum Panel Products and Fiber-Reinforced Cement Panels*.

7.14.9.6* An approved method to prevent water from infiltrating into the hoistway enclosure from the operation of the automatic sprinkler system outside the enclosed occupant evacuation elevator lobby shall be provided.

7.14.9.7 Occupant evacuation shaft system elevator lobby doors, other than doors to the hoistway, exit stair enclosure, control room, or control space, shall have all of the following features:

(1) The doors shall have a fire protection rating of not less than ¾ hour.
(2) The doors shall be smoke leakage–rated assemblies in accordance with NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*.
(3) The doors shall have an automatic positioning bottom seal to resist the passage of water at floor level from outside the shaft system.

7.14.9.8 Occupant evacuation shaft system elevator lobby doors shall have the following features:

(1) Each door, other than doors to the hoistway, exit stair enclosure, control room, or control space, shall be automatic-closing in accordance with 7.2.1.8.2, as modified by 7.14.9.8(2).
(2) In addition to the automatic-closing means addressed by 7.2.1.8.2, the elevator lobby door on any floor shall also close in response to any alarm signal initiated on that floor.
(3) Each door shall be provided with a vision panel arranged to allow people on either side of the door to view conditions on the other side of the door.

7.14.9.9 Each occupant evacuation shaft system exit stair enclosure door shall be provided with a vision panel arranged to allow people on either side of the door to view conditions on the other side of the door.

Chapter 8 Features of Fire Protection

8.1 General.

8.1.1 Application. The features of fire protection set forth in this chapter shall apply to both new construction and existing buildings.

8.1.2 Automatic Sprinkler Systems. Where another provision of this chapter requires an automatic sprinkler system, the automatic sprinkler system shall be installed in accordance with the subparts of 9.7.1.1, as permitted by the applicable occupancy chapter.

8.2 Construction and Compartmentation.

8.2.1 Construction.

8.2.1.1 Buildings or structures occupied or used in accordance with the individual occupancy chapters, Chapters 11 through 43, shall meet the minimum construction requirements of those chapters.

8.2.1.2* NFPA 220, *Standard on Types of Building Construction*, shall be used to determine the requirements for the construction classification.

8.2.1.3 Where the building or facility includes additions or connected structures of different construction types, the rating and classification of the structure shall be based on one of the following:

(1) Separate buildings, if a 2-hour or greater vertically aligned fire barrier wall in accordance with NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, exists between the portions of the building
(2) Separate buildings, if provided with previously approved separations
(3) Least fire-resistive construction type of the connected portions, if separation as specified in 8.2.1.3(1) or (2) is not provided

8.2.2 General.

8.2.2.1 Where required by other chapters of this *Code*, every building shall be divided into compartments to limit the spread of fire and restrict the movement of smoke.

8.2.2.2 Fire compartments shall be formed with fire barriers that comply with Section 8.3.

8.2.2.3 Smoke compartments shall be formed with smoke barriers that comply with Section 8.5.

8.2.2.4 Where door assemblies are required elsewhere in this *Code* to be smoke leakage–rated in accordance with 8.2.2.4, door assemblies shall comply with all of the following:

(1) They shall be tested in accordance with ANSI/UL 1784, *Standard for Air Leakage Tests for Door Assemblies*.
(2) The maximum air leakage rate of the door assembly shall be 3.0 $ft^3/min/ft^2$ (0.9 $m^3/min/m^2$) of door opening at 0.10 in. water column (25 N/m^2) for both the ambient and elevated temperature tests.
(3) Door assemblies shall be installed and maintained in accordance with NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*.

8.2.3 Fire Resistance–Rated Construction.

8.2.3.1* The fire resistance of structural elements and building assemblies shall be determined in accordance with test procedures set forth in ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*; other approved test methods; or analytical methods approved by the authority having jurisdiction.

8.2.3.1.1 Materials used to construct fire resistance–rated elements and assemblies shall be limited to those permitted in this *Code*.

8.2.3.1.2 In new construction, end-jointed lumber used in an assembly required to have a fire resistance rating shall have the designation "Heat Resistant Adhesive" or "HRA" included in its grade mark.

8.2.3.2 Fire resistance–rated floor and roof assemblies shall be classified as restrained or unrestrained in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*; or other approved test methods. The construction shall be considered restrained only where a registered design professional has furnished the authority having jurisdiction with satisfactory documentation verifying that the construction is restrained. The classification of fire resistance–rated floor and roof construction shall be identified on the plans as restrained or unrestrained.

8.2.3.3 Structural elements that support fire barriers shall be permitted to have only the fire resistance rating required for the construction classification of the building, provided that both of the following criteria are met:

(1) Such structural elements support nonbearing wall or partition assemblies that have a required 1-hour fire resistance rating or less.

(2) Such structural elements do not serve as exit enclosures or protection for vertical openings.

8.2.3.4 The requirement of 8.2.3.3 shall not apply to health care occupancy structural elements supporting floor assemblies in accordance with the provisions of 18.1.6 and 19.1.6.

8.2.4 Analytical Methods.

8.2.4.1 Analytical methods utilized to determine the fire resistance rating of building assemblies shall comply with 8.2.4.2 through 8.2.4.5.

8.2.4.2* Where calculations are used to establish the fire resistance rating of structural elements or assemblies, they shall be permitted to be performed in accordance with ASCE/SFPE 29, *Standard Calculation Methods for Structural Fire Protection*.

8.2.4.3 Where calculations are used to establish the fire resistance rating of concrete or masonry elements or assemblies, the provisions of ACI 216.1/TMS 0216.1, *Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies*, shall be permitted to be used.

8.2.4.4 Except for the methods specified in 8.2.4.2 and 8.2.4.3, analytical methods used to calculate the fire resistance of building assemblies or structural elements shall be approved.

8.2.4.5 Where an approved analytical method is utilized to establish the fire resistance rating of a structural element or building assembly, the calculations shall be based upon the fire exposure and acceptance criteria specified in ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*.

8.3 Fire Barriers.

8.3.1 General.

8.3.1.1 Fire barriers used to provide enclosure, subdivision, or protection under this *Code* shall be classified in accordance with one of the following fire resistance ratings:

(1) 3-hour fire resistance rating
(2) 2-hour fire resistance rating
(3) 1-hour fire resistance rating
(4)*½-hour fire resistance rating

8.3.1.2* Fire barriers shall comply with one of the following:

(1) The fire barriers are continuous from outside wall to outside wall or from one fire barrier to another, or a combination thereof, including continuity through all concealed spaces, such as those found above a ceiling, including interstitial spaces.
(2) The fire barriers are continuous from outside wall to outside wall or from one fire barrier to another, and from the floor to the bottom of the interstitial space, provided that the construction assembly forming the bottom of the interstitial space has a fire resistance rating not less than that of the fire barrier.

8.3.1.3 Walls used as fire barriers shall comply with Chapter 7 of NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*. The NFPA 221 limitation on percentage width of openings shall not apply.

8.3.2 Walls.

8.3.2.1 The fire-resistive materials, assemblies, and systems used shall be limited to those permitted in this *Code* and this chapter.

8.3.2.1.1* Fire resistance–rated glazing tested in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, shall be permitted.

8.3.2.1.2 New fire resistance–rated glazing shall bear the identifier "W-XXX" where "XXX" is the fire resistance rating in minutes. Such identification shall be permanently affixed.

8.3.2.2 The construction materials and details for fire-resistive assemblies and systems for walls described shall comply with all other provisions of this *Code*, except as modified herein.

8.3.2.3 Interior walls and partitions of nonsymmetrical construction shall be evaluated from both directions and assigned a fire resistance rating based on the shorter duration obtained in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. When the wall is tested with the least fire-resistive side exposed to the furnace, the wall shall not be required to be subjected to tests from the opposite side.

8.3.3 Fire Doors and Windows.

8.3.3.1 Openings required to have a fire protection rating by Table 8.3.4.2 shall be protected by approved, listed, labeled fire door assemblies and fire window assemblies and their accompanying hardware, including all frames, closing devices, anchorage, and sills in accordance with the requirements of NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, except as otherwise specified in this *Code*.

8.3.3.1.1 Fire resistance–rated glazing tested in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, shall be permitted in fire door assemblies and fire window assemblies where tested and installed in accordance with their listings.

8.3.3.1.2 New fire resistance–rated glazing shall be marked in accordance with Table 8.3.3.12 and Table 8.3.4.2. Such marking shall be permanently affixed.

8.3.3.2* Fire protection ratings for products required to comply with 8.3.3 shall be as determined and reported by a nationally recognized testing agency in accordance with NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*; ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*; ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*; NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*; or ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*.

8.3.3.2.1 Fire protection–rated glazing shall be evaluated under positive pressure in accordance with NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*.

8.3.3.2.2 All products required to comply with 8.3.3.2 shall bear an approved label.

8.3.3.2.3* Labels.

8.3.3.2.3.1 Labels on fire door assemblies shall be maintained in a legible condition.

8.3.3.2.3.2 In existing installations, steel door frames without a label shall be permitted where approved by the authority having jurisdiction.

8.3.3.3 Unless otherwise specified, fire doors shall be self-closing or automatic-closing in accordance with 7.2.1.8.

8.3.3.4 Floor fire door assemblies shall be tested in accordance with NFPA 288, *Standard Methods of Fire Tests of Horizontal Fire Door Assemblies Installed in Horizontal Fire Resistance–Rated Assemblies*, and shall achieve a fire resistance rating not less than the assembly being penetrated. Floor fire door assemblies shall be listed and labeled.

8.3.3.5 Fire protection–rated glazing shall be permitted in fire barriers having a required fire resistance rating of 1 hour or less and shall be of an approved type with the appropriate fire protection rating for the location in which the barriers are installed.

8.3.3.6* Glazing in fire window assemblies, other than in existing fire window installations of wired glass and other fire-rated glazing material, shall be of a design that has been tested to meet the conditions of acceptance of NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*, or ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*. Fire protection–rated glazing in fire door assemblies, other than in existing fire-rated door assemblies, shall be of a design that has been tested to meet the conditions of acceptance of NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*; ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*; or ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*.

8.3.3.7 Fire resistance–rated glazing complying with 8.3.2.1.1 shall be permitted in fire doors and fire window assemblies in accordance with their listings.

8.3.3.8 Glazing materials that have been tested, listed, and labeled to indicate the type of opening to be protected for fire protection purposes shall be permitted to be used in approved opening protectives in accordance with Table 8.3.4.2 and in sizes in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

8.3.3.9 Existing installations of wired glass of ¼ in. (6.3 mm) thickness and labeled for fire protection purposes shall be permitted to be used in approved opening protectives, provided that the maximum size specified by the listing is not exceeded.

8.3.3.10 Nonsymmetrical fire protection–rated glazing systems shall be tested with each face exposed to the furnace, and the assigned fire protection rating shall be that of the shortest duration obtained from the two tests conducted in compliance with NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*, or ANSI/UL 9, *Standard for Fire Tests of Window Assemblies*.

8.3.3.11 The total combined area of glazing in fire-rated window assemblies and fire-rated door assemblies used in fire barriers shall not exceed 25 percent of the area of the fire barrier that is common with any room, unless the installation meets one of the following criteria:

(1) The installation is an existing fire window installation of wired glass and other fire-rated glazing materials in approved frames.
(2) The fire protection–rated glazing material is installed in approved existing frames.

8.3.3.12 New fire protection–rated glazing shall be marked in accordance with Table 8.3.3.12 and Table 8.3.4.2, and such marking shall be permanently affixed.

8.3.3.13 Fire-rated door assemblies shall be inspected and tested in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

8.3.4 Opening Protectives.

8.3.4.1 Every opening in a fire barrier shall be protected to limit the spread of fire and restrict the movement of smoke from one side of the fire barrier to the other.

8.3.4.2* The fire protection rating for opening protectives in fire barriers, fire-rated smoke barriers, and fire-rated smoke partitions shall be in accordance with Table 8.3.4.2, except as otherwise permitted in 8.3.4.3 or 8.3.4.4.

8.3.4.2.1 Fire-rated glazing assemblies marked as complying with hose stream requirements (H) shall be permitted in applications that do not require compliance with hose stream requirements. Fire-rated glazing assemblies marked as complying with temperature rise requirements (T) shall be permitted in applications that do not require compliance with temperature rise requirements. Fire-rated glazing assemblies marked with ratings that exceed the ratings required by this *Code* (XXX) shall be permitted.

8.3.4.3 Existing fire door assemblies having a minimum ¾-hour fire protection rating shall be permitted to continue to be used in vertical openings and in exit enclosures in lieu of the minimum 1-hour fire protection rating required by Table 8.3.4.2.

8.3.4.4 Where a 20-minute fire protection–rated door is required in existing buildings, an existing 1¾ in. (44 mm) solid-bonded wood-core door, an existing steel-clad (tin-clad) wood door, or an existing solid-core steel door with positive latch and closer shall be permitted, unless otherwise specified by Chapters 11 through 43.

8.3.5 Penetrations. The provisions of 8.3.5 shall govern the materials and methods of construction used to protect through-penetrations and membrane penetrations in fire walls, fire barrier walls, and fire resistance–rated horizontal assemblies. The provisions of 8.3.5 shall not apply to approved existing materials and methods of construction used to protect existing through-penetrations and existing membrane penetrations in fire walls, fire barrier walls, or fire resistance–rated horizontal assemblies, unless otherwise required by Chapters 11 through 43.

8.3.5.1* Firestop Systems and Devices Required. Penetrations for cables, cable trays, conduits, pipes, tubes, combustion vents and exhaust vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a wall, floor, or floor/ceiling assembly constructed as a fire barrier shall be protected by a firestop system or device. The firestop system or device shall be tested in accordance with ASTM E 814, *Standard Test Method for Fire Tests of Through Penetration Fire Stops*, or ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, at a minimum positive pressure differential of 0.01 in. water column (2.5 N/m^2) between the exposed and the unexposed surface of the test assembly.

Table 8.3.3.12 Marking Fire-Rated Glazing Assemblies

Fire Test Standard	Marking	Definition of Marking
ASTM E119, or ANSI/UL 263[a]	W	Meets wall assembly criteria
NFPA 257	OH	Meets fire window assembly criteria, including the hose stream test
NFPA 252	D	Meets fire door assembly criteria
	H	Meets fire door assembly hose stream test
	T	Meets 450°F (232°C) temperature rise criteria for 30 minutes
	XXX	The time, in minutes, of fire resistance or fire protection rating of the glazing assembly

[a]ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials* and ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials.*

Table 8.3.4.2 Minimum Fire Ratings for Opening Protectives in Fire Resistance–Rated Assemblies and Fire-Rated Glazing Markings

Component	Walls and Partitions (hr)	Fire Door Assemblies (hr)	Door Vision Panel Maximum Size (in.^{2})	Fire-Rated Glazing Marking Door Vision Panel	Minimum Side Light/Transom Assembly Rating (hr)		Fire-Rated Glazing Marking Side Light/Transom Panel		Minimum Fire-Rated Windows Rating [a,b] (hr)		Fire-Rated Window Marking	
					Fire protection	Fire resistance	Fire protection	Fire resistance	Fire protection	Fire resistance	Fire protection	Fire resistance
Elevator hoistways	2	1-½	155 in.^{2} [c]	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
	1	1	155 in.^{2} [c]	D-H-60 or D-H-W-60	NP	1	NP	D-H-W-60	NP	1	NP	W-60
	½	⅓	85 in.^{2} [d]	D-20 or D-W-20	⅓	⅓	D-H-20	D-W-20	⅓	⅓	OH-20	W-30
Elevator lobby (per 7.2.13.4)	1	1	100 in.^{2} [a]	≤100 in.^{2}, D-H-T-60 or D-H-W-60 >100 in.^{2}, D-H-W-60	NP	1	NP	D-H-W-60	NP	1	NP	W-60
Vertical shafts (including stairways, exits and refuse chutes	2	1-½	Maximum size tested	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
	1	1	Maximum size tested	D-H-60 or D-H-W-60	NP	1	NP	D-H-W-60	NP	1	NP	W-60
Replacement Panels in Existing Vertical Shafts	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D-H-20	D-W-20	⅓	⅓	OH-20	W-30
Fire barriers	3	3	100 in.^{2} [a]	≤100 in.^{2}, D-H-180 or D-H-W-180 >100 in.^{2}, D-H-W-180	NP	3	NP	D-H-W-180	NP	3	NP	W-180
	2	1-½	Maximum size tested	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
	1	¾	Maximum size tested[e]	D-H-45 or D-H-W-45	¾ [e]	¾ [e]	D-H-45	D-H-W-45	¾	¾	OH-45	W-60
	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D-H-20	D-W-20	⅓	⅓	OH-20	W-30

(continues)

Table 8.3.4.2 ***Continued***

Component	Walls and Partitions (hr)	Fire Door Assemblies (hr)	Door Vision Panel Maximum Size (in.^{2})	Fire-Rated Glazing Marking Door Vision Panel	Minimum Side Light/Transom Assembly Rating (hr)		Fire-Rated Glazing Marking Side Light/Transom Panel		Minimum Fire-Rated Windows Rating [a,b] (hr)		Fire-Rated Window Marking	
					Fire protection	Fire resistance	Fire protection	Fire resistance	Fire protection	Fire resistance	Fire protection	Fire resistance
Horizontal exits	2	1-½	Maximum size tested	D-H-90 or D-H-W-90	NP	2	NP	D-H-W-120	NP	2	NP	W-120
Horizontal exits served by bridges between buildings	2	¾	Maximum size tested[e]	D-H-45 or D-H-W-45	¾ [e]	¾ [e]	D-H-45	D-H-W-45	¾	¾	OH-45	W-120
Exit access corridors[f]	1	⅓	Maximum size tested	D-20 or D-W-20	¾	¾	D- H-45	D-H-W-20	¾	¾	OH-45	W-60
	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D- H-20	D-H-W-20	⅓	⅓	OH-20	W-30
Smoke barriers[f]	1	⅓	Maximum size tested	D-20 or D-W-20	¾	¾	D- H-45	D-H-W-20	¾	¾	OH-45	W-60
Smoke partitions[f,g]	½	⅓	Maximum size tested	D-20 or D-W-20	⅓	⅓	D- H-20	D-H-W-20	⅓	⅓	OH-20	W-30

For SI units, 1 in.^{2} = 0.00064516 m^2.
NP: Not permitted.
[a] Fire resistance–rated glazing tested to ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*; or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, shall be permitted in the maximum size tested *(see 8.3.3.7)*.
[b] Fire-rated glazing in exterior windows shall be marked in accordance with Table 8.3.3.12.
[c] See ASME A17.1, *Safety Code for Elevators and Escalators*, for additional information.
[d] See ASME A17.3, *Safety Code for Existing Elevators and Escalators*, for additional information.
[e] Maximum area of individual exposed lights shall be 1296 in.^{2} (0.84 m^2), with no dimension exceeding 54 in. (1.37 m) unless otherwise tested. [**80:** Table 4.4.5 Note b and **80:**4.4.5.1].
[f] Fire doors are not required to have a hose stream test per ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*; or ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*.
[g] For residential board and care, see 32.2.3.1 and 33.2.3.1.

8.3.5.1.1 The requirements of 8.3.5.1 shall not apply where otherwise permitted by any one of the following:

(1) Where penetrations are tested and installed as part of an assembly tested and rated in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*
(2) Where penetrations through floors are enclosed in a shaft enclosure designed as a fire barrier
(3) Where concrete, grout, or mortar has been used to fill the annular spaces around cast-iron, copper, or steel piping that penetrates one or more concrete or masonry fire resistance–rated assemblies and both of the following criteria are also met:
   (a) The nominal diameter of each penetrating item shall not exceed 6 in. (150 mm), and the opening size shall not exceed 1 ft^2 (0.09 m^2).
   (b) The thickness of the concrete, grout, or mortar shall be the full thickness of the assembly.
(4) Where firestopping materials are used with the following penetrating items, the penetration is limited to one floor, and the firestopping material is capable of preventing the passage of flame and hot gases sufficient to ignite cotton waste when subjected to the time–temperature fire conditions of ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, under a minimum positive pressure differential of 0.01 in. water column (2.5 Pa) at the location of the penetration for the time period equivalent to the required fire resistance rating of the assembly penetrated:
   (a) Steel, ferrous, or copper cables
   (b) Cable or wire with steel jackets
   (c) Cast-iron, steel, or copper pipes
   (d) Steel conduit or tubing

8.3.5.1.2 The maximum nominal diameter of the penetrating item, as indicated in 8.3.5.1.1(4)(a) through (d), shall not be greater than 4 in. (100 mm) and shall not exceed an aggregate 100 in.^{2} (64,520 mm^2) opening in any 100 ft^2 (9.3 m^2) of floor or wall area.

8.3.5.1.3 Firestop systems and devices shall have a minimum 1-hour F rating, but not less than the required fire resistance rating of the fire barrier penetrated.

8.3.5.1.4 T Ratings. Penetrations in fire resistance–rated horizontal assemblies shall be required to have a T rating of at least 1 hour, but not less than the fire resistance rating of the horizontal assembly, and shall not be required for either of the following:

(1) Floor penetrations contained within the cavity of a wall assembly.

(2) Penetrations through floors or floor assemblies where the penetration is not in direct contact with combustible material.

8.3.5.2 Sleeves. Where the penetrating item uses a sleeve to penetrate the wall or floor, the sleeve shall be securely set in the wall or floor, and the space between the item and the sleeve shall be filled with a material that complies with 8.3.5.1.

8.3.5.3 Insulation and Coverings. Insulation and coverings for penetrating items shall not pass through the wall or floor unless the insulation or covering has been tested as part of the firestop system or device.

8.3.5.4 Transmission of Vibrations. Where designs take transmission of vibrations into consideration, any vibration isolation shall meet one of the following conditions:

(1) It shall be provided on either side of the wall or floor.
(2) It shall be designed for the specific purpose.

8.3.5.5 Transitions.

8.3.5.5.1 Where piping penetrates a fire resistance–rated wall or floor assembly, combustible piping shall not connect to noncombustible piping within 36 in. (915 mm) of the firestop system or device without demonstration that the transition will not reduce the fire resistance rating, except in the case of previously approved installations.

8.3.5.5.2 Unshielded couplings shall not be used to connect noncombustible piping to combustible piping unless it can be demonstrated that the transition complies with the fire-resistive requirements of 8.3.5.1.

8.3.5.6 Membrane Penetrations.

8.3.5.6.1 Membrane penetrations for cables, cable trays, conduits, pipes, tubes, combustion vents and exhaust vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a membrane of a wall, floor, or floor/ceiling assembly constructed as a fire barrier shall be protected by a firestop system or device and shall comply with 8.3.5.1 through 8.3.5.5.2.

8.3.5.6.2 The firestop system or device shall be tested in accordance with ASTM E 814, *Standard Test Method for Fire Tests of Through Penetration Fire Stops*, or ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, at a minimum positive pressure differential of 0.01 in. water column (2.5 N/m^2) between the exposed and the unexposed surface of the test assembly, unless one of the following applies:

(1) Membrane penetrations of ceilings that are not an integral part of a fire resistance–rated floor/ceiling or roof/ceiling assembly shall be permitted.
(2) Membrane penetrations of steel, ferrous, or copper conduits, and pipes, tubes, or combustion vents or exhaust vents, shall be permitted where the annular space is protected with an approved material and the aggregate area of the openings does not exceed 0.7 ft^2 (0.06 m^2) in any 100 ft^2 (9.3 m^2) of ceiling area.
(3) Electrical outlet boxes and fittings shall be permitted, provided that such devices are listed for use in fire resistance–rated assemblies and are installed in accordance with their listing.
(4) The annular space created by the membrane penetration of a fire sprinkler shall be permitted, provided that the space is covered by a metal escutcheon plate.

8.3.5.6.3 Where walls or partitions are required to have a minimum 1-hour fire resistance rating, recessed fixtures shall be installed in the wall or partition in such a manner that the required fire resistance is not reduced, unless one of the following is met:

(1) Any steel electrical box not exceeding 0.1 ft^2 (0.01 m^2) shall be permitted where the aggregate area of the openings provided for the boxes does not exceed 0.7 ft^2 (0.06 m^2) in any 100 ft^2 (9.3 m^2) of wall area, and, where outlet boxes are installed on opposite sides of the wall, the boxes shall be separated by one of the following:
   (a) Horizontal distance of not less than 24 in. (610 mm)
   (b) Horizontal distance of not less than the depth of the wall cavity, where the wall cavity is filled with cellulose loose-fill, rock wool, or slag wool insulation
   (c)*Solid fireblocking
   (d) Other listed materials and methods
(2) Membrane penetrations for any listed electrical outlet box made of any material shall be permitted, provided that such boxes have been tested for use in fire resistance–rated assemblies and are installed in accordance with the instructions included in the listing.
(3) The annular space created by the membrane penetration of a fire sprinkler shall be permitted, provided that the space is covered by a metal escutcheon plate.
(4) Membrane penetrations by electrical boxes of any size or type, which have been listed as part of a wall opening protective material system for use in fire resistance–rated assemblies and are installed in accordance with the instructions included in the listing, shall be permitted.

8.3.5.7 Openings for Air-Handling Ductwork. Openings in fire barriers for air-handling ductwork or air movement shall be protected in accordance with 9.2.1.

8.3.6 Joints.

8.3.6.1 The provisions of 8.3.6 shall govern the materials and methods of construction used to protect joints in between and at the perimeter of fire barriers or, where fire barriers meet other fire barriers, the floor or roof deck above, or the outside walls. The provisions of 8.3.6 shall not apply to approved existing materials and methods of construction used to protect existing joints in fire barriers, unless otherwise required by Chapters 11 through 43.

8.3.6.2 Joints made within or at the perimeter of fire barriers shall be protected with a joint system that is capable of limiting the transfer of smoke.

8.3.6.3 Joints made within or between fire barriers shall be protected with a smoke-tight joint system that is capable of limiting the transfer of smoke.

8.3.6.4 Testing of the joint system in a fire barrier shall be representative of the actual installation suitable for the required engineering demand without compromising the fire resistance rating of the assembly or the structural integrity of the assembly.

8.3.6.5* Joints made within or between fire resistance–rated assemblies shall be protected with a joint system that is designed and tested to prevent the spread of fire for a time period equal to that of the assembly in which the joint is located. Such materials, systems, or devices shall be tested as part of the assembly in accordance with the requirements of ASTM E 1966, *Standard Test*

Method for Fire-Resistive Joint Systems, or ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*.

8.3.6.6 All joint systems shall be tested at their maximum joint width in accordance with the requirements of ASTM E 1966, *Standard Test Method for Fire-Resistive Joint Systems*, or ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*, under a minimum positive pressure differential of 0.01 in. water column (2.5 N/m^2) for a time period equal to that of the assembly. All test specimens shall comply with the minimum height or length required by the standard. Wall assemblies shall be subjected to a hose stream test in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*.

8.3.6.7* Exterior Curtain Walls and Perimeter Joints.

8.3.6.7.1 Voids created between the fire resistance–rated floor assembly and the exterior curtain wall shall be protected with a perimeter joint system that is designed and tested in accordance with ASTM E 2307, *Standard Test Method for Fire Resistance of Perimeter Fire Barriers Using Intermediate-Scale, Multi-story Apparatus*.

8.3.6.7.2 The perimeter joint system shall have an F rating equal to the fire resistance rating of the floor assembly.

8.4 Smoke Partitions.

8.4.1* General. Where required elsewhere in this *Code*, smoke partitions shall be provided to limit the transfer of smoke.

8.4.2 Continuity. Smoke partitions shall comply with the following:

(1) They shall extend from the floor to the underside of the floor or roof deck above, through any concealed spaces, such as those above suspended ceilings, and through interstitial structural and mechanical spaces.
(2)*They shall be permitted to extend from the floor to the underside of a monolithic or suspended ceiling system where all of the following conditions are met:
   (a) The ceiling system forms a continuous membrane.
   (b) A smoke-tight joint is provided between the top of the smoke partition and the bottom of the suspended ceiling.
   (c) The space above the ceiling is not used as a plenum.
(3) Smoke partitions enclosing hazardous areas shall be permitted to terminate at the underside of a monolithic or suspended ceiling system where all of the following conditions are met:
   (a) The ceiling system forms a continuous membrane.
   (b) A smoke-tight joint is provided between the top of the smoke partition and the bottom of the suspended ceiling.
   (c) Where the space above the ceiling is used as a plenum, return grilles from the hazardous area into the plenums are not permitted.

8.4.3 Opening Protectives.

8.4.3.1 Doors in smoke partitions shall comply with 8.4.3.2 through 8.4.3.5.

8.4.3.2 Doors shall comply with the provisions of 7.2.1.

8.4.3.3 Doors shall not include louvers.

8.4.3.4* Door clearances shall be in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

8.4.3.5 Doors shall be self-closing or automatic-closing in accordance with 7.2.1.8.

8.4.4 Penetrations. The provisions of 8.4.4 shall govern the materials and methods of construction used to protect through-penetrations and membrane penetrations of smoke partitions.

8.4.4.1 Penetrations for cables, cable trays, conduits, pipes, tubes, vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a smoke partition shall be protected by a system or material that is capable of limiting the transfer of smoke.

8.4.4.2 Where designs take transmission of vibrations into consideration, any vibration isolation shall meet one of the following conditions:

(1) It shall be provided on either side of the smoke partition.
(2) It shall be designed for the specific purpose.

8.4.5 Joints.

8.4.5.1 The provisions of 8.4.5 shall govern the materials and methods of construction used to protect joints in between and at the perimeter of smoke partitions or, where smoke partitions meet other smoke partitions, the floor or roof deck above, or the outside walls. The provisions of 8.4.5 shall not apply to approved existing materials and methods of construction used to protect existing joints in smoke partitions, unless otherwise required by Chapters 11 through 43.

8.4.5.2 Joints made within or at the perimeter of smoke partitions shall be protected with a joint system that is capable of limiting the transfer of smoke.

8.4.6 Air-Transfer Openings.

8.4.6.1 General. The provisions of 8.4.6 shall govern the materials and methods of construction used to protect air-transfer openings in smoke partitions.

8.4.6.2* Smoke Dampers. Air-transfer openings in smoke partitions shall be provided with approved smoke dampers designed and tested in accordance with the requirements of ANSI/UL 555S, *Standard for Smoke Dampers*, to limit the transfer of smoke.

8.4.6.3 Smoke Damper Ratings. Smoke damper leakage ratings shall be not less than Class II. Elevated temperature ratings shall be not less than 250°F (140°C).

8.4.6.4 Smoke Detectors. Dampers in air-transfer openings shall close upon detection of smoke by approved smoke detectors installed in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

8.5 Smoke Barriers.

8.5.1* General. Where required by Chapters 11 through 43, smoke barriers shall be provided to subdivide building spaces for the purpose of restricting the movement of smoke.

8.5.2* Continuity.

8.5.2.1 Smoke barriers required by this *Code* shall be continuous from an outside wall to an outside wall, from a floor to a floor, or from a smoke barrier to a smoke barrier, or by use of a combination thereof.

8.5.2.2 Smoke barriers required by this *Code* shall be continuous through all concealed spaces, such as those found above a ceiling, including interstitial spaces.

8.5.2.3 A smoke barrier required for an occupied space below an interstitial space shall not be required to extend through the interstitial space, provided that the construction assembly forming the bottom of the interstitial space provides resistance to the passage of smoke equal to that provided by the smoke barrier.

8.5.3 Fire Barrier Used as Smoke Barrier. A fire barrier shall be permitted to be used as a smoke barrier, provided that it meets the requirements of Section 8.5.

8.5.4 Opening Protectives.

8.5.4.1* Doors in smoke barriers shall close the opening, leaving only the minimum clearance necessary for proper operation, and shall be without louvers or grilles. For other than previously approved existing doors, the clearance under the bottom of the doors shall be a maximum of ¾ in. (19 mm).

8.5.4.2 Where required by Chapters 11 through 43, doors in smoke barriers that are required to be smoke leakage–rated shall comply with the requirements of 8.2.2.4.

8.5.4.3 Latching hardware shall be required on doors in smoke barriers, unless specifically exempted by Chapters 11 through 43.

8.5.4.4* Doors in smoke barriers shall be self-closing or automatic-closing in accordance with 7.2.1.8 and shall comply with the provisions of 7.2.1.

8.5.4.5 Fire window assemblies shall comply with 8.3.3.

8.5.5 Ducts and Air-Transfer Openings.

8.5.5.1 General. The provisions of 8.5.5 shall govern the materials and methods of construction used to protect ducts and air-transfer openings in smoke barriers.

8.5.5.2 Smoke Dampers.

8.5.5.2.1 Where a smoke barrier is penetrated by a duct or air-transfer opening, a smoke damper designed and tested in accordance with the requirements of ANSI/UL 555S, *Standard for Smoke Dampers*, shall be installed.

8.5.5.2.2 Where a smoke barrier is also constructed as a fire barrier, a combination fire/smoke damper designed and tested in accordance with the requirements of ANSI/UL 555, *Standard for Fire Dampers*, and ANSI/UL 555S, *Standard for Smoke Dampers*, shall be installed.

8.5.5.3 Smoke Damper Exemptions. Smoke dampers shall not be required under any of the following conditions:

(1) Where specifically exempted by provisions in Chapters 11 through 43
(2) Where ducts or air-transfer openings are part of an engineered smoke control system and the smoke damper will interfere with the operation of a smoke control system
(3) Where the air in ducts continues to move and the air handling system installed is arranged to prevent recirculation of exhaust or return air under fire emergency conditions
(4) Where the air inlet or outlet openings in ducts are limited to a single smoke compartment
(5) Where ducts penetrate floors that serve as smoke barriers
(6) Where ducts penetrate smoke barriers forming a communicating space separation in accordance with 8.6.6(4)(a)

8.5.5.4 Installation, Testing, and Maintenance.

8.5.5.4.1 Air-conditioning, heating, ventilating ductwork, and related equipment, including smoke dampers and combination fire and smoke dampers, shall be installed in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*, or NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, as applicable.

8.5.5.4.2 Smoke dampers and combination fire and smoke dampers required by this *Code* shall be inspected, tested, and maintained in accordance with NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*.

8.5.5.4.3 The equipment specified in 8.5.5.4.1 shall be installed in accordance with the requirements of 8.5.5, the manufacturer's installation instructions, and the equipment listing.

8.5.5.5 Access and Identification.

8.5.5.5.1 Access to the dampers shall be provided for inspection, testing, and maintenance.

8.5.5.5.2 Smoke and combination fire and smoke dampers in new construction shall be provided with an approved means of access, as follows:

(1) The means of access shall be large enough to allow inspection and maintenance of the damper and its operating parts.
(2) The access shall not affect the integrity of fire resistance–rated assemblies or smoke barrier continuity.
(3) The access openings shall not reduce the fire resistance rating of the assembly.
(4) Access doors in ducts shall be tight-fitting and suitable for the required duct construction.
(5) Access and maintenance shall comply with the requirements of the mechanical code.

8.5.5.5.3 Identification. Access points to fire and smoke dampers in new construction shall be permanently identified by one of the following:

(1) A label having letters not less than ½ in. (13 mm) in height and reading as one of the following:
    (a) FIRE/SMOKE DAMPER
    (b) SMOKE DAMPER
    (c) FIRE DAMPER
(2) Symbols as approved by the authority having jurisdiction

8.5.5.6 Smoke Damper Ratings. Smoke damper leakage ratings shall be not less than Class II. Elevated temperature ratings shall be not less than 250°F (140°C).

8.5.5.7 Smoke Detectors.

8.5.5.7.1 Required smoke dampers in ducts penetrating smoke barriers shall close upon detection of smoke by approved smoke detectors in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, unless one of the following conditions exists:

(1) The ducts penetrate smoke barriers above the smoke barrier doors, and the door release detector actuates the damper.
(2) Approved smoke detector installations are located within the ducts in existing installations.

8.5.5.7.2 Where a duct is provided on one side of the smoke barrier, the smoke detectors on the duct side shall be in accordance with 8.5.5.7.1.

8.5.5.7.3 Required smoke dampers in air-transfer openings shall close upon detection of smoke by approved smoke detectors in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

8.5.6 Penetrations.

8.5.6.1 The provisions of 8.5.6 shall govern the materials and methods of construction used to protect through-penetrations and membrane penetrations of smoke barriers.

8.5.6.2 Penetrations for cables, cable trays, conduits, pipes, tubes, vents, wires, and similar items to accommodate electrical, mechanical, plumbing, and communications systems that pass through a wall, floor, or floor/ceiling assembly constructed as a smoke barrier, or through the ceiling membrane of the roof/ceiling of a smoke barrier assembly, shall be protected by a system or material capable of restricting the transfer of smoke.

8.5.6.3 Where a smoke barrier is also constructed as a fire barrier, the penetrations shall be protected in accordance with the requirements of 8.3.5 to limit the spread of fire for a time period equal to the fire resistance rating of the assembly and 8.5.6 to restrict the transfer of smoke, unless the requirements of 8.5.6.4 are met.

8.5.6.4 Where sprinklers penetrate a single membrane of a fire resistance–rated assembly in buildings equipped throughout with an approved automatic fire sprinkler system, noncombustible escutcheon plates shall be permitted, provided that the space around each sprinkler penetration does not exceed ½ in. (13 mm), measured between the edge of the membrane and the sprinkler.

8.5.6.5 Where the penetrating item uses a sleeve to penetrate the smoke barrier, the sleeve shall be securely set in the smoke barrier, and the space between the item and the sleeve shall be filled with a listed system or a material capable of restricting the transfer of smoke.

8.5.6.6 Where designs take transmission of vibrations into consideration, any vibration isolation shall meet one of the following conditions:

(1) It shall be provided on either side of the smoke barrier.
(2) It shall be designed for the specific purpose.

8.5.7 Joints.

8.5.7.1 The provisions of 8.5.7 shall govern the materials and methods of construction used to protect joints in between and at the perimeter of smoke barriers or, where smoke barriers meet other smoke barriers, the floor or roof deck above, or the outside walls. The provisions of 8.5.7 shall not apply to approved existing materials and methods of construction used to protect existing joints in smoke barriers, unless otherwise required by Chapters 11 through 43.

8.5.7.2 Joints made within or at the perimeter of smoke barriers shall be protected with a joint system that is capable of limiting the transfer of smoke.

8.5.7.3 Joints made within or between smoke barriers shall be protected with a smoke-tight joint system that is capable of limiting the transfer of smoke.

8.5.7.4 Smoke barriers that are also constructed as fire barriers shall be protected with a joint system that is designed and tested to resist the spread of fire for a time period equal to the required fire resistance rating of the assembly and restrict the transfer of smoke.

8.5.7.5 Testing of the joint system in a smoke barrier that also serves as fire barrier shall be representative of the actual installation.

8.6 Vertical Openings.

8.6.1 Floor Smoke Barriers. Every floor that separates stories in a building shall meet the following criteria:

(1) It shall be constructed as a smoke barrier in accordance with Section 8.5.
(2) It shall be permitted to have openings as described by 8.6.6, 8.6.7, 8.6.8, 8.6.9, or Chapters 11 through 43.

8.6.2* Continuity. Openings through floors shall be enclosed with fire barrier walls, shall be continuous from floor to floor, or floor to roof, and shall be protected as appropriate for the fire resistance rating of the barrier.

8.6.3 Continuity Exemptions. The requirements of 8.6.2 shall not apply where otherwise permitted by any of the following:

(1) Where penetrations for cables, cable trays, conduits, pipes, tubes, combustion vents and exhaust vents, wires, pneumatic tube conveyors, and similar items to accommodate electrical, mechanical, plumbing, and communications systems are protected in accordance with 8.3.5.1 and 8.5.6
(2) Where specified by 8.6.6, 8.6.7, 8.6.8, 8.6.9.1, 8.6.9.2, 8.6.9.3, or Chapters 11 through 43
(3) Where escalators and moving walks are protected in accordance with 8.6.9.6 or 8.6.9.7
(4) Where expansion or seismic joints are designed to prevent the penetration of fire and are shown to have a fire resistance rating of not less than that required for the floor when tested in accordance with ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*
(5) Where existing mail chutes meet one of the following criteria:
    (a) The cross-sectional area does not exceed 0.1 ft^2 (0.01 m^2).
    (b) The building is protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

8.6.4 Shafts. Shafts that do not extend from the bottom to the top of the building or structure shall comply with 8.6.4.1, 8.6.4.2, or 8.6.4.3, as modified by 8.6.4.4 or 8.6.4.5.

8.6.4.1 Shafts that do not extend to the top of the building or structure shall be enclosed at the highest level of the shaft with construction in accordance with 8.6.5.

8.6.4.2 Shafts that do not extend to the bottom of the building or structure shall be enclosed at the lowest level of the shaft with construction in accordance with 8.6.5.

8.6.4.3 Shafts that do not extend to the bottom and to the top of the building or structure shall be enclosed at the lowest and highest level of the shaft with construction in accordance with 8.6.5.

8.6.4.4 In lieu of any enclosure required at lowest or highest level of a shaft by 8.6.4.1 through 8.6.4.3, shafts shall be permitted to terminate in a room or space having a use related to the purpose of the shaft, provided that the room or space is separated from the remainder of the building by construction having a fire resistance rating and opening protectives in accordance with 8.6.5 and 8.3.4.

8.6.4.5 Any enclosure required at the lowest or highest level of a shaft by 8.6.4.1 through 8.6.4.3 shall be permitted to be protected by approved fire dampers installed in accordance with their listing.

8.6.5* Required Fire Resistance Rating. The minimum fire resistance rating for the enclosure of floor openings shall be as follows *(see 7.1.3.2.1 for enclosure of exits):*

(1) Enclosures connecting four or more stories in new construction — 2-hour fire barriers
(2) Other enclosures in new construction — 1-hour fire barriers
(3) Existing enclosures in existing buildings — ½-hour fire barriers
(4) Enclosures for lodging and rooming houses — as specified in Chapter 26
(5) Enclosures for new hotels — as specified in Chapter 28
(6) Enclosures for new apartment buildings — as specified in Chapter 30

8.6.6 Communicating Space. Unless prohibited by Chapters 11 through 43, unenclosed floor openings forming a communicating space between floor levels shall be permitted, provided that the following conditions are met:

(1) The communicating space does not connect more than three contiguous stories.
(2) The lowest or next-to-lowest story within the communicating space is a street floor.
(3) The entire floor area of the communicating space is open and unobstructed, such that a fire in any part of the space will be readily obvious to the occupants of the space prior to the time it becomes an occupant hazard.
(4) The communicating space is separated from the remainder of the building by fire barriers with not less than a 1-hour fire resistance rating, unless one of the following is met:
    (a) In buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, a smoke barrier in accordance with Section 8.5 shall be permitted to serve as the separation required by 8.6.6(4).
    (b) The requirement of 8.6.6(4) shall not apply to fully sprinklered residential housing units of detention and correctional occupancies in accordance with 22.3.1(2) and 23.3.1.1(2).
(5) The communicating space has ordinary hazard contents protected throughout by an approved automatic sprinkler system in accordance with Section 9.7 or has only low hazard contents. *(See 6.2.2.)*
(6) Egress capacity is sufficient to allow all the occupants of all levels within the communicating space to simultaneously egress the communicating space by considering it as a single floor area in determining the required egress capacity.
(7)*Each occupant within the communicating space has access to not less than one exit without having to traverse another story within the communicating space.
(8) Each occupant not in the communicating space has access to not less than one exit without having to enter the communicating space.

8.6.7* Atriums. Unless prohibited by Chapters 11 through 43, an atrium shall be permitted, provided that all of the following conditions are met:

(1) The atrium is separated from the adjacent spaces by fire barriers with not less than a 1-hour fire resistance rating, with opening protectives for corridor walls, unless one of the following is met:
    (a) The requirement of 8.6.7(1) shall not apply to existing, previously approved atriums.
    (b) Any number of levels of the building shall be permitted to open directly to the atrium without enclosure, based on the results of the engineering analysis required in 8.6.7(5).
    (c)*Glass walls and inoperable windows shall be permitted in lieu of the fire barriers where all the following are met:
        i. Automatic sprinklers are spaced along both sides of the glass wall and the inoperable windows at intervals not to exceed 6 ft (1830 mm).
        ii. The automatic sprinklers specified in 8.6.7(c)i are located at a distance from the glass wall not to exceed 12 in. (305 mm) and arranged so that the entire surface of the glass is wet upon operation of the sprinklers.
        iii. The glass wall is of tempered, wired, or laminated glass held in place by a gasket system that allows the glass framing system to deflect without breaking (loading) the glass before the sprinklers operate.
        iv. The automatic sprinklers required by 8.6.7(c)i are not required on the atrium side of the glass wall and the inoperable window where there is no walkway or other floor area on the atrium side above the main floor level.
        v. Doors in the glass walls are of glass or other material that resists the passage of smoke.
        vi. Doors in the glass walls are self-closing or automatic-closing upon detection of smoke.
        vii. The glass is continuous vertically, without horizontal mullions, window treatments, or other obstructions that would interfere with the wetting of the entire glass surface.
(2) Access to exits is permitted to be within the atrium, and exit discharge in accordance with 7.7.2 is permitted to be within the atrium.
(3) The occupancy within the atrium meets the specifications for classification as low or ordinary hazard contents. *(See 6.2.2.)*
(4) The entire building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(5)*For other than existing, previously approved atriums, an engineering analysis is performed that demonstrates that the building is designed to keep the smoke layer interface above the highest unprotected opening to adjoining spaces, or 6 ft (1830 mm) above the highest floor level of exit access open to the atrium, for a period equal to 1.5 times the calculated egress time or 20 minutes, whichever is greater.
(6)*For other than existing, previously approved smoke control systems, where an engineered smoke control system is installed to meet the requirements of 8.6.7, the system is independently activated by each of the following:
    (a) Upon actuation of the required automatic sprinkler system within the atrium or areas open to the atrium
    (b) Manual controls that are readily accessible to the fire department

8.6.8 Two-Story Openings with Partial Enclosure. A vertical opening serving as other than an exit enclosure, connecting only two adjacent stories and piercing only one floor, shall be permitted to be open to one of the two stories.

8.6.9 Convenience Openings.

8.6.9.1 Where permitted by Chapters 11 through 43, unenclosed vertical openings not concealed within the building construction shall be permitted as follows:

(1) Such openings shall connect not more than two adjacent stories (one floor pierced only).
(2) Such openings shall be separated from unprotected vertical openings serving other floors by a barrier complying with 8.6.5.
(3) Such openings shall be separated from corridors.
(4)*In other than approved, existing convenience openings, such openings shall be separated from other fire or smoke compartments on the same floor.
(5) In new construction, the convenience opening shall be separated from the corridor referenced in 8.6.9.1(3) by a smoke partition, unless Chapters 11 through 43 require the corridor to have a fire resistance rating.
(6)*Such openings shall not serve as a required means of egress.

8.6.9.2 Where permitted by Chapters 11 through 43, unenclosed vertical openings created by convenience stairways shall comply with all of the following:

(1) The convenience stair openings shall not serve as required means of egress.
(2) The building shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(3)*The convenience stair openings shall be protected in accordance with the method detailed for the protection of vertical openings in NFPA 13, *Standard for the Installation of Sprinkler Systems.*
(4) In new construction, the area of the floor opening shall not exceed twice the horizontal projected area of the stairway.
(5) For new construction, such openings shall not connect more than four contiguous stories, unless otherwise permitted by Chapters 11 through 43.

8.6.9.3 Convenience stairs shall be permitted to be unenclosed in large open areas such as atriums and shopping malls.

8.6.9.4 For other than existing hoistways in existing buildings, elevator cars located within a building shall be enclosed as follows:

(1) Where there are three or fewer elevator cars in the building, they shall be permitted to be located within the same hoistway enclosure.
(2) Where there are four elevator cars in the building, they shall be divided in such a manner that not less than two separate hoistway enclosures are provided.
(3) Where there are more than four elevator cars in the building, the number of elevator cars located within a single hoistway enclosure shall not exceed four.

8.6.9.5 Service openings for conveyors, elevators, and dumbwaiters, where required to be open on more than one story at the same time for purposes of operation, shall be provided with closing devices in accordance with 7.2.1.8.

8.6.9.6 Any escalators and moving walks serving as a required exit in existing buildings shall be enclosed in the same manner as exit stairways. *(See 7.1.3.2.)*

8.6.9.7 Any escalators and moving walks not constituting an exit shall have their floor openings enclosed or protected as required for other vertical openings, unless otherwise permitted by one of the following:

(1) The requirement of 8.6.9.7 shall not apply to escalators in large open areas, such as atriums and enclosed shopping malls.
(2)*In existing buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, escalator and moving walk openings shall be permitted to be protected in accordance with the method detailed in NFPA 13, *Standard for the Installation of Sprinkler Systems*, or in accordance with a method approved by the authority having jurisdiction.
(3) In new buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, escalator and moving walk openings shall be permitted to be protected in accordance with the method detailed in NFPA 13, *Standard for the Installation of Sprinkler Systems*, or in accordance with a method approved by the authority having jurisdiction, and the opening shall not connect more than four contiguous stories unless otherwise permitted by Chapters 11 through 43.
(4) In buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, escalator and moving walk openings shall be permitted to be protected by rolling steel shutters appropriate for the fire resistance rating of the vertical opening and complying with all of the following:
    (a) The shutters shall close automatically and independently of each other upon smoke detection and sprinkler operation.
    (b) A manual means of operating and testing the operation of the shutters shall be provided.
    (c) The shutters shall be operated not less than once a week to ensure that they remain in proper operating condition.
    (d) The shutters shall operate at a speed not to exceed 30 ft/min (0.15 m/s) and shall be equipped with a sensitive leading edge.
    (e) The leading edge shall arrest the progress of a moving shutter and cause it to retract a distance of approximately 6 in. (150 mm) upon the application of a force not exceeding 20 lbf (90 N) applied to the surface of the leading edge.
    (f) The shutter, following the retraction specified in 8.6.9.7(4)(e), shall continue to close.
    (g) The operating mechanism for the rolling shutter shall be provided with standby power complying with the provisions of *NFPA 70, National Electrical Code.*

8.6.10 Mezzanines.

8.6.10.1 General. Multilevel residential housing areas in detention and correctional occupancies in accordance with Chapters 22 and 23 shall be exempt from the provisions of 8.6.10.2 and 8.6.10.3.

8.6.10.2 Area Limitations.

8.6.10.2.1 The aggregate area of mezzanines located within a room, other than those located in special-purpose industrial occupancies, shall not exceed one-third the open area of the room in which the mezzanines are located. Enclosed space shall not be included in a determination of the size of the room in which the mezzanine is located.

8.6.10.2.2 No limit on the number of mezzanines in a room shall be required.

8.6.10.2.3 For purposes of determining the allowable mezzanine area, the aggregate area of the mezzanines shall not be included in the area of the room.

8.6.10.3 Openness. The openness of mezzanines shall be in accordance with 8.6.10.3.1 or 8.6.10.3.2.

8.6.10.3.1 All portions of a mezzanine, other than walls not more than 42 in. (1065 mm) high, columns, and posts, shall be open to and unobstructed from the room in which the mezzanine is located, unless the occupant load of the aggregate area of the enclosed space does not exceed 10.

8.6.10.3.2 A mezzanine having two or more means of egress shall not be required to open into the room in which it is located if not less than one of the means of egress provides direct access from the enclosed area to an exit at the mezzanine level.

8.6.11 Concealed Spaces and Draftstops.

8.6.11.1 Any concealed combustible space in which building materials having a flame spread index greater than Class A are exposed shall be draftstopped as follows:

(1) Every exterior and interior wall and partition shall be firestopped at each floor level, at the top story ceiling level, and at the level of support for roofs.
(2) Every unoccupied attic space shall be subdivided by draftstops into areas not to exceed 3000 ft^2 (280 m^2).
(3) Any concealed space between the ceiling and the floor or roof above shall be draftstopped for the full depth of the space along the line of support for the floor or roof structural members and, if necessary, at other locations to form areas not to exceed 1000 ft^2 (93 m^2) for any space between the ceiling and floor, and 3000 ft^2 (280 m^2) for any space between the ceiling and roof.

8.6.11.2 The requirements of 8.6.11.1 shall not apply where any of the following conditions are met:

(1) Where the space is protected throughout by an approved automatic sprinkler system in accordance with Section 9.7
(2)*Where concealed spaces serve as plenums
(3) Where the installation is an existing installation

8.6.11.3* Draftstopping materials shall be not less than ½ in. (13 mm) thick gypsum board, 15⁄32 in. (12 mm) thickwood structural panel, or other approved materials that are adequately supported.

8.6.11.4 The integrity of all draftstops shall be maintained.

8.6.11.5 In existing buildings, firestopping and draftstopping shall be provided as required by Chapters 11 through 43.

8.7 Special Hazard Protection.

8.7.1 General.

8.7.1.1* Protection from any area having a degree of hazard greater than that normal to the general occupancy of the building or structure shall be provided by one of the following means:

(1) Enclosing the area with a fire barrier without windows that has a 1-hour fire resistance rating in accordance with Section 8.3
(2) Protecting the area with automatic extinguishing systems in accordance with Section 9.7
(3) Applying both 8.7.1.1(1) and (2) where the hazard is severe or where otherwise specified by Chapters 11 through 43

8.7.1.2 In new construction, where protection is provided with automatic extinguishing systems without fire-resistive separation, the space protected shall be enclosed with smoke partitions in accordance with Section 8.4, unless otherwise permitted by one of the following conditions:

(1) Where mercantile occupancy general storage areas and stockrooms are protected by automatic sprinklers in accordance with Section 9.7
(2) Where hazardous areas in industrial occupancies are protected by automatic extinguishing systems in accordance with 40.3.2
(3) Where hazardous areas in detention and correctional occupancies are protected by automatic sprinklers in accordance with 22.3.2

8.7.1.3 Doors in barriers required to have a fire resistance rating shall have a minimum ¾-hour fire protection rating and shall be self-closing or automatic-closing in accordance with 7.2.1.8.

8.7.2* Explosion Protection. Where hazardous processes or storage is of such a character as to introduce an explosion potential, an explosion venting system or an explosion suppression system specifically designed for the hazard involved shall be provided.

8.7.3 Flammable Liquids and Gases.

8.7.3.1 The storage and handling of flammable liquids or gases shall be in accordance with the following applicable standards:

(1) NFPA 30, *Flammable and Combustible Liquids Code*
(2) NFPA 54, *National Fuel Gas Code*
(3) NFPA 58, *Liquefied Petroleum Gas Code*

8.7.3.2* No storage or handling of flammable liquids or gases shall be permitted in any location where such storage would jeopardize egress from the structure, unless otherwise permitted by 8.7.3.1.

8.7.3.3* Alcohol-Based Hand-Rub Dispensers. Where permitted by Chapters 11 through 43, alcohol-based hand-rub dispensers shall be permitted provided they meet all of the following criteria:

(1) The maximum individual dispenser fluid capacity shall be as follows:
    (a) 0.32 gal (1.2 L) for dispensers in corridors and areas open to corridors
    (b) 0.53 gal (2.0 L) for dispensers in rooms or suites of rooms separated from corridors
(2) Where aerosol containers are used, the maximum capacity of the aerosol dispenser shall be 18 oz. (0.51 kg) and shall be limited to Level 1 aerosols as defined in NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.
(3) Dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Not more than an aggregate 10 gal (37.8 L) of alcohol-based hand-rub solution or 1135 oz (32.2 kg) of Level 1 aerosols, or a combination of liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gal (37.8 L) or 1135 oz (32.2 kg,) shall be in use outside of a storage cabinet in a single smoke compartment or fire compartment or story, whichever is less in area. One dispenser complying with 8.7.3.3 (1) per room and located in that room shall not be included in the aggregated quantity.

(5) Storage of quantities greater than 5 gal (18.9 L) in a single smoke compartment or fire compartment or story, whichever is less in area, shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(6) Dispensers shall not be installed in the following locations:
   (a) Above an ignition source for a horizontal distance of 1 in. (25 mm) to each side of the ignition source
   (b) To the side of an ignition source within a 1 in. (25 mm) horizontal distance from the ignition source
   (c) Beneath an ignition source within a 1 in. (25 mm) vertical distance from the ignition source
(7) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered areas of the building.
(8) The alcohol-based hand-rub solution shall not exceed 95 percent alcohol content by volume.
(9) Operation of the dispenser shall comply with the following criteria:
   (a) The dispenser shall not release its contents except when the dispenser is activated, either manually or automatically by touch-free activation.
   (b) Any activation of the dispenser shall only occur when an object is placed within 4 in. (100 mm) of the sensing device.
   (c) An object placed within the activation zone and left in place shall not cause more than one activation.
   (d) The dispenser shall not dispense more solution than the amount required for hand hygiene consistent with label instructions.
   (e) The dispenser shall be designed, constructed, and operated in a manner that ensures accidental or malicious activation of the dispensing device is minimized.
   (f) The dispenser shall be tested in accordance with the manufacturer's care and use instructions each time a new refill is installed.

8.7.4 Laboratories.

8.7.4.1 Laboratories that use chemicals shall comply with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, unless otherwise modified by other provisions of this *Code*.

8.7.4.2 Laboratories in health care occupancies and medical and dental offices shall comply with NFPA 99, *Health Care Facilities Code*.

8.7.5* Hyperbaric Facilities. All occupancies containing hyperbaric facilities shall comply with NFPA 99, *Health Care Facilities Code*, Chapter 20, unless otherwise modified by other provisions of this *Code*.

8.8* Inspection and Testing of Door Assemblies. Doors, other than those listed in 8.2.2.4 and 8.3.3.13, that are required to be self-closing or automatic closing shall comply with all of the following:

(1) Door assemblies shall be inspected annually.
(2) Doors shall be operated to confirm full closure.
(3) Parts found to be damaged or inoperative shall be replaced.
(4) Door openings and the surrounding areas shall be kept clear of anything that could obstruct or interfere with the free operation of the door.
(5) Blocking or wedging of doors in the open position shall be prohibited.
(6) Self-closing and automatic closing devices shall be kept in working condition at all times.

Chapter 9 Building Service and Fire Protection Equipment

9.1 Utilities.

9.1.1 Gas. Equipment using gas and related gas piping shall be in accordance with NFPA 54, *National Fuel Gas Code*, or NFPA 58, *Liquefied Petroleum Gas Code*, unless such installations are approved existing installations, which shall be permitted to be continued in service.

9.1.2 Electrical Systems. Electrical wiring and equipment shall be in accordance with *NFPA 70*, *National Electrical Code*, unless such installations are approved existing installations, which shall be permitted to be continued in service.

9.1.3 Emergency Generators and Standby Power Systems. Where required for compliance with this *Code*, emergency generators and standby power systems shall comply with 9.1.3.1 and 9.1.3.2.

9.1.3.1 Emergency generators and standby power systems shall be installed, tested, and maintained in accordance with NFPA 110, *Standard for Emergency and Standby Power Systems*.

9.1.3.2 New generator controllers shall be monitored by the fire alarm system, where provided, or at an attended location, for the following conditions:

(1) Generator running
(2) Generator fault
(3) Generator switch in nonautomatic position

9.1.4 Stored Electrical Energy Systems. Stored electrical energy systems shall be installed, tested, and maintained in accordance with NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*.

9.2 Heating, Ventilating, and Air-Conditioning.

9.2.1 Air-Conditioning, Heating, Ventilating Ductwork, and Related Equipment. Air-conditioning, heating, ventilating ductwork, and related equipment shall be in accordance with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, or NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*, as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service.

9.2.2 Ventilating or Heat-Producing Equipment. Ventilating or heat-producing equipment shall be in accordance with NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids*; NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*; NFPA 31, *Standard for the Installation of Oil-Burning Equipment*; NFPA 54, *National Fuel Gas Code*; or *NFPA 70*, *National Electrical Code*, as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service.

9.2.3 Commercial Cooking Operations. Where required by another section of this *Code*, commercial cooking operations shall be protected in accordance with NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, unless such installations are approved existing installations, which shall be permitted to be continued in service.

9.2.4 Ventilating Systems in Laboratories Using Chemicals. Ventilating systems in laboratories using chemicals shall be in accordance with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

9.3 Smoke Control.

9.3.1 Installation. Where required by another section of this *Code*, smoke control systems shall be designed, installed, inspected, tested, and maintained in accordance with NFPA 92, *Standard for Smoke Control Systems*; NFPA 204, *Standard for Smoke and Heat Venting*; or nationally recognized standards, engineering guides, or recommended practices, as approved by the authority having jurisdiction.

9.3.2 System Design. The engineer of record shall clearly identify the intent of the system, the design method used, the appropriateness of that method, and the required means of inspecting, testing, and maintaining the system.

9.3.3 Acceptance Testing. Acceptance testing shall be performed by a special inspector in accordance with Section 9.13.

9.3.4 Smoke Control System Operation.

9.3.4.1 Floor- or zone-dependent smoke control systems shall be automatically activated by sprinkler waterflow or smoke detection systems.

9.3.4.2 Means for manual operation of smoke control systems shall be provided at an approved location.

9.4 Elevators, Escalators, and Conveyors.

9.4.1* General. An elevator, other than an elevator in accordance with 7.2.13, shall not be considered a component in a required means of egress but shall be permitted as a component in an accessible means of egress.

9.4.2 Code Compliance.

9.4.2.1 Except as modified herein, new elevators, escalators, dumbwaiters, and moving walks shall be in accordance with the requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

9.4.2.2 Except as modified herein, existing elevators, escalators, dumbwaiters, and moving walks shall be in accordance with the requirements of ASME A17.3, *Safety Code for Existing Elevators and Escalators*.

9.4.2.3 Elevators in accordance with ASME A17.7/CSA B44.7, *Performance-Based Safety Code for Elevators and Escalators*, shall be deemed to comply with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, or ASME A17.3, *Safety Code for Existing Elevators and Escalators*.

9.4.2.4 For other than elevators used for occupant-controlled evacuation in accordance with Section 7.14 and other than existing elevators, the elevator corridor call station pictograph specified in 2.27.9 of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, shall be provided at each elevator landing.

9.4.3 Fire Fighters' Emergency Operations.

9.4.3.1 All new elevators shall conform to the fire fighters' emergency operations requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

9.4.3.2 All existing elevators having a travel distance of 25 ft (7620 mm) or more above or below the level that best serves the needs of emergency personnel for fire-fighting or rescue purposes shall conform to the fire fighters' emergency operations requirements of ASME A17.3, *Safety Code for Existing Elevators and Escalators*.

9.4.4 Number of Cars. The number of elevator cars permitted in a hoistway shall be in accordance with 8.6.9.4.

9.4.5* Elevator Machine Rooms. Elevator machine rooms that contain solid-state equipment for elevators, other than existing elevators, having a travel distance exceeding 50 ft (15 m) above the level of exit discharge, or exceeding 30 ft (9.1 m) below the level of exit discharge, shall be provided with independent ventilation or air-conditioning systems to maintain temperature during fire fighters' emergency operations for elevator operation *(see 9.4.3)*. The operating temperature shall be established by the elevator equipment manufacturer's specifications. When standby power is connected to the elevator, the machine room ventilation or air-conditioning shall be connected to standby power.

9.4.6 Elevator Testing.

9.4.6.1 Elevators shall be subject to periodic inspections and tests as specified in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

9.4.6.2 All elevators equipped with fire fighters' emergency operations in accordance with 9.4.3 shall be subject to a monthly operation with a written record of the findings made and kept on the premises as required by ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

9.4.6.3 The elevator inspections and tests required by 9.4.6.1 shall be performed at frequencies complying with one of the following:

(1) Inspection and test frequencies specified in Appendix N of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*
(2) Inspection and test frequencies specified by the authority having jurisdiction

9.4.7 Openings to Exit Enclosures. Conveyors, elevators, dumbwaiters, and pneumatic conveyors serving various stories of a building shall not open to an exit enclosure.

9.5 Waste Chutes, Incinerators, and Laundry Chutes.

9.5.1 Enclosure.

9.5.1.1 Waste chutes and laundry chutes shall be separately enclosed by walls or partitions in accordance with the provisions of Section 8.3.

9.5.1.2 Chute intake openings shall be protected in accordance with Section 8.3.

9.5.1.3 The doors of chutes specified in 9.5.1.2 shall open only to a room that is designed and used exclusively for accessing the chute opening.

9.5.1.4 Chute service opening rooms shall be separated from other spaces in accordance with Section 8.7.

9.5.1.5 The requirements of 9.5.1.1 through 9.5.1.4 shall not apply where otherwise permitted by the following:

(1) Existing installations having properly enclosed service chutes and properly installed and maintained chute intake doors shall be permitted to have chute intake doors open to a corridor or normally occupied space.
(2) Waste chutes and laundry chutes shall be permitted to open into rooms not exceeding 400 ft^2 (37 m^2) that are used for storage, provided that the room is protected by automatic sprinklers.

9.5.2 Installation and Maintenance. Waste chutes, laundry chutes, and incinerators shall be installed and maintained in accordance with NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, unless such installations are approved existing installations, which shall be permitted to be continued in service.

9.6 Fire Detection, Alarm, and Communications Systems.

9.6.1* General.

9.6.1.1 The provisions of Section 9.6 shall apply only where specifically required by another section of this *Code*.

9.6.1.2 Fire detection, alarm, and communications systems installed to make use of an alternative permitted by this *Code* shall be considered required systems and shall meet the provisions of this *Code* applicable to required systems.

9.6.1.3 Fire alarm systems required by this *Code* shall be installed, tested, and maintained in accordance with the applicable requirements of *NFPA 70*, *National Electrical Code*, and *NFPA 72*, *National Fire Alarm and Signaling Code*, unless it is an approved existing installation, which shall be permitted to be continued in use.

9.6.1.4* To ensure operational integrity, the fire alarm system shall have an approved maintenance and testing program complying with the applicable requirements of *NFPA 70*, *National Electrical Code*, and *NFPA 72*, *National Fire Alarm and Signaling Code*.

9.6.1.5* Fire alarm system impairment procedures shall comply with *NFPA 72, National Fire Alarm and Signaling Code*.

9.6.2 Signal Initiation.

9.6.2.1 Where required by other sections of this *Code*, actuation of the fire alarm system shall occur by any or all of the following means of initiation but shall not be limited to such means:

(1) Manual fire alarm initiation
(2) Automatic detection
(3) Extinguishing system operation

9.6.2.2 Manual fire alarm boxes shall be used only for fire-protective signaling purposes. Combination fire alarm and guard's tour stations shall be permitted.

9.6.2.3 A manual fire alarm box shall be provided as follows, unless modified by another section of this *Code*:

(1) For new alarm system installations, the manual fire alarm box shall be located within 60 in. (1525 mm) of exit doorways.
(2) For existing alarm system installations, the manual fire alarm box either shall be provided in the natural exit access path near each required exit or within 60 in. (1525 mm) of exit doorways.

9.6.2.4 Manual fire alarm boxes shall be mounted on both sides of grouped openings over 40 ft (12.2 m) in width, and within 60 in. (1525 mm) of each side of the opening.

9.6.2.5* Additional manual fire alarm boxes shall be located so that, on any given floor in any part of the building, no horizontal distance on that floor exceeding 200 ft (61 m) shall need to be traversed to reach a manual fire alarm box.

9.6.2.6* For fire alarm systems using automatic fire detection or waterflow detection devices to initiate the fire alarm system in accordance with Chapters 11 through 43, not less than one manual fire alarm box, located as required by the authority having jurisdiction, shall be provided to initiate a fire alarm signal.

9.6.2.7* Manual fire alarm boxes shall be accessible, unobstructed, and visible.

9.6.2.8 Where a sprinkler system provides automatic detection and alarm system initiation, it shall be provided with an approved alarm initiation device that operates when the flow of water is equal to or greater than that from a single automatic sprinkler.

9.6.2.9 Where a total (complete) coverage smoke detection system is required by another section of this *Code*, automatic detection of smoke in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, shall be provided in all occupiable areas in environments that are suitable for proper smoke detector operation.

9.6.2.10 Smoke Alarms.

9.6.2.10.1 Where required by another section of this *Code*, single-station and multiple-station smoke alarms shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, unless otherwise provided in 9.6.2.10.3, 9.6.2.10.4, 9.6.2.10.5, or 9.6.2.10.6.

9.6.2.10.2 Where automatic smoke detection is required by Chapters 11 through 43, smoke alarms shall not be used as a substitute.

9.6.2.10.3* The interconnection of smoke alarms shall apply only to new construction as provided in 9.6.2.10.8.

9.6.2.10.4* Smoke alarms and smoke detectors shall not be installed within an area of exclusion determined by a 10 ft (3.0 m) radial distance along a horizontal flow path from a stationary or fixed cooking appliance, unless listed for installation in close proximity to cooking appliances. Smoke alarms and smoke detectors installed between 10 ft (3.0 m) and 20 ft (6.1 m) along a horizontal flow path from a stationary or fixed cooking appliance shall be equipped with an alarm-silencing means or use photoelectric detection.

Exception: Smoke alarms or smoke detectors that use photoelectric detection shall be permitted for installation at a radial distance greater than 6 ft (1.8 m) from any stationary or fixed cooking appliance when the following conditions are met:

(1) The kitchen or cooking area and adjacent spaces have no clear interior partitions or headers
(2) The 10 ft (3.0 m) area of exclusion would prohibit the placement of a smoke alarm or smoke detector required by other sections of this NFPA 72.

*[**72:**29.8.3.4(4)]*

9.6.2.10.5* Smoke alarms and smoke detectors shall not be installed within a 36 in. (910 mm) horizontal path from a door to a bathroom containing a shower or tub unless listed for installation in close proximity to such locations. [**72:**29.8.3.4 (6)]

9.6.2.10.6 System smoke detectors in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, and arranged to function in the same manner as single-station or multiple-station smoke alarms shall be permitted in lieu of smoke alarms.

9.6.2.10.7 Smoke alarms, other than battery-operated smoke alarms as permitted by other sections of this *Code*, shall be powered in accordance with the requirements of *NFPA 72, National Fire Alarm and Signaling Code*.

9.6.2.10.8* In new construction, where two or more smoke alarms are required within a dwelling unit, suite of rooms, or similar area, they shall be arranged so that operation of any smoke alarm shall cause the alarm in all smoke alarms within the dwelling unit, suite of rooms, or similar area to sound, unless otherwise permitted by one of the following:

(1) The requirement of 9.6.2.10.8 shall not apply where permitted by another section of this *Code*.
(2) The requirement of 9.6.2.10.8 shall not apply to configurations that provide equivalent distribution of the alarm signal.

9.6.2.10.9 The alarms described in 9.6.2.10.8 shall sound only within an individual dwelling unit, suite of rooms, or similar area and shall not actuate the building fire alarm system, unless otherwise permitted by the authority having jurisdiction.

9.6.2.10.10 Smoke alarms shall be permitted to be connected to the building fire alarm system for the purpose of annunciation in accordance with *NFPA 72*.

9.6.3 Occupant Notification.

9.6.3.1 Occupant notification shall be provided to alert occupants of a fire or other emergency where required by other sections of this *Code*.

9.6.3.2 Occupant notification shall be in accordance with 9.6.3.3 through 9.6.3.10.2, unless otherwise provided in 9.6.3.2.1 through 9.6.3.2.4.

9.6.3.2.1* Elevator lobby, hoistway, and associated machine room smoke detectors used solely for elevator recall, and heat detectors used solely for elevator power shutdown, shall not be required to activate the building evacuation alarm if the power supply and installation wiring to such detectors are monitored by the building fire alarm system, and if the activation of such detectors initiates a supervisory signal at a constantly attended location.

9.6.3.2.2* Smoke detectors used solely for closing dampers or heating, ventilating, and air-conditioning system shutdown shall not be required to activate the building evacuation alarm, provided that the power supply and installation wiring to the detectors are monitored by the building fire alarm system, and the activation of the detectors initiates a supervisory signal at a constantly attended location.

9.6.3.2.3* Smoke detectors located at doors for the exclusive operation of automatic door release shall not be required to activate the building evacuation alarm, provided that the power supply and installation wiring to the detectors are monitored by the building fire alarm system, and the activation of the detectors initiates a supervisory signal at a constantly attended location.

9.6.3.2.4 Detectors in accordance with 22.3.4.3.1(2) and 23.3.4.3.1(2) shall not be required to activate the building evacuation alarm.

9.6.3.3 Where permitted by Chapters 11 through 43, a presignal system shall be permitted where the initial fire alarm signal is automatically transmitted without delay to a municipal fire department, to a fire brigade (if provided), and to an on-site staff person trained to respond to a fire emergency.

9.6.3.4 Where permitted by Chapters 11 through 43, a positive alarm sequence shall be permitted, provided that it is in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

9.6.3.5 Unless otherwise provided in 9.6.3.5.1 through 9.6.3.5.8, notification signals for occupants to evacuate shall be by audible and visible signals in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, and ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, or other means of notification acceptable to the authority having jurisdiction.

9.6.3.5.1 Areas not subject to occupancy by persons who are hearing impaired shall not be required to comply with the provisions for visible signals.

9.6.3.5.2 Visible-only signals shall be provided where specifically permitted in health care occupancies in accordance with Chapters 18 and 19.

9.6.3.5.3 Existing alarm systems shall not be required to comply with the provision for visible signals.

9.6.3.5.4 Visible signals shall not be required in lodging or rooming houses in accordance with Chapter 26.

9.6.3.5.5 Visible signals shall not be required in exit stair enclosures.

9.6.3.5.6 Visible signals shall not be required in elevator cars.

9.6.3.5.7* Public mode visual notification appliances in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, shall not be required in designated areas as permitted by Chapters 11 through 43, provided that they are replaced with approved alternative visible means.

9.6.3.5.8* Where visible signals are not required, as permitted by 9.6.3.5.7, documentation of such omission shall be maintained in accordance with 9.13.3.

9.6.3.6 The general evacuation alarm signal shall operate in accordance with one of the methods prescribed by 9.6.3.6.1 through 9.6.3.6.3.

9.6.3.6.1 The general evacuation alarm signal shall operate throughout the entire building other than the locations described in 9.6.3.6.4 and 9.6.3.6.5.

9.6.3.6.2* Where total evacuation of occupants is impractical due to building configuration, only the occupants in the affected zones shall be initially notified, and provisions shall be made to selectively notify occupants in other zones to afford orderly evacuation of the entire building, provided that such arrangement is approved by the authority having jurisdiction.

9.6.3.6.3 Where occupants are incapable of evacuating themselves because of age, physical or mental disabilities, or physical restraint, all of the following shall apply:

(1) The private operating mode, as described in *NFPA 72, National Fire Alarm and Signaling Code*, shall be permitted to be used.
(2) Only the attendants and other personnel required to evacuate occupants from a zone, area, floor, or building shall be required to be notified.
(3) Notification of personnel as specified in 9.6.3.6.3(2) shall include means to readily identify the zone, area, floor, or building in need of evacuation.

9.6.3.6.4 The general evacuation signal shall not be required in exit stair enclosures.

9.6.3.6.5 The general evacuation signal shall not be required in elevator cars.

9.6.3.7 Audible alarm notification appliances shall be of such character and so distributed as to be effectively heard above the average ambient sound level that exists under normal conditions of occupancy.

9.6.3.8 Audible alarm notification appliances shall produce signals that are distinctive from audible signals used for other purposes in a given building.

9.6.3.9 Automatically transmitted or live voice evacuation or relocation instructions shall be permitted to be used to notify occupants and shall comply with either 9.6.3.9.1 or 9.6.3.9.2.

9.6.3.9.1 Automatically transmitted or live voice evacuation or relocation instructions shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

9.6.3.9.2* Where permitted by Chapters 11 through 43, automatically transmitted or live voice announcements shall be permitted to be made via a voice communication or public address system that complies with all of the following:

(1) Occupant notification, either live or recorded, shall be initiated at a constantly attended receiving station by personnel trained to respond to an emergency.
(2) An approved secondary power supply shall be provided for other than existing, previously approved systems.
(3) The system shall be audible above the expected ambient noise level.
(4) Emergency announcements shall take precedence over any other use.

9.6.3.10 Unless otherwise permitted by another section of this *Code*, audible and visible fire alarm notification appliances shall comply with either 9.6.3.10.1 or 9.6.3.10.2.

9.6.3.10.1 Audible and visible fire alarm notification appliances shall be used only for fire alarm system or other emergency purposes.

9.6.3.10.2 Emergency voice/alarm communication systems shall be permitted to be used for other purposes in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

9.6.4 Emergency Forces Notification.

9.6.4.1 Where required by another section of this *Code*, emergency forces notification shall be provided to alert the municipal fire department and fire brigade (if provided) of fire or other emergency.

9.6.4.2 Where emergency forces notification is required by another section of this *Code*, the fire alarm system shall be arranged to transmit the alarm automatically via any of the following means acceptable to the authority having jurisdiction and shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code:*

(1) Auxiliary fire alarm system
(2) Central station fire alarm system
(3) Proprietary supervising station fire alarm system
(4) Remote supervising station fire alarm system

9.6.4.3 For existing installations where none of the means of notification specified in 9.6.4.2(1) through (4) are available, an approved plan for notification of the municipal fire department shall be permitted.

9.6.4.4 For other than existing installations, where fire alarm systems are required to provide emergency forces notification, supervisory signals and trouble signals shall sound and be visibly displayed either at an approved, remotely located receiving facility or at a location within the protected building that is constantly attended by qualified personnel.

9.6.5 Fire Safety Functions.

9.6.5.1 Fire safety functions shall be installed in accordance with the requirements of *NFPA 72, National Fire Alarm and Signaling Code.*

9.6.5.2 Where required by another section of this *Code*, the following functions shall be actuated:

(1) Release of hold-open devices for doors or other opening protectives
(2) Stairwell or elevator shaft pressurization
(3) Smoke management or smoke control systems
(4) Unlocking of doors
(5) Elevator recall and shutdown
(6) HVAC shutdown

9.6.6 Location of Controls. Operator controls, alarm indicators, and manual communications capability shall be installed at a convenient location acceptable to the authority having jurisdiction.

9.6.7 Annunciation.

9.6.7.1 Where alarm annunciation is required by another section of this *Code*, it shall comply with 9.6.7.2 through 9.6.7.8.

9.6.7.2 Alarm annunciation at the control center shall be by means of audible and visible indicators.

9.6.7.3 For the purposes of alarm annunciation, each floor of the building, other than floors of existing buildings, shall be considered as not less than one zone, unless otherwise permitted by 9.6.7.4.4, 9.6.7.4.5, 9.6.7.4.6, or another section of this *Code.*

9.6.7.4 Where a floor area exceeds 22,500 ft^2 (2090 m^2), additional fire alarm zoning shall be provided, and the length of any single fire alarm zone shall not exceed 300 ft (91 m) in any direction, except as provided in 9.6.7.4.1 through 9.6.7.4.6, or as otherwise modified by another section of this *Code.*

9.6.7.4.1 Where permitted by another section of this *Code*, fire alarm zones shall be permitted to exceed 22,500 ft^2 (2090 m^2), and the length of a zone shall be permitted to exceed 300 ft (91 m) in any direction.

9.6.7.4.2 Where the building is protected by an automatic sprinkler system in accordance with 9.7.1.1(1), the area of the fire alarm zone shall be permitted to coincide with the allowable area of the sprinkler system.

9.6.7.4.3 Where the building is protected by a water mist system in accordance with 9.8.1 and Table 9.8.1, the area of the fire alarm zone shall be permitted to coincide with the allowable area of the water mist system.

9.6.7.4.4 Unless otherwise prohibited by another section of this *Code*, where a building not exceeding four stories in height is protected by an automatic water mist system in accordance with 9.8.1, the water mist system shall be permitted to be annunciated on the fire alarm system as a single zone.

9.6.7.4.5 Unless otherwise prohibited by another section of this *Code*, where a building not exceeding four stories in height is protected by an automatic sprinkler system in accordance with 9.7.1.1(1), the sprinkler system shall be permitted to be annunciated on the fire alarm system as a single zone.

9.6.7.4.6 Where the building is protected by an automatic sprinkler system in accordance with 9.7.1.1(2) or 9.7.1.1(3), the sprinkler system shall be permitted to be annunciated on the fire alarm system as a single zone.

9.6.7.5 A system trouble signal shall be annunciated by means of audible and visible indicators in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

9.6.7.6 A system supervisory signal shall be annunciated by means of audible and visible indicators in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

9.6.7.7 Where the system serves more than one building, each building shall be annunciated separately.

9.6.7.8 Where permitted by another section of this *Code*, the alarm zone shall be permitted to coincide with the permitted area for smoke compartments.

9.7 Automatic Sprinklers.

9.7.1 General.

9.7.1.1* Each automatic sprinkler system required by another section of this *Code* shall be in accordance with one of the following:

(1) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(2) NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*
(3) NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*

9.7.1.2 Sprinkler piping serving not more than six sprinklers for any hazardous area shall be permitted to be connected directly to a domestic water supply system having a capacity sufficient to provide 0.15 gpm/ft^2 (6.1 mm/min) throughout the entire enclosed area.

9.7.1.3 Sprinkler piping serving hazardous areas as described in 9.7.1.2 shall be provided with an indicating shutoff valve, supervised in accordance with 9.7.2 or NFPA 13, *Standard for the Installation of Sprinkler Systems,* and installed in an accessible, visible location between the sprinklers and the connection to the domestic water supply.

9.7.1.4* In areas protected by automatic sprinklers, automatic heat-detection devices required by other sections of this *Code* shall not be required.

9.7.1.5 Automatic sprinkler systems installed to make use of an alternative permitted by this *Code* shall be considered required systems and shall meet the provisions of this *Code* that apply to required systems.

9.7.2 Supervision.

9.7.2.1* Supervisory Signals.

9.7.2.1.1 Where supervised automatic sprinkler systems are required by another section of this *Code*, supervisory attachments shall be installed and monitored for integrity in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, and a distinctive supervisory signal shall be provided to indicate a condition that would impair the satisfactory operation of the sprinkler system.

9.7.2.1.2 Supervisory signals shall sound and shall be displayed either at a location within the protected building that is constantly attended by qualified personnel or at an approved, remotely located receiving facility.

9.7.2.2 Alarm Signal Transmission.

9.7.2.2.1 Where supervision of automatic sprinkler systems is required by another section of this *Code*, waterflow alarms shall be transmitted to an approved, proprietary alarm-receiving facility, a remote station, a central station, or the fire department.

9.7.2.2.2 The connection described in 9.7.2.2.1 shall be in accordance with 9.6.1.3.

9.8 Other Automatic Extinguishing Equipment.

9.8.1* Alternative Systems. In any occupancy where the character of the fuel for fire is such that extinguishment or control of fire is accomplished by a type of automatic extinguishing system in lieu of an automatic sprinkler system, such extinguishing system shall be installed in accordance with the applicable standard referenced in Table 9.8.1.

Table 9.8.1 Fire Suppression System Installation Standards

Fire Suppression System	Installation Standard
Low-, medium-, and high-expansion foam systems	NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
Carbon dioxide systems	NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
Halon 1301 systems	NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
Water spray fixed systems	NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
Deluge foam-water sprinkler systems	NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
Dry chemical systems	NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
Wet chemical systems	NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
Water mist systems	NFPA 750, *Standard on Water Mist Fire Protection Systems*
Clean agent extinguishing systems	NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

9.8.2 Alarm Activation.

9.8.2.1 If the extinguishing system is installed in lieu of a required, supervised automatic sprinkler system, the activation of the extinguishing system shall activate the building fire alarm system, where provided.

9.8.2.2 The actuation of an extinguishing system that is not installed in lieu of a required, supervised automatic sprinkler system shall be indicated at the building fire alarm system, where provided.

9.8.2.3 In areas protected by an automatic water mist system, automatic heat-detection devices required by other sections of this *Code* shall not be required.

9.9* Portable Fire Extinguishers. Where required by another section of this *Code*, portable fire extinguishers shall be selected, installed, inspected, and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers.*

9.10 Standpipe Systems.

9.10.1 Where required by another section of this *Code*, standpipe and hose systems shall be provided in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.*

9.10.2 Where standpipe and hose systems are installed in combination with automatic sprinkler systems, installation shall be in accordance with the appropriate provisions established by NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*.

9.11 Fire Protection System Operating Features.

9.11.1 Maintenance and Testing. All automatic sprinkler and standpipe systems required by this *Code* shall be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

9.11.2 Sprinkler System Impairments. Sprinkler impairment procedures shall comply with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

9.11.3 Documentation.

9.11.3.1 All required documentation regarding the design of the fire protection system and the procedures for maintenance, inspection, and testing of the fire protection system shall be maintained at an approved, secured location for the life of the fire protection system.

9.11.3.2 Testing and maintenance records required by NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, shall be maintained at an approved, secured location.

9.12 Carbon Monoxide (CO) Detection and Warning Equipment. Where required by another section of this *Code*, carbon monoxide (CO) detection and warning equipment shall be provided in accordance with NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*.

9.13 Special Inspections and Tests.

9.13.1 System Verification. Where required by another section of this *Code*, special inspections and tests shall be performed to verify the operation of the fire protection system in its final condition for acceptance by the authority having jurisdiction.

9.13.2 Experience. The special inspector's relevant experience in the design, installation, and testing of the fire protection systems shall be documented.

9.13.3 Documentation. The design documents shall provide the procedures and methods to be used and items subject to special inspections and tests.

9.13.4 Report. The special inspector shall submit an inspection and test report to the authority having jurisdiction and registered design professional (RDP) in responsible charge.

Chapter 10 Interior Finish, Contents, and Furnishings

10.1 General.

10.1.1 Application. The interior finish, contents, and furnishings provisions set forth in this chapter shall apply to new construction and existing buildings.

10.1.2 Automatic Sprinkler Systems. Where another provision of this chapter requires an automatic sprinkler system, the automatic sprinkler system shall be installed in accordance with the subparts of 9.7.1.1 as permitted by the applicable occupancy chapter.

10.1.3 Definitions.

10.1.3.1 General. For definitions see Chapter 3 Definitions.

10.1.3.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Contents and Furnishings.** See 3.3.49.
(2) **Flashover.** See 3.3.114.
(3) **Interior Finish.** See 3.3.92.2.
(4) **Interior Ceiling Finish.** See 3.3.92.1.
(5) **Interior Floor Finish.** See 3.3.92.3.
(6) **Interior Wall Finish.** See 3.3.92.4.

10.2* Interior Finish.

10.2.1* General.

10.2.1.1 Classification of interior finish materials shall be in accordance with tests made under conditions simulating actual installations, provided that the authority having jurisdiction is permitted to establish the classification of any material for which classification by a standard test is not available, unless otherwise provided in 10.2.1.2 or 10.2.1.4.

10.2.1.2 The provisions of 10.2.1.1 shall not apply to materials having a total thickness of less than 1⁄28 in. (0.9 mm) that are applied directly to the surface of walls and ceilings where both of the following conditions are met:

(1) The wall or ceiling surface is a noncombustible or limited-combustible material.
(2) The materials applied meet the requirements of Class A interior wall or ceiling finish when tested in accordance with 10.2.3, using fiber cement board as the substrate material.

10.2.1.3 If a material having a total thickness of less than 1⁄28 in. (0.9 mm) is applied to a surface that is not noncombustible or not limited-combustible, the provisions of 10.2.1.1 shall apply.

10.2.1.4 Approved existing installations of materials applied directly to the surface of walls and ceilings in a total thickness of less than 1⁄28 in. (0.9 mm) shall be permitted to remain in use, and the provisions of 10.2.2 through 10.2.3.7.2 shall not apply.

10.2.1.5* Fixed or movable walls and partitions, paneling, wall pads, and crash pads applied structurally or for decoration, acoustical correction, surface insulation, or other purposes shall be considered interior finish and shall not be considered decorations or furnishings.

10.2.1.6 Lockers constructed of combustible materials shall be considered interior finish.

10.2.2* Use of Interior Finishes.

10.2.2.1 Requirements for interior wall and ceiling finish shall apply as follows:

(1) Where specified elsewhere in this *Code* for specific occupancies *(see Chapter 7 and Chapters 11 through 43)*
(2) As specified in 10.2.3 through 10.2.6.

10.2.2.2* Interior floor finish shall comply with 10.2.7 under any of the following conditions:

(1) Where floor finish requirements are specified elsewhere in the *Code*

(2) Where the fire performance of the floor finish cannot be demonstrated to be equivalent to floor finishes with a critical radiant flux of at least 0.1 W/cm^2

10.2.3* Interior Wall or Ceiling Finish Testing and Classification. Interior wall or ceiling finish that is required elsewhere in this *Code* to be Class A, Class B, or Class C shall be classified based on test results from ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, except as indicated in 10.2.3.1 or 10.2.3.2.

10.2.3.1 Exposed portions of structural members complying with the requirements for Type IV(2HH) construction in accordance with NFPA 220, *Standard on Types of Building Construction*, or with the building code shall be exempt from testing and classification in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.

10.2.3.2 Interior wall and ceiling finish tested in accordance with NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, and meeting the conditions of 10.2.3.7.2 shall be permitted to be used where interior wall and ceiling finish is required to be Class A in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.

10.2.3.3 For fire-retardant coatings, see 10.2.6.

10.2.3.4* Products required to be tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, shall be grouped in the classes described in 10.2.3.4.1 through 10.2.3.4.3 in accordance with their flame spread index and smoke developed index, except as indicated in 10.2.3.4.4.

10.2.3.4.1 Class A Interior Wall and Ceiling Finish. Class A interior wall and ceiling finishes shall be those finishes with a flame spread index of 0–25 and a smoke developed index of 0–450 and shall include any material classified at 25 or less on the flame spread index test scale and 450 or less on the smoke developed index test scale.

10.2.3.4.2 Class B Interior Wall and Ceiling Finish. Class B interior wall and ceiling finishes shall be those finishes with a flame spread index of 26–75 and a smoke developed index of 0–450 and shall include any material classified at more than 25 but not more than 75 on the flame spread index test scale and 450 or less on the smoke developed index test scale.

10.2.3.4.3 Class C Interior Wall and Ceiling Finish. Class C interior wall and ceiling finishes shall be those finishes with a flame spread index of 76–200 and a smoke developed index of 0–450 and shall include any material classified at more than 75 but not more than 200 on the flame spread index test scale and 450 or less on the smoke developed index test scale.

10.2.3.4.4 Existing interior finish shall be exempt from the smoke developed index criteria of 10.2.3.4.1 through 10.2.3.4.3.

10.2.3.5 The classification of interior finish specified in 10.2.3.4 shall be that of the basic material used by itself or in combination with other materials.

10.2.3.6 Wherever the use of Class C interior wall and ceiling finish is required, Class A or Class B shall be permitted. Where Class B interior wall and ceiling finish is required, Class A shall be permitted.

10.2.3.7* Products tested in accordance with NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*, shall comply with the criteria of 10.2.3.7.1. Products tested in accordance with NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, shall comply with the criteria of 10.2.3.7.2.

10.2.3.7.1* The interior finish shall comply with all of the following when tested using method B of the test protocol of NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*:

(1) During the 40 kW exposure, flames shall not spread to the ceiling.
(2) The flame shall not spread to the outer extremities of the samples on the 8 ft × 12 ft (2440 mm × 3660 mm) walls.
(3) Flashover, as described in NFPA 265, shall not occur.
(4) For new installations, the total smoke released throughout the test shall not exceed 1000 m^2.

10.2.3.7.2 The interior finish shall comply with all of the following when tested using the test protocol of NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*:

(1) During the 40 kW exposure, flames shall not spread to the ceiling.
(2) The flame shall not spread to the outer extremity of the sample on any wall or ceiling.
(3) Flashover, as described in NFPA 286, shall not occur.
(4) The peak heat release rate throughout the test shall not exceed 800 kW.
(5) For new installations, the total smoke released throughout the test shall not exceed 1000 m^2.

10.2.4* Specific Materials.

10.2.4.1* Textile Wall and Textile Ceiling Materials. The use of textile materials on walls or ceilings shall comply with one of the following conditions:

(1) Textile materials meeting the requirements of Class A when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, using the specimen preparation and mounting method of ASTM E 2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper or Polymeric (Including Vinyl) Wall or Ceiling Coverings, and of Facings and Wood Veneers Intended to be Applied on Site Over a Wood Substrate, to Assess Surface Burning Characteristics (see 10.2.3.4)*, shall be permitted on the walls or ceilings of rooms or areas protected by an approved automatic sprinkler system.
(2) Textile materials meeting the requirements of Class A when tested in accordance with ASTM E 84 or ANSI/UL 723, using the specimen preparation and mounting method of ASTM E 2404 *(see 10.2.3.4)*, shall be permitted on partitions that do not exceed three-quarters of the floor-to-ceiling height or do not exceed 8 ft (2440 mm) in height, whichever is less.

(3) Textile materials meeting the requirements of Class A when tested in accordance with ASTM E 84 or ANSI/UL 723, using the specimen preparation and mounting method of ASTM E 2404 *(see 10.2.3.4)*, shall be permitted to extend not more than 48 in. (1220 mm) above the finished floor on ceiling-height walls and ceiling-height partitions.
(4) Previously approved existing installations of textile material meeting the requirements of Class A when tested in accordance with ASTM E 84 or ANSI/UL 723 *(see 10.2.3.4)* shall be permitted to be continued to be used.
(5) Textile materials shall be permitted on walls and partitions where tested in accordance with NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls. (See 10.2.3.7.)*
(6) Textile materials shall be permitted on walls, partitions, and ceilings where tested in accordance with NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth. (See 10.2.3.7.)*

10.2.4.2* Expanded Vinyl Wall and Expanded Vinyl Ceiling Materials. The use of expanded vinyl wall or expanded vinyl ceiling materials shall comply with one of the following conditions:

(1) Materials meeting the requirements of Class A when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, using the specimen preparation and mounting method of ASTM E 2404, *Standard Practice for Specimen Preparation and Mounting of Textile, Paper, or Polymeric (Including Vinyl) Wall or Ceiling Coverings, and of Facings and Wood Veneers Intended to be Applied on Site Over a Wood Substrate, to Assess Surface Burning Characteristics (see 10.2.3.4)*, shall be permitted on the walls or ceilings of rooms or areas protected by an approved automatic sprinkler system.
(2) Materials meeting the requirements of Class A when tested in accordance with ASTM E 84 or ANSI/UL 723, using the specimen preparation and mounting method of ASTM E 2404 *(see 10.2.3.4)*, shall be permitted on partitions that do not exceed three-quarters of the floor-to-ceiling height or do not exceed 8 ft (2440 mm) in height, whichever is less.
(3) Materials meeting the requirements of Class A when tested in accordance with ASTM E 84 or ANSI/UL 723, using the specimen preparation and mounting method of ASTM E 2404 *(see 10.2.3.4)*, shall be permitted to extend not more than 48 in. (1220 mm) above the finished floor on ceiling-height walls and ceiling-height partitions.
(4) Previously approved existing installations of materials meeting the requirements for the occupancy involved, when tested in accordance with ASTM E 84 or ANSI/UL 723 *(see 10.2.3.4)*, shall be permitted to be continued to be used.
(5) Materials shall be permitted on walls and partitions where tested in accordance with NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls. (See 10.2.3.7.)*
(6) Materials shall be permitted on walls, partitions, and ceilings where tested in accordance with NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth. (See 10.2.3.7.)*

10.2.4.3 Cellular or Foamed Plastic. Cellular or foamed plastic materials shall not be used as interior wall and ceiling finish unless specifically permitted by 10.2.4.3.1 or 10.2.4.3.2. The requirements of 10.2.4.3 through 10.2.4.3.2 shall apply both to exposed foamed plastics and to foamed plastics used in conjunction with a textile or vinyl facing or cover.

10.2.4.3.1* Cellular or foamed plastic materials shall be permitted where subjected to large-scale fire tests that substantiate their combustibility and smoke release characteristics for the use intended under actual fire conditions.

10.2.4.3.1.1 One of the following fire tests shall be used for assessing the combustibility of cellular or foamed plastic materials as interior finish:

(1) NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, with the acceptance criteria of 10.2.3.7.2
(2) ANSI/UL 1715, *Standard for Fire Test of Interior Finish Material* (including smoke measurements, with total smoke release not to exceed 1000 m^2)
(3) ANSI/UL 1040, *Standard for Fire Test of Insulated Wall Construction*
(4) ANSI/FM 4880, *American National Standard for Evaluating Insulated Wall or Wall and Roof/Ceiling Assemblies, Plastic Interior Finish Materials, Plastic Exterior Building Panels, Wall/Ceiling Coating Systems, Interior or Exterior Finish Systems*

10.2.4.3.1.2* The tests shall be performed on a finished foamed plastic assembly related to the actual end-use configuration, including any cover or facing, and at the maximum thickness intended for use.

10.2.4.3.2 Cellular or foamed plastic shall be permitted for trim not in excess of 10 percent of the specific wall or ceiling area to which it is applied, provided that it is not less than 20 lb/ft^3 (320 kg/m^3) in density, is limited to ½ in. (13 mm) in thickness and 4 in. (100 mm) in width, and complies with the requirements for Class A or Class B interior wall and ceiling finish as described in 10.2.3.4; however, the smoke developed index shall not be limited.

10.2.4.4* Light-Transmitting Plastics. Light-transmitting plastics shall be permitted to be used as interior wall and ceiling finish if approved by the authority having jurisdiction.

10.2.4.5 Decorations and Furnishings. Decorations and furnishings that do not meet the definition of interior finish, as defined in 3.3.92.2, shall be regulated by the provisions of Section 10.3.

10.2.4.6 Metal Ceiling and Wall Panels. Listed factory finished metal ceiling and wall panels meeting the requirements of Class A when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials (see 10.2.3.4)*, shall be permitted to be finished with one additional application of paint. Such painted panels shall be permitted for use in areas where Class A interior finishes are required. The total paint thickness shall not exceed 1⁄28 in. (0.9 mm).

10.2.4.7 Polypropylene (PP) and High-Density Polyethylene (HDPE). Polypropylene and high-density polyethylene materials shall not be permitted as interior wall or ceiling finish unless the material complies with the requirements of 10.2.3.7.2. The tests shall be performed on a finished assembly and on the maximum thickness intended for use.

10.2.4.8 Site-Fabricated Stretch Systems. For new installations, site-fabricated stretch systems containing all three components described in the definition in Chapter 3 shall be tested in the manner intended for use and shall comply with the requirements of 10.2.3 or 10.2.3.2. If the materials are tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, specimen preparation and mounting shall be in accordance with ASTM E 2573, *Standard Practice for Specimen Preparation and Mounting of Site-Fabricated Stretch Systems to Assess Surface Burning Characteristics*.

10.2.4.9 Reflective Insulation Materials. Reflective insulation materials shall be tested in the manner intended for use and shall comply with the requirements of 10.2.3. If the materials are tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, specimen preparation and mounting shall be in accordance with ASTM E 2599, *Standard Practice for Specimen Preparation and Mounting of Reflective Insulation, Radiant Barrier, and Vinyl Stretch Ceiling Materials for Building Applications to Assess Surface Burning Characteristics*.

10.2.5 Trim and Incidental Finish.

10.2.5.1 General. Interior wall and ceiling trim and incidental finish, other than wall base in accordance with 10.2.5.2 and bulletin boards, posters, and paper in accordance with 10.2.5.3, not in excess of 10 percent of the specific wall and ceiling areas of any room or space to which it is applied shall be permitted to be Class C materials in occupancies where interior wall and ceiling finish of Class A or Class B is required.

10.2.5.2 Wall Base. Interior floor trim material used at the junction of the wall and the floor to provide a functional or decorative border, and not exceeding 6 in. (150 mm) in height, shall meet the requirements for interior wall finish for its location or the requirements for Class II interior floor finish as described in 10.2.7.4 using the test described in 10.2.7.3. If a Class I floor finish is required, the interior floor trim shall be Class I.

10.2.5.3 Bulletin Boards, Posters, and Paper.

10.2.5.3.1 Bulletin boards, posters, and paper attached directly to the wall shall not exceed 20 percent of the aggregate wall area to which they are applied.

10.2.5.3.2 The provision of 10.2.5.3.1 shall not apply to artwork and teaching materials in sprinklered educational or day-care occupancies in accordance with 14.7.4.3(2), 15.7.4.3(2), 16.7.4.3(2), or 17.7.4.3(2).

10.2.6* Fire-Retardant Coatings.

10.2.6.1* The required flame spread index or smoke developed index of existing surfaces of walls, partitions, columns, and ceilings shall be permitted to be secured by applying approved fire-retardant coatings to surfaces having higher flame spread index values than permitted. Such treatments shall be tested, or shall be listed and labeled for application to the material to which they are applied, and shall comply with the requirements of NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*.

10.2.6.2* Surfaces of walls, partitions, columns, and ceilings shall be permitted to be finished with factory-applied fire-retardant-coated products that have been listed and labeled to demonstrate compliance with the requirements of ASTM E 2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials*, on the coated surface.

10.2.6.3 Fire-retardant coatings or factory-applied fire-retardant coated assemblies shall possess the desired degree of permanency and shall be maintained so as to retain the effectiveness of the treatment under the service conditions encountered in actual use.

10.2.7* Interior Floor Finish Testing and Classification.

10.2.7.1* Carpet and carpetlike interior floor finishes shall comply with ASTM D 2859, *Standard Test Method for Ignition Characteristics of Finished Textile Floor Covering Materials*.

10.2.7.2* Floor coverings, other than carpet for which 10.2.2.2 establishes requirements for fire performance, shall have a minimum critical radiant flux of 0.1 W/cm^2.

10.2.7.3* Interior floor finishes shall be classified in accordance with 10.2.7.4, based on test results from NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, or ASTM E 648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*.

10.2.7.4 Interior floor finishes shall be grouped in the classes specified in 10.2.7.4.1 and 10.2.7.4.2 in accordance with the critical radiant flux requirements.

10.2.7.4.1 Class I Interior Floor Finish. Class I interior floor finish shall have a critical radiant flux of not less than 0.45 W/cm^2, as determined by the test described in 10.2.7.3.

10.2.7.4.2 Class II Interior Floor Finish. Class II interior floor finish shall have a critical radiant flux of not less than 0.22 W/cm^2, but less than 0.45 W/cm^2, as determined by the test described in 10.2.7.3.

10.2.7.5 Wherever the use of Class II interior floor finish is required, Class I interior floor finish shall be permitted.

10.2.8 Automatic Sprinklers.

10.2.8.1 Other than as required in 10.2.4, where an approved automatic sprinkler system is installed in accordance with Section 9.7, Class C interior wall and ceiling finish materials shall be permitted in any location where Class B is required, and Class B interior wall and ceiling finish materials shall be permitted in any location where Class A is required.

10.2.8.2 Where an approved automatic sprinkler system is installed in accordance with Section 9.7, throughout the fire compartment or smoke compartment containing the interior floor finish, Class II interior floor finish shall be permitted in any location where Class I interior floor finish is required, and where Class II is required, the provisions of 10.2.7.2 shall apply.

10.3 Contents and Furnishings.

10.3.1* Where required by the applicable provisions of this *Code*, draperies, curtains, and other similar loosely hanging furnishings and decorations shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

10.3.2 Smoldering Ignition of Upholstered Furniture and Mattresses.

10.3.2.1* Upholstered Furniture. Newly introduced upholstered furniture, except as otherwise permitted by Chapters 11 through 43, shall be resistant to a cigarette ignition (i.e., smoldering) in accordance with one of the following:

(1) The components of the upholstered furniture shall meet the requirements for Class I when tested in accordance with NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture*.
(2) Mocked-up composites of the upholstered furniture shall have a char length not exceeding 1½ in. (38 mm) when tested in accordance with NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes*.

10.3.2.2* Mattresses. Newly introduced mattresses, except as otherwise permitted by Chapters 11 through 43, shall have a char length not exceeding 2 in. (51 mm) when tested in accordance with 16 CFR 1632, "Standard for the Flammability of Mattresses and Mattress Pads" (FF 4-72).

10.3.3* Where required by the applicable provisions of this *Code*, upholstered furniture, unless the furniture is located in a building protected throughout by an approved automatic sprinkler system, shall have limited rates of heat release when tested in accordance with ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, as follows:

(1) The peak rate of heat release for the single upholstered furniture item shall not exceed 80 kW.
(2) The total heat released by the single upholstered furniture item during the first 10 minutes of the test shall not exceed 25 MJ.

10.3.4* Where required by the applicable provisions of this *Code*, mattresses, unless the mattress is located in a building protected throughout by an approved automatic sprinkler system, shall have limited rates of heat release when tested in accordance with ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses*, as follows:

(1) The peak rate of heat release for the mattress shall not exceed 100 kW.
(2) The total heat released by the mattress during the first 10 minutes of the test shall not exceed 25 MJ.

10.3.5* Furnishings or decorations of an explosive or highly flammable character shall not be used.

10.3.6 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use.

10.3.7* Where required by the applicable provisions of this *Code*, furnishings and contents made with foamed plastic materials that are unprotected from ignition shall have a heat release rate not exceeding 100 kW when tested in accordance with UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*,using the 20 kW ignition source.

10.3.8 Lockers.

10.3.8.1 Combustible Lockers. Where lockers constructed of combustible materials other than wood are used, the lockers shall be considered interior finish and shall comply with Section 10.2, except as permitted by 10.3.8.2.

10.3.8.2 Wood Lockers. Lockers constructed entirely of wood and of noncombustible materials shall be permitted to be used in any location where interior finish materials are required to meet a Class C classification in accordance with 10.2.3.

10.3.9 Containers for Waste, or Linen.

10.3.9.1 Where required by Chapters 11 through 43, newly introduced containers for waste or linen, with a capacity of 20 gal (75.7 L) or more, shall meet both of the following:

(1) Such containers shall be provided with lids.
(2) Such containers and their lids shall be constructed of noncombustible materials or of materials that meet a peak rate of heat release not exceeding 300 kW/m^2 when tested at an incident heat flux of 50 kW/m^2 in the horizontal orientation and at a thickness as used in the container but not less than ¼ in. (6.3 mm), in accordance with ASTM E 1354, *Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*.

10.3.9.2 Where required by Chapters 11 through 43, newly introduced metal wastebaskets and other metal waste, or linen containers with a capacity of 20 gal (75.7 L) or more shall be listed in accordance with ANSI/UL 1315, *Standard for Safety for Metal Waste Paper Containers*, and shall be provided with a noncombustible lid.

Chapter 11 Special Structures and High-Rise Buildings

11.1 General Requirements.

11.1.1 Application. The requirements of Sections 11.1 through 11.11 shall apply to occupancies regulated by Chapters 12 through 42 that are in a special structure. The applicable provisions of Chapters 12 through 42 shall apply, except as modified by this chapter. Section 11.8 shall apply to high-rise buildings only where specifically required by Chapters 12 through 42.

11.1.2 Multiple Occupancies. See 6.1.14.

11.1.3 Definitions.

11.1.3.1 General. For definitions see Chapter 3 Definitions.

11.1.3.2 Special Definitions. Special terms used in this chapter are located within each special structure section.

11.1.4 Classification of Occupancy. Occupancies regulated by Chapters 12 through 42 that are in special structures shall meet the requirements of those chapters, except as modified by this chapter.

11.1.5 Classification of Hazard of Contents. Classification of hazard of contents shall be in accordance with Section 6.2.

11.1.6 Minimum Construction Requirements. Minimum construction requirements shall be in accordance with the applicable occupancy chapter.

11.1.7 Occupant Load. The occupant load of special structures shall be based on the use of the structure as regulated by Chapters 12 through 42.

11.1.8 Automatic Sprinkler Systems. Where another provision of this chapter requires an automatic sprinkler system, the automatic sprinkler system shall be installed in accordance with the subparts of 9.7.1.1 as permitted by the applicable occupancy chapter.

11.2 Open Structures.

11.2.1 Application.

11.2.1.1 General. The provisions of Section 11.1 shall apply.

11.2.1.2 Definition — Open Structure. See 3.3.272.6.

11.2.2* Means of Egress.

11.2.2.1 General. The means of egress provisions of the applicable occupancy chapter, Chapters 12 through 42, shall apply, except as modified by 11.2.2.2 through 11.2.2.10.

11.2.2.2 Means of Egress Components.

11.2.2.2.1 Fire Escape Ladders. Open structures that are designed for occupancy by not more than three persons shall be permitted to be served by fire escape ladders complying with 7.2.9.

11.2.2.2.2 Reserved.

11.2.2.3 Capacity of Means of Egress. Open structures shall be exempt from the requirements for capacity of means of egress.

11.2.2.4 Number of Means of Egress.

11.2.2.4.1* Open structures at the finished ground level are exempt from the requirements for number of means of egress.

11.2.2.4.2 Open structures occupied by not more than three persons, with travel distance of not more than 200 ft (61 m), shall be permitted to have a single exit.

11.2.2.5 Arrangement of Means of Egress. (No modifications.)

11.2.2.6 Travel Distance to Exits. Open structures shall be exempt from travel distance limitations.

11.2.2.7 Discharge from Exits. Open structures permitted to have a single exit per 11.2.2.4 shall be permitted to have 100 percent of the exit discharge through areas on the level of exit discharge.

11.2.2.8 Illumination of Means of Egress. Open structures shall be exempt from illumination of means of egress requirements.

11.2.2.9 Emergency Lighting. Open structures shall be exempt from emergency lighting requirements.

11.2.2.10 Marking of Means of Egress. Open structures shall be exempt from marking of means of egress requirements.

11.2.3 Protection.

11.2.3.1 Protection of Vertical Openings. Open structures shall be exempt from protection of vertical opening requirements.

11.2.3.2 Protection from Hazards. Every open structure, other than those structures with only occasional occupancy, shall have automatic, manual, or other protection that is appropriate to the particular hazard and that is designed to minimize danger to occupants in case of fire or other emergency before they have time to use the means of egress.

11.2.3.3 Interior Finish. (No modifications.)

11.2.3.4 Detection, Alarm, and Communications Systems. Open structures shall be exempt from requirements for detection, alarm, and communications systems.

11.2.3.5 Extinguishing Requirements. (No modifications.)

11.3 Towers.

11.3.1 Application.

11.3.1.1 General. The provisions of Section 11.1 shall apply.

11.3.1.2 Definition — Tower. See 3.3.281.

11.3.1.3 Use of Accessory Levels.

11.3.1.3.1 Sprinklered Towers. In towers protected throughout by an automatic sprinkler system in accordance with Section 9.7, the levels located below the observation level shall be permitted to be occupied only for the following uses that support tower operations:

(1) Use as electrical and mechanical equipment rooms, including emergency power, radar, communications, and electronics rooms
(2)*Incidental accessory uses

11.3.1.3.2 Electronic supervision of supervisory signals shall be provided in accordance with 9.7.2.1. Waterflow alarms shall be monitored in accordance with 9.7.2.2.

11.3.2 Means of Egress.

11.3.2.1 General. The means of egress provisions of the applicable occupancy chapter, Chapters 12 through 42, shall apply, except as modified by 11.3.2.2 through 11.3.2.10.

11.3.2.2 Means of Egress Components.

11.3.2.2.1 Fire Escape Ladders. Towers, such as forest fire observation or railroad signal towers, that are designed for occupancy by not more than three persons shall be permitted to be served by fire escape ladders complying with 7.2.9.

11.3.2.2.2 Elevators. Towers subject to occupancy by not more than 90 persons shall be permitted to use elevators in the means of egress in accordance with 7.2.13.

11.3.2.3 Capacity of Means of Egress.

11.3.2.3.1 Means of egress for towers shall be provided for the number of persons expected to occupy the space.

11.3.2.3.2 Spaces not subject to human occupancy because of machinery or equipment shall be excluded from consideration.

11.3.2.4* Number of Means of Egress.

11.3.2.4.1 Towers shall be permitted to have a single exit, provided that the following conditions are met:

(1) The tower shall be subject to occupancy by fewer than 25 persons.
(2) The tower shall not be used for living or sleeping purposes.
(3) The tower shall be of Type I, Type II, or Type IV construction. *(See 8.2.1.)*
(4) The tower interior wall and ceiling finish shall be Class A or Class B.
(5) No combustible materials shall be located within the tower, under the tower, or within the immediate vicinity of the tower, except necessary furniture.
(6) No high hazard occupancies shall be located within the tower or within its immediate vicinity.
(7) Where the tower is located above a building, the single exit from the tower shall be provided by one of the following:
    (a) Exit enclosure separated from the building with no door openings to or from the building

(b) Exit enclosure leading directly to an exit enclosure serving the building, with walls and door separating the exit enclosures from each other, and another door allowing access to the top floor of the building that provides access to a second exit serving that floor

11.3.2.4.2 Towers with 360-degree line-of-sight requirements shall be permitted to have a single means of egress for a distance of travel not exceeding 75 ft (23 m), or 100 ft (30 m) if the tower is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

11.3.2.4.3 Electronic supervision of sprinkler system supervisory signals shall be provided in accordance with 9.7.2.1 and waterflow alarms shall be monitored in accordance with 9.7.2.2.

11.3.2.5 Arrangement of Means of Egress. (No modifications.)

11.3.2.6 Travel Distance to Exits. Towers where ladders are permitted by 11.3.2.2.1 shall be exempt from travel distance limitations.

11.3.2.7 Discharge from Exits. Towers permitted to have a single exit per 11.3.2.4 shall be permitted to have 100 percent of the exit discharge through areas on the level of exit discharge.

11.3.2.8 Illumination of Means of Egress. Towers where ladders are permitted by 11.3.2.2.1 shall be exempt from illumination of means of egress requirements.

11.3.2.9 Emergency Lighting.

11.3.2.9.1 Towers where ladders are permitted by 11.3.2.2.1 shall be exempt from emergency lighting requirements.

11.3.2.9.2 Locations not routinely inhabited by humans shall be exempt from emergency lighting requirements.

11.3.2.9.3 Structures occupied only during daylight hours, with windows arranged to provide the required level of illumination of all portions of the means of egress during such hours, shall be exempt from emergency lighting requirements where approved by the authority having jurisdiction.

11.3.2.10 Marking of Means of Egress.

11.3.2.10.1 Towers where ladders are permitted by 11.3.2.2.1 shall be exempt from marking of means of egress requirements.

11.3.2.10.2 Locations not routinely inhabited by humans shall be exempt from marking of means of egress requirements.

11.3.3 Protection.

11.3.3.1 Protection of Vertical Openings.

11.3.3.1.1 Towers where ladders are permitted by 11.3.2.2.1 shall be exempt from protection of vertical opening requirements.

11.3.3.1.2 In towers where the support structure is open and there is no occupancy below the top floor level, stairs shall be permitted to be open with no enclosure required, or fire escape stairs shall be permitted.

11.3.3.2 Protection from Hazards. Every tower, other than structures with only occasional occupancy, shall have automatic, manual, or other protection that is appropriate to the particular hazard and that is designed to minimize danger to occupants in case of fire or other emergency before they have time to use the means of egress.

11.3.3.3 Interior Finish. (No modifications.)

11.3.3.4 Detection, Alarm, and Communications Systems. Towers designed for occupancy by not more than three persons shall be exempt from requirements for detection, alarm, and communications systems.

11.3.3.5 Extinguishing Requirements. (No modifications.)

11.3.3.6 Corridors. (No modifications.)

11.3.4 Additional Requirements for Air Traffic Control Towers.

11.3.4.1 Definition — Air Traffic Control Tower. See 3.3.281.1.

11.3.4.2 Use of Accessory Levels. The levels located below the observation level shall be permitted to be occupied only for the following uses that support tower operations:

(1) Use as electrical and mechanical equipment rooms, including emergency and standby power, radar, communications, and electronics rooms
(2)*Incidental accessory uses

11.3.4.3 Minimum Construction Requirements. New air traffic control towers shall be of Type I or Type II construction. *(See 8.2.1.)*

11.3.4.4 Means of Egress.

11.3.4.4.1 Number of Means of Egress. Air traffic control towers shall be permitted to have a single exit, provided that the following conditions are met in addition to the requirements of 11.3.2.4:

(1) Each level of new air traffic control towers, served by a single exit, shall be subject to a calculated occupant load of 15 or fewer persons.
(2) The requirements of 11.3.2.4.1(1) shall not apply to existing air traffic control towers.
(3) Smoke detection shall be provided throughout air traffic control towers to meet the requirements of partial coverage, as defined in 17.5.3.2 of *NFPA 72, National Fire Alarm and Signaling Code*, and shall include coverage of all of the following:
    (a) Occupiable areas
    (b) Common areas
    (c) Work spaces
    (d) Equipment areas
    (e) Means of egress
    (f) Accessible utility shafts
(4) The requirements of 11.3.2.4.1(5) shall not apply.
(5) Rooms or spaces used for the storage, processing, or use of combustible supplies shall be permitted in quantities deemed acceptable by the authority having jurisdiction.

11.3.4.4.2 Egress for Occupant Load. Means of egress for air traffic control towers shall be provided for the occupant load, as determined in accordance with 7.3.1.

11.3.4.4.3 Areas Excluded from Occupant Load. Shafts, stairs, and spaces and floors not subject to human occupancy shall be excluded from consideration in determining the total calculated occupant load of the tower as required by 11.3.2.4.1(1) and 11.3.4.4.1(1).

11.3.4.4.4 Single Means of Egress. A single means of egress shall be permitted from the observation level of an air traffic control tower, as permitted by 11.3.2.4.2.

11.3.4.4.5 Smokeproof Enclosures. For other than existing, previously approved air traffic control towers, smokeproof exit enclosures complying with 7.2.3 shall be provided for all air traffic control tower exit stair enclosures.

11.3.4.4.6 Discharge from Exits.

11.3.4.4.6.1 Air traffic control towers shall comply with the requirements of 7.7.2, except as permitted by 11.3.4.4.6.2.

11.3.4.4.6.2 Existing, single-exit air traffic control towers shall be permitted to have discharge of the exit comply with one of the following:

(1) Discharge of the exit in a previously approved, single-exit air traffic control tower is permitted to a vestibule or foyer complying with the requirements of 7.7.2(4)(b).
(2)*Discharge of the exit in a single-exit air traffic control tower is permitted within the building to a location where two means of egress are available and are arranged to allow travel in independent directions after leaving the exit enclosure, so that both means of egress do not become compromised by the same fire or similar emergency.

11.3.4.5 Protection.

11.3.4.5.1 Detection, Alarm, and Communications Systems. For other than existing, previously approved air traffic control towers, air traffic control towers shall be provided with a fire alarm system in accordance with Section 9.6. Smoke detection shall be provided throughout the air traffic control tower to meet the requirements for selective coverage, as defined in 17.5.3.2 of *NFPA 72, National Fire Alarm and Signaling Code*, and shall include coverage of all of the following:

(1) At equipment areas
(2) Outside each opening into exit enclosures
(3) Along the single means of egress permitted from observation levels in 11.3.2.4.2
(4) Outside each opening into the single means of egress permitted from observation levels in 11.3.2.4.2

11.3.4.5.2 Extinguishing Requirements. New air traffic control towers shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

11.3.4.5.3 Standpipe Requirements. New air traffic control towers where the floor of the cab is greater than 30 ft (9.1 m) above the lowest level of fire department vehicle access shall be protected throughout with a Class I standpipe system in accordance with Section 9.7. Class I standpipes shall be manual standpipes, as defined in NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, where permitted by the authority having jurisdiction.

11.3.4.6 Contents and Furnishings. Contents and furnishings in air traffic control towers shall comply with 10.3.1, 10.3.2, 10.3.6, and 10.3.7.

11.3.4.7 Uses. Sleeping areas shall be prohibited in air traffic control towers.

11.4 Water-Surrounded Structures.

11.4.1 Application.

11.4.1.1 General. The provisions of Sections 11.1 and 11.4 shall apply to those structures that are not under the jurisdiction of the U.S. Coast Guard and not designed and arranged in accordance with U.S. Coast Guard regulations.

11.4.1.2 Definition — Water-Surrounded Structure. See 3.3.272.12.

11.4.2 Means of Egress.

11.4.2.1 General. The means of egress provisions of the applicable occupancy chapter, Chapters 12 through 42, shall apply, except as modified by 11.4.2.2 through 11.4.2.10.

11.4.2.2 Means of Egress Components. (No modifications.)

11.4.2.3 Capacity of Means of Egress. Spaces in water-surrounded structures that are not subject to human occupancy because of machinery or equipment shall be exempt from the requirements for capacity of means of egress.

11.4.2.4 Number of Means of Egress. (No modifications.)

11.4.2.5 Arrangement of Means of Egress. (No modifications.)

11.4.2.6 Travel Distance to Exits. (No modifications.)

11.4.2.7 Discharge from Exits. Structures permitted to have a single exit per the applicable occupancy chapter shall be permitted to have 100 percent of the exit discharge through areas on the level of exit discharge.

11.4.2.8 Illumination of Means of Egress. (No modifications.)

11.4.2.9 Emergency Lighting.

11.4.2.9.1 Locations not routinely inhabited by humans are exempt from emergency lighting requirements.

11.4.2.9.2 Structures occupied only during daylight hours, with windows arranged to provide the required level of illumination of all portions of the means of egress during such hours, shall be exempt from emergency lighting requirements where approved by the authority having jurisdiction.

11.4.2.10 Marking of Means of Egress. Locations not routinely inhabited by humans shall be exempt from marking of means of egress requirements.

11.4.3 Protection.

11.4.3.1 Protection of Vertical Openings. (No modifications.)

11.4.3.2 Protection from Hazards. Every water-surrounded structure, other than structures with only occasional occupancy, shall have automatic, manual, or other protection that is appropriate to the particular hazard and that is designed to minimize danger to occupants in case of fire or other emergency before they have time to use the means of egress.

11.4.3.3 Interior Finish. (No modifications.)

11.4.3.4 Detection, Alarm, and Communications Systems. (No modifications.)

11.4.3.5 Extinguishing Requirements. (No modifications.)

11.4.3.6 Corridors. (No modifications.)

11.5* Piers.

11.5.1 Application. The provisions of Section 11.1 shall apply.

11.5.2 Number of Means of Egress.

11.5.2.1 Piers used exclusively to moor cargo vessels and to store material shall be exempt from number of means of egress requirements where provided with proper means of egress from structures thereon to the pier and a single means of access to the mainland, as appropriate to the pier's arrangement.

11.5.2.2 Buildings on piers not meeting the requirements of 11.5.2.1 and occupied for other than cargo handling and storage shall be in accordance with both of the following:

(1) Means of egress shall be arranged in accordance with Chapters 12 through 43.
(2) One of the following measures shall be provided on piers extending over 150 ft (46 m) from shore to minimize the

possibility that fire under or on the pier blocks the escape of occupants to shore:

(a) The pier shall be arranged to provide two separate ways to travel to shore, such as by two well-separated walkways or independent structures.
(b) The pier deck shall be open, fire resistive, and set on noncombustible supports.
(c) The pier shall be open, unobstructed, and not less than 50 ft (15 m) in width if less than 500 ft (150 m) long, or its width shall be not less than 10 percent of its length if more than 500 ft (150 m) long.
(d) The pier deck shall be provided with an approved automatic sprinkler system in accordance with Section 9.7 for combustible substructures and all superstructures.
(e) The sprinkler system specified in 11.5.2.2(2)(d) shall be supervised where required by the applicable occupancy chapter, Chapters 12 through 42.

11.6* Vehicles and Vessels.

11.6.1 Vehicles. Where immobile, attached to a building, or permanently fixed to a foundation, and where subject to human occupancy, the following vehicles shall comply with the requirements of this *Code* that are appropriate to buildings of similar occupancy:

(1) Trailers
(2) Railroad cars
(3) Streetcars
(4) Buses
(5) Conveyances similar to those in 11.6.1(1) through (4)

11.6.2 Vessels. Any ship, barge, or other vessel permanently fixed to a foundation or mooring, or unable to get underway by means of its own power, and occupied for purposes other than navigation shall be subject to the requirements of this *Code* that apply to buildings of similar occupancy.

11.7 Underground and Limited Access Structures.

11.7.1 Application. The provisions of Section 11.1 shall apply.

11.7.2 Special Definitions. A list of special terms used in Section 11.7 follows:

(1) **Limited Access Structure.** See 3.3.272.3.
(2) **Underground Structure.** See 3.3.272.11.

11.7.3 Special Provisions for Underground and Limited Access Structures.

11.7.3.1 A structure or portion of a structure that does not have openings in compliance with 11.7.3.1.1 and 11.7.3.1.2 shall be designated as a limited access structure and shall comply with 11.7.3.4 and 11.7.3.5.

11.7.3.1.1 One-Story Structures. One-story structures shall have finished ground level doors or emergency access openings in accordance with 11.7.3.2 on two sides of the building, spaced not more than 125 ft (38 m) apart on the exterior walls.

11.7.3.1.2 Multiple-Story Structures. Multiple-story structures shall comply with the following:

(1) The story at the finished ground level shall comply with 11.7.3.1.1.
(2) Other stories shall be provided with emergency access openings in accordance with 11.7.3.2 on two sides of the building, spaced not more than 30 ft (9.1 m) apart.

11.7.3.2* Emergency access openings shall consist of a window, panel, or similar opening that complies with all of the following:

(1) The opening shall have dimensions of not less than 22 in. (560 mm) in width and 24 in. (610 mm) in height and shall be unobstructed to allow for ventilation and rescue operations from the exterior.
(2) The bottom of the opening shall be not more than 44 in. (1120 mm) above the floor.
(3) The opening shall be readily identifiable from both the exterior and interior.
(4) The opening shall be readily openable from both the exterior and interior.

11.7.3.3 A structure or portion of a structure shall not be considered an underground structure if the story is provided, on not less than two sides, with not less than 20 ft^2 (1.9 m^2) of emergency access opening located entirely above the adjoining finished ground level in each 50 lineal ft (15 lineal m) of exterior enclosing wall area.

11.7.3.4 Underground and limited access structures, and all areas and floor levels traversed in traveling to the exit discharge, shall be protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7, unless such structures meet one of the following criteria:

(1) They have an occupant load of 50 or fewer persons in new underground or limited access portions of the structure.
(2) They have an occupant load of 100 or fewer persons in existing underground or limited access portions of the structure.
(3) The structure is a one-story underground or limited access structure that is permitted to have a single exit per Chapters 12 through 43, with a common path of travel not greater than 50 ft (15 m).

11.7.3.5 Underground or limited access portions of structures and all areas traversed in traveling to the exit discharge, other than in one- and two-family dwellings, shall be provided with emergency lighting in accordance with Section 7.9.

11.7.4 Additional Provisions for Underground Structures.

11.7.4.1 The requirements of 11.7.3 shall apply.

11.7.4.2 Exits from underground structures with an occupant load of more than 100 persons in the underground portions of the structure and having a floor used for human occupancy located more than 30 ft (9.1 m) below the lowest level of exit discharge, or having more than one level located below the lowest level of exit discharge, shall be provided with outside smoke-venting facilities or other means to prevent the exits from becoming charged with smoke from any fire in the areas served by the exits.

11.7.4.3 The underground portions of an underground structure, other than an existing underground structure, shall be provided with approved automatic smoke venting in accordance with Section 9.3 where the underground structure has the following features:

(1) Occupant load of more than 100 persons in the underground portions of the structure
(2) Floor level used for human occupancy located more than 30 ft (9.1 m) below the lowest level of exit discharge, or more than one level located below the lowest level of exit discharge
(3) Combustible contents, combustible interior finish, or combustible construction

11.7.4.4 Exit stair enclosures in underground structures having a floor level used for human occupancy located more than 30 ft (9.1 m) below the lowest level of exit discharge, or having more than one level located below the lowest level of exit discharge, shall be provided with signage in accordance with 7.2.2.5.4 at each floor level landing traversed in traveling to the exit discharge. The signs shall include a chevron-shaped indicator to show direction to the exit discharge.

11.8 High-Rise Buildings.

11.8.1 General.

11.8.1.1 The provisions of Section 11.8 shall apply to the following:

(1) New high-rise buildings, as defined in 3.3.36.7
(2) Existing high-rise buildings as required by Chapters 13, 15, 17, 19, 21, 23, 26, 29, 31, 33, 37, 39, 40, 42, or 43

11.8.1.2 In addition to the requirements of Section 11.8, compliance with all other applicable provisions of this *Code* shall be required.

11.8.2 Means of Egress Requirements.

11.8.2.1 Reserved.

11.8.2.2 Elevator Lobby Exit Access Door Locking. In other than newly constructed high-rise buildings, locks in accordance with 7.2.1.6.3 shall be permitted.

11.8.3 Extinguishing Requirements.

11.8.3.1* High-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7. A sprinkler control valve and a waterflow device shall be provided for each floor.

11.8.3.2 High-rise buildings shall be protected throughout by a Class I standpipe system in accordance with Section 9.7.

11.8.4 Detection, Alarm, and Communications Systems.

11.8.4.1* A fire alarm system using an approved emergency voice/alarm communication system shall be installed in accordance with Section 9.6.

11.8.4.2 Two-way telephone service shall be in accordance with 11.8.4.2.1 and 11.8.4.2.2.

11.8.4.2.1 Two-way telephone communication service shall be provided for fire department use. This system shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code*. The communications system shall operate between the emergency command center and every elevator car, every elevator lobby, and each floor level of exit stairs.

11.8.4.2.2 The requirement of 11.8.4.2.1 shall not apply where the fire department radio system is approved as an equivalent system.

11.8.5 Emergency Lighting and Standby Power.

11.8.5.1 Emergency lighting in accordance with Section 7.9 shall be provided.

11.8.5.2 Requirements for standby power shall be as specified in 11.8.5.2.1 through 11.8.5.2.4.

11.8.5.2.1 Type 60, Class 1, Level 1, standby power in accordance with Article 701 of *NFPA 70, National Electrical Code*, and NFPA 110, *Standard for Emergency and Standby Power Systems*, shall be provided.

11.8.5.2.2 The standby power system shall have a capacity and rating sufficient to supply all equipment required to be connected by 11.8.5.2.4.

11.8.5.2.3 Selective load pickup and load shedding shall be permitted in accordance with *NFPA 70, National Electrical Code*.

11.8.5.2.4 The standby power system shall be connected to the following:

(1) Electric fire pump
(2) Jockey pump, except as otherwise provided in 40.4.2 for special-purpose industrial occupancies
(3) Air compressor serving dry-pipe and pre-action systems, except as otherwise provided in 40.4.2 for special-purpose industrial occupancies
(4) Emergency command center equipment and lighting
(5) Not less than one elevator serving all floors, with standby power transferable to any elevator
(6) Mechanical equipment for smokeproof enclosures
(7) Mechanical equipment required to conform with the requirements of Section 9.3
(8) Stairway video monitoring equipment as required by 11.8.8

11.8.5.3 Power for detection, alarm, and communications systems shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

11.8.6* Emergency Command Center.

11.8.6.1 An emergency command center shall be provided in a location approved by the fire department.

11.8.6.2 The emergency command center shall contain the following:

(1) Voice fire alarm system panels and controls
(2) Fire department two-way telephone communication service panels and controls where required by another section of this *Code*
(3) Fire detection and fire alarm system annunciation panels
(4) Elevator floor location and operation annunciators
(5) Elevator fire recall switch in accordance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*
(6) Elevator emergency power selector switch(es) where provided in accordance with ASME A17.1/CSA B44
(7) Sprinkler valve and waterflow annunciators
(8) Emergency generator status indicators
(9) Controls for any automatic stairway door unlocking system
(10) Fire pump status indicators
(11) Telephone for fire department use with controlled access to the public telephone system
(12) Stairway video monitoring equipment as required by 11.8.8

11.8.7 Emergency Action Plans. Emergency action plans shall be provided in accordance with 4.8.2.

11.8.8 Stairway Video Monitoring.

11.8.8.1* General.

11.8.8.1.1 For high-rise buildings having an occupant load of 4,000 or more persons, real-time remote monitoring of exit stair usage shall be provided in accordance with 11.8.8.2 through 11.8.8.4 and shall be displayed at the emergency command center.

11.8.8.1.2 Where the monitoring system is integrated with a security system, the security system shall be in accordance with

NFPA 731, *Standard for the Installation of Electronic Premises Security Systems.*

11.8.8.1.3 Where the monitoring system includes video cameras also used for video image smoke detection, the portions of the system used for such detection shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*

11.8.8.2 Approved video monitoring equipment shall be provided at the exit stairs immediately adjacent to exit stairway discharge doors to capture discharge from, entry to, and passage through the discharge floor landing.

11.8.8.3 Approved video monitoring equipment shall be provided for exit stairs above the level of exit discharge, at building height intervals not exceeding 5 stories, so that descent and ascent flows on the stairways, at the floor entry landings, can be remotely monitored.

11.8.8.4 Approved video monitoring equipment shall be provided, at locations stipulated by the authority having jurisdiction, for exit stairs below the level of exit discharge where levels are normally occupied by the public.

11.9 Permanent Membrane Structures.

11.9.1 Application.

11.9.1.1 General. The provisions of Section 11.1 shall apply.

11.9.1.2 Use of Membrane Roofs. Membrane roofs shall be used in accordance with the following:

(1) Membrane materials shall not be used where fire resistance ratings are required for walls or roofs.
(2) Where every part of the roof, including the roof membrane, is not less than 20 ft (6100 mm) above any floor, balcony, or gallery, a noncombustible or limited-combustible membrane shall be permitted to be used as the roof in any construction type.
(3) With approval of the authority having jurisdiction, membrane materials shall be permitted to be used where every part of the roof membrane is sufficiently above every significant fire potential, such that the imposed temperature cannot exceed the capability of the membrane, including seams, to maintain its structural integrity.

11.9.1.3 Testing. Testing of membrane materials for compliance with the requirements of Section 11.9 for use of the categories of noncombustible and limited-combustible materials shall be performed on weathered-membrane material, as defined in 3.3.171.5.

11.9.1.4 Flame Spread Index. The flame spread index of all membrane materials exposed within the structure shall be Class A in accordance with Section 10.2.

11.9.1.5 Roof Covering Classification. Roof membranes shall have a roof covering classification, as required by the applicable building codes, when tested in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings.*

11.9.1.6 Flame Propagation Performance.

11.9.1.6.1 All membrane structure fabric shall meet the flame propagation performance criteria contained in Test Method 2 of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*

11.9.1.6.2 One of the following shall serve as evidence that the fabric materials have the required flame propagation performance:

(1) The authority having jurisdiction shall require a certificate or other evidence of acceptance by an organization acceptable to the authority having jurisdiction.
(2) The authority having jurisdiction shall require a report of tests made by other inspection authorities or organizations acceptable to the authority having jurisdiction.

11.9.1.6.3 Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the structure.

11.9.2 Tensioned-Membrane Structures.

11.9.2.1 The design, materials, and construction of the building shall be based on plans and specifications prepared by a licensed architect or engineer knowledgeable in tensioned-membrane construction.

11.9.2.2 Material loads and strength shall be based on physical properties of the materials verified and certified by an approved testing laboratory.

11.9.2.3 The membrane roof for structures in climates subject to freezing temperatures and ice buildup shall be composed of two layers separated by an air space through which heated air can be moved to guard against ice accumulation. As an alternative to the two layers, other approved methods that protect against ice accumulation shall be permitted.

11.9.2.4 Roof drains shall be equipped with electrical elements to protect against ice buildup that can prevent the drains from functioning. Such heating elements shall be served by on-site standby electrical power in addition to the normal public service. As an alternative to such electrical elements, other approved methods that protect against ice accumulation shall be permitted.

11.9.3 Air-Supported and Air-Inflated Structures.

11.9.3.1 General. In addition to the general provisions of 11.9.1, the requirements of 11.9.3 shall apply to air-supported and air-inflated structures.

11.9.3.2 Pressurization (Inflation) System. The pressurization system shall consist of one or more operating blower units. The system shall include automatic control of auxiliary blower units to maintain the required operating pressure. Such equipment shall meet the following requirements:

(1) Blowers shall be powered by continuous-rated motors at the maximum power required.
(2) Blowers shall have personnel protection, such as inlet screens and belt guards.
(3) Blower systems shall be weather protected.
(4) Blower systems shall be equipped with backdraft check dampers.
(5) Not less than two blower units shall be provided, each of which has capacity to maintain full inflation pressure with normal leakage.
(6) Blowers shall be designed to be incapable of overpressurization.
(7) The auxiliary blower unit(s) shall operate automatically if there is any loss of internal pressure or if an operating blower unit becomes inoperative.
(8) The design inflation pressure and the capacity of each blower system shall be certified by a professional engineer.

11.9.3.3 Standby Power System.

11.9.3.3.1* A fully automatic standby power system shall be provided. The system shall be either an auxiliary engine generator set capable of running the blower system or a supplementary blower unit that is sized for 1 times the normal operating capacity and is powered by an internal combustion engine.

11.9.3.3.2 The standby power system shall be fully automatic to ensure continuous inflation in the event of any failure of the primary power. The system shall be capable of operating continuously for a minimum of 4 hours.

11.9.3.3.3 The sizing and capacity of the standby power system shall be certified by a professional engineer.

11.9.4 Maintenance and Operation.

11.9.4.1 Instructions in both operation and maintenance shall be transmitted to the owner by the manufacturer of the tensioned-membrane, air-supported, or air-inflated structure.

11.9.4.2 Annual inspection and required maintenance of each structure shall be performed to ensure safety conditions. At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

11.9.5 Services.

11.9.5.1 Fired Heaters.

11.9.5.1.1 Only labeled heating devices shall be used.

11.9.5.1.2 Fuel-fired heaters and their installation shall be approved by the authority having jurisdiction.

11.9.5.1.3 Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any temporary membrane structure and shall be in accordance with the provisions of NFPA 58, *Liquefied Petroleum Gas Code*.

11.9.5.1.4 Tanks shall be secured in the upright position and protected from vehicular traffic.

11.9.5.2 Electric Heaters.

11.9.5.2.1 Only labeled heaters shall be permitted.

11.9.5.2.2 Electric heaters, their placement, and their installation shall be approved by the authority having jurisdiction.

11.9.5.2.3 Heaters shall be connected to electricity by electric cable that is suitable for outside use and is of sufficient size to handle the electrical load.

11.10 Temporary Membrane Structures.

11.10.1 Application.

11.10.1.1 General. The provisions of Section 11.1 shall apply.

11.10.1.2 Required Approval. Membrane structures designed to meet all the requirements of Section 11.10 shall be permitted to be used as temporary buildings subject to the approval of the authority having jurisdiction.

11.10.1.3 Alternative Requirements. Temporary tensioned-membrane structures shall be permitted to comply with Section 11.11 instead of Section 11.10.

11.10.1.4 Roof Covering Classification. Roof membranes shall have a roof covering classification, as required by the applicable building codes, when tested in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.

11.10.1.5 Flame Propagation Performance.

11.10.1.5.1 All membrane structure fabric shall meet the flame propagation performance criteria contained in Test Method 2 of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

11.10.1.5.2 One of the following shall serve as evidence that the fabric materials have the required flame propagation performance:

(1) The authority having jurisdiction shall require a certificate or other evidence of acceptance by an organization acceptable to the authority having jurisdiction.
(2) The authority having jurisdiction shall require a report of tests made by other inspection authorities or organizations acceptable to the authority having jurisdiction.

11.10.1.5.3 Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the structure.

11.10.2 Fire Hazards.

11.10.2.1 The finished ground level enclosed by any temporary membrane structure, and the finished ground level for a reasonable distance but for not less than 10 ft (3050 mm) outside of such a structure, shall be cleared of all flammable or combustible material or vegetation that is not used for necessary support equipment. The clearing work shall be accomplished to the satisfaction of the authority having jurisdiction prior to the erection of such a structure. The premises shall be kept free from such flammable or combustible materials during the period for which the premises are used by the public.

11.10.2.2 Where prohibited by the authority having jurisdiction, smoking shall not be permitted in any temporary membrane structure.

11.10.3 Fire-Extinguishing Equipment. Portable fire-extinguishing equipment of approved types shall be furnished and maintained in temporary membrane structures in such quantity and in such locations as directed by the authority having jurisdiction.

11.10.4 Tensioned-Membrane Structures.

11.10.4.1 The design, materials, and construction of the building shall be based on plans and specifications prepared by a licensed architect or engineer knowledgeable in tensioned-membrane construction.

11.10.4.2 Material loads and strength shall be based on physical properties of the materials verified and certified by an approved testing laboratory.

11.10.4.3 The membrane roof for structures in climates subject to freezing temperatures and ice buildup shall be composed of two layers separated by an air space through which heated air can be moved to guard against ice accumulation. As an alternative to the two layers, other approved methods that protect against ice accumulation shall be permitted.

11.10.4.4 Roof drains shall be equipped with electrical elements to protect against ice buildup that can prevent the drains from functioning. Such heating elements shall be served by on-site standby electrical power in addition to the normal public service. As an alternative to such electrical elements, other approved methods that protect against ice accumulation shall be permitted.

11.10.5 Air-Supported and Air-Inflated Structures.

11.10.5.1 General. In addition to the general provisions of 11.10.1, the requirements of 11.10.5 shall apply to air-supported and air-inflated structures.

11.10.5.2 Pressurization (Inflation) System. The pressurization system shall consist of one or more operating blower units. The system shall include automatic control of auxiliary blower units to maintain the required operating pressure. Such equipment shall meet the following requirements:

(1) Blowers shall be powered by continuous-rated motors at the maximum power required.
(2) Blowers shall have personnel protection, such as inlet screens and belt guards.
(3) Blower systems shall be weather protected.
(4) Blower systems shall be equipped with backdraft check dampers.
(5) Not less than two blower units shall be provided, each of which has capacity to maintain full inflation pressure with normal leakage.
(6) Blowers shall be designed to be incapable of overpressurization.
(7) The auxiliary blower unit(s) shall operate automatically if there is any loss of internal pressure or if an operating blower unit becomes inoperative.
(8) The design inflation pressure and the capacity of each blower system shall be certified by a professional engineer.

11.10.5.3 Standby Power System.

11.10.5.3.1 A fully automatic standby power system shall be provided. The system shall be either an auxiliary engine generator set capable of running the blower system or a supplementary blower unit that is sized for 1 times the normal operating capacity and is powered by an internal combustion engine.

11.10.5.3.2 The standby power system shall be fully automatic to ensure continuous inflation in the event of any failure of the primary power. The system shall be capable of operating continuously for a minimum of 4 hours.

11.10.5.3.3 The sizing and capacity of the standby power system shall be certified by a professional engineer.

11.10.6 Maintenance and Operation.

11.10.6.1 Instructions in both operation and maintenance shall be transmitted to the owner by the manufacturer of the tensioned-membrane, air-supported, or air-inflated structure.

11.10.6.2 Annual inspection and required maintenance of each structure shall be performed to ensure safety conditions. At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

11.10.7 Services.

11.10.7.1 Fired Heaters.

11.10.7.1.1 Only labeled heating devices shall be used.

11.10.7.1.2 Fuel-fired heaters and their installation shall be approved by the authority having jurisdiction.

11.10.7.1.3 Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any temporary membrane structure and shall be in accordance with the provisions of NFPA 58, *Liquefied Petroleum Gas Code*.

11.10.7.1.4 Tanks shall be secured in the upright position and protected from vehicular traffic.

11.10.7.2 Electric Heaters.

11.10.7.2.1 Only labeled heaters shall be permitted.

11.10.7.2.2 Heaters used inside a temporary membrane structure shall be approved.

11.10.7.2.3 Heaters shall be connected to electricity by electric cable that is suitable for outside use and is of sufficient size to handle the electrical load.

11.11 Tents.

11.11.1 General.

11.11.1.1 The provisions of Section 11.1 shall apply.

11.11.1.2 Tents shall be permitted only on a temporary basis.

11.11.1.3 Tents shall be erected to cover not more than 75 percent of the premises, unless otherwise approved by the authority having jurisdiction.

11.11.2 Flame Propagation Performance.

11.11.2.1 All tent fabric shall meet the flame propagation performance criteria contained in Test Method 2 of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.

11.11.2.2 One of the following shall serve as evidence that the tent fabric materials have the required flame propagation performance:

(1) The authority having jurisdiction shall require a certificate or other evidence of acceptance by an organization acceptable to the authority having jurisdiction.
(2) The authority having jurisdiction shall require a report of tests made by other inspection authorities or organizations acceptable to the authority having jurisdiction.

11.11.2.3 Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material, which shall have been affixed at the time of manufacture to the exterior of the tent.

11.11.3 Location and Spacing.

11.11.3.1 There shall be a minimum of 10 ft (3050 mm) between stake lines.

11.11.3.2 Adjacent tents shall be spaced to provide an area to be used as a means of emergency egress. Where 10 ft (3050 mm) between stake lines does not meet the requirements for means of egress, the distance necessary for means of egress shall govern.

11.11.3.3 Tents not occupied by the public and not used for the storage of combustible material shall be permitted to be erected less than 10 ft (3050 mm) from other structures where the authority having jurisdiction deems such close spacing to be safe from hazard to the public.

11.11.3.4 Tents, each not exceeding 1200 ft^2 (112 m^2) in finished ground level area and located in fairgrounds or similar open spaces, shall not be required to be separated from each other, provided that safety precautions meet the approval of the authority having jurisdiction.

11.11.3.5 The placement of tents relative to other structures shall be at the discretion of the authority having jurisdiction, with consideration given to occupancy, use, opening, exposure, and other similar factors.

11.11.4 Fire Hazards.

11.11.4.1 The finished ground level enclosed by any tent, and the finished ground level for a reasonable distance, but for not less than 10 ft (3050 mm) outside of such a tent, shall be cleared of all flammable or combustible material or vegetation that is not used for necessary support equipment. The clearing work shall be accomplished to the satisfaction of the authority having jurisdiction prior to the erection of such a tent. The premises shall be kept free from such flammable or combustible materials during the period for which the premises are used by the public.

11.11.4.2 Smoking.

11.11.4.2.1 Smoking shall not be permitted in any tent, unless approved by the authority having jurisdiction.

11.11.4.2.2 In rooms or areas where smoking is prohibited, plainly visible signs shall be posted that read as follows:

NO SMOKING

11.11.5 Fire-Extinguishing Equipment. Portable fire-extinguishing equipment of approved types shall be furnished and maintained in tents in such quantity and in such locations as directed by the authority having jurisdiction.

11.11.6 Services.

11.11.6.1 Fired Heaters.

11.11.6.1.1 Only labeled heating devices shall be used.

11.11.6.1.2 Fuel-fired heaters and their installation shall be approved by the authority having jurisdiction.

11.11.6.1.3 Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any tent and shall be in accordance with the provisions of NFPA 58, *Liquefied Petroleum Gas Code*.

11.11.6.1.4 Tanks shall be secured in the upright position and protected from vehicular traffic.

11.11.6.2 Electric Heaters.

11.11.6.2.1 Only labeled heaters shall be permitted.

11.11.6.2.2 Heaters used inside a tent shall be approved.

11.11.6.2.3 Heaters shall be connected to electricity by electric cable that is suitable for outside use and is of sufficient size to handle the electrical load.

Chapter 12 New Assembly Occupancies

12.1 General Requirements.

12.1.1 Application.

12.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as an assembly occupancy. *(See 1.3.1.)*

12.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

12.1.1.3 General. The provisions of Chapter 4, General, shall apply.

12.1.2* Classification of Occupancy. See 6.1.2.

12.1.3 Multiple Occupancies.

12.1.3.1 General. Multiple occupancies shall be in accordance with 6.1.14.

12.1.3.2 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

12.1.3.3* Simultaneous Occupancy. Exits shall be sufficient for simultaneous occupancy of both the assembly occupancy and other parts of the building, except where the authority having jurisdiction determines that the conditions are such that simultaneous occupancy will not occur.

12.1.3.4 Assembly and Mercantile Occupancies in Mall Buildings.

12.1.3.4.1 The provisions of Chapter 12 shall apply to the assembly occupancy tenant space.

12.1.3.4.2 The provisions of 36.4.4 shall be permitted to be used outside the assembly occupancy tenant space.

12.1.4 Definitions.

12.1.4.1 General. For definitions, see Chapter 3, Definitions.

12.1.4.2* Special Definitions. The following is a list of special terms used in this chapter :

(1) **Aisle Accessway.** *(See 3.3.11.)*
(2) **Aisle Stair.** *(See 3.3.265.1.)*
(3) **Exhibit.** *(See 3.3.79.)*
(4) **Exhibitor.** *(See 3.3.80.)*
(5) **Exposition.** *(See 3.3.86.)*
(6) **Exposition Facility.** *(See 3.3.90.1.)*
(7) **Festival Seating.** *(See 3.3.239.1.)*
(8) **Flow Time.** *(See 3.3.117.)*
(9) **Fly Gallery.** *(See 3.3.118.)*
(10) **Gridiron.** *(See 3.3.128.)*
(11) **Legitimate Stage.** *(See 3.3.264.1.)*
(12) **Life Safety Evaluation.** *(See 3.3.160.)*
(13) **Multilevel Play Structure.** *(See 3.3.272.5.)*
(14) **Multipurpose Assembly Occupancy.** *(See 3.3.190.2.1.)*
(15) **Pinrail.** *(See 3.3.210.)*
(16) **Platform.** *(See 3.3.211.)*
(17) **Proscenium Wall.** *(See 3.3.288.2.)*
(18) **Regular Stage.** *(See 3.3.264.2.)*
(19) **Smoke-Protected Assembly Seating.** *(See 3.3.239.4.)*
(20) **Special Amusement Building.** *(See 3.3.36.10.)*
(21) **Stage.** *(See 3.3.264.)*
(22) **Temporary Platform.** *(See 3.3.211.1.)*

12.1.5 Classification of Hazard of Contents. Contents of assembly occupancies shall be classified in accordance with the provisions of Section 6.2.

12.1.6 Minimum Construction Requirements. Assembly occupancies shall be limited to the building construction types specified in Table 12.1.6, based on the number of stories in height as defined in 4.6.3, unless otherwise permitted by the following *(see 8.2.1)*:

(1) This requirement shall not apply to outdoor grandstands of Type I or Type II construction.
(2) This requirement shall not apply to outdoor grandstands of Type III, Type IV, or Type V construction that meet the requirements of 12.4.9.

(3) This requirement shall not apply to grandstands of noncombustible construction supported by the floor in a building meeting the construction requirements of Table 12.1.6.
(4) This requirement shall not apply to assembly occupancies within mall buildings in accordance with 36.4.4.

12.1.7 Occupant Load.

12.1.7.1* General. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

12.1.7.1.1 In areas not in excess of 10,000 ft^2 (930 m^2), the occupant load shall not exceed one person in 5 ft^2 (0.46 m^2).

12.1.7.1.2 In areas in excess of 10,000 ft^2 (930 m^2), the occupant load shall not exceed one person in 7 ft^2 (0.65 m^2).

12.1.7.2 Waiting Spaces. In theaters and other assembly occupancies where persons are admitted to the building at times when seats are not available, or when the permitted occupant load has been reached based on 12.1.7.1 and persons are allowed to wait in a lobby or similar space until seats or space is available, all of the following requirements shall apply:

(1) Such use of a lobby or similar space shall not encroach upon the required clear width of exits.
(2) The waiting spaces shall be restricted to areas other than the required means of egress.
(3) Exits shall be provided for the waiting spaces on the basis of one person for each 3 ft^2 (0.28 m^2) of waiting space area.
(4) Exits for waiting spaces shall be in addition to the exits specified for the main auditorium area and shall conform in construction and arrangement to the general rules for exits given in this chapter.

12.1.7.3 Life Safety Evaluation. Where the occupant load of an assembly occupancy exceeds 6000, a life safety evaluation shall be performed in accordance with 12.4.1.

12.1.7.4 Outdoor Facilities. In outdoor facilities, where approved by the authority having jurisdiction, the number of occupants who are each provided with not less than 15 ft^2 (1.4 m^2) of lawn surface shall be permitted to be excluded from the maximum occupant load of 6000 of 12.1.7.3 in determining the need for a life safety evaluation.

12.2 Means of Egress Requirements.

12.2.1 General. All means of egress shall be in accordance with Chapter 7 and this chapter.

12.2.2 Means of Egress Components.

12.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 12.2.2.2 through 12.2.2.12.

12.2.2.2 Doors.

12.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

12.2.2.2.2 Assembly occupancies with occupant loads of 300 or less in malls *(see 36.4.4.4.2(4)* shall be permitted to have horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) on the main entrance/exits.

12.2.2.2.3 Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to delayed-egress locks as permitted in 12.2.2.2.5.
(2) This requirement shall not apply to access-controlled egress doors as permitted in 12.2.2.2.6.

12.2.2.2.4 Locking devices complying with 7.2.1.5.5 shall be permitted to be used on a single door or a single pair of doors if both of the following conditions apply:

(1) The door or pair of doors serve as the main exit and the assembly occupancy has an occupant load not greater than 500.
(2) Any latching devices on such a door(s) from an assembly occupancy having an occupant load of 100 or more are released by panic hardware or fire exit hardware.

12.2.2.2.5 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted on doors other than main entrance/exit doors.

12.2.2.2.6 Doors in the means of egress shall be permitted to be equipped with an approved access control system complying with 7.2.1.6.2, and such doors shall not be locked from the egress side when the assembly occupancy is occupied. *(See 7.2.1.1.3.)*

12.2.2.2.7 Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

12.2.2.2.8 Revolving doors complying with the requirements of 7.2.1.10 shall be permitted.

12.2.2.2.9 The provisions of 7.2.1.11.1.1 to permit turnstiles where revolving doors are permitted shall not apply.

12.2.2.2.10 No turnstiles or other devices that restrict the movement of persons shall be installed in any assembly occupancy in such a manner as to interfere with required means of egress facilities.

12.2.2.3 Stairs.

12.2.2.3.1 General. Stairs complying with 7.2.2 shall be permitted, unless one of the following criteria applies:

(1)*Stairs serving seating that is designed to be repositioned shall not be required to comply with 7.2.2.3.1.
(2) This requirement shall not apply to stages and platforms as permitted by 12.4.6.1.2.
(3) The stairs connecting only a stage or platform and the immediately adjacent assembly seating shall be permitted to have a handrail in the center only or on one side only.
(4) The stairs connecting only a stage or platform and the immediately adjacent assembly seating shall be permitted to omit the guards required by 7.1.8 where both of the following criteria are met:
    (a) The guard would restrict audience sight lines to the stage or platform.
    (b) The height between any part of the stair and the adjacent floor is not more than 42 in. (1065 mm).

12.2.2.3.2 Catwalk, Gallery, and Gridiron Stairs.

12.2.2.3.2.1 Noncombustible grated stair treads and landing floors shall be permitted in means of egress from lighting and access catwalks, galleries, and gridirons.

12.2.2.3.2.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted in means of egress from lighting and access catwalks, galleries, and gridirons.

Table 12.1.6 Construction Type Limitations

Construction Type	Sprinklered[a]	Stories Below	Stories in Height[b] 1	2	3	4	≥5
I (442)[c, d, e]	Yes	X	X	X	X	X	X
	No	NP	X4	X4	X4	X4	X4
I (332)[c, d, e]	Yes	X	X	X	X	X	X
	No	NP	X4	X4	X4	X4	X4
II (222)[c, d, e]	Yes	X	X	X	X	X	X
	No	NP	X4	X4	X4	X4	X4
II (111)[c, d, e]	Yes	X1	X	X	X	X3	NP
	No	NP	X4	X4	X4	NP	NP
II (000)	Yes	X2	X	X4	NP	NP	NP
	No	NP	X4	NP	NP	NP	NP
III (211)[d]	Yes	X1	X	X	X	X3	NP
	No	NP	X4	X4	X4	NP	NP
III (200)	Yes	X2	X3	X4	NP	NP	NP
	No	NP	X4	NP	NP	NP	NP
IV (2HH)	Yes	X1	X	X	X	X3	NP
	No	NP	X4	X4	X4	NP	NP
V (111)	Yes	X1	X	X	X	X3	NP
	No	NP	X4	X4	X4	NP	NP
V (000)	Yes	X2	X3	X4	NP	NP	NP
	No	NP	X4	NP	NP	NP	NP

X: Permitted for assembly of any occupant load.

X1: Permitted for assembly of any occupant load, but limited to one story below the level of exit discharge.

X2: Permitted for assembly limited to an occupant load of 1000 or less, and limited to one story below the level of exit discharge.

X3: Permitted for assembly limited to an occupant load of 1000 or less.

X4: Permitted for assembly limited to an occupant load of 300 or less.

NP: Not permitted.

[a]Protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 in the following locations:

(1) Throughout the story of the assembly occupancy

(2) Throughout all stories below the story of the assembly occupancy, including all stories below the level of exit discharge

(3) In the case of an assembly occupancy located below the level of exit discharge, throughout all stories intervening between the story of the assembly occupancy and the level of exit discharge, including the level of exit discharge

[b] See 4.6.3.

[c]Where every part of the structural framework of roofs in Type I or Type II construction is 20 ft (6100 mm) or more above the floor immediately below, omission of all fire protection of the structural members is permitted, including protection of trusses, roof framing, decking, and portions of columns above 20 ft (6100 mm).

[d]In open-air fixed seating facilities, including stadia, omission of fire protection of structural members exposed to the outside atmosphere is permitted where substantiated by an approved engineering analysis.

[e]Where seating treads and risers serve as floors, such seating treads and risers are permitted to be of 1-hour fire resistance–rated construction. Structural members supporting seating treads and risers are required to conform to the requirements of Table 12.1.6. Joints between seating tread and riser units are permitted to be unrated, provided that such joints do not involve separation from areas containing high hazard contents and the facility is constructed and operated in accordance with 12.4.2.

12.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

12.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

12.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted, and the following alternatives shall also apply:

(1) Ramps not part of an accessible means of egress and serving only stages or nonpublic areas shall be permitted to have a slope not steeper than 1 in 8.
(2) Ramped aisles not part of an accessible means of egress shall be permitted to have a slope not steeper than 1 in 8.

12.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

12.2.2.8 Reserved.

12.2.2.9 Reserved.

12.2.2.10 Fire Escape Ladders.

12.2.2.10.1 Fire escape ladders complying with 7.2.9 shall be permitted.

12.2.2.10.2 For ladders serving catwalks, the three-person limitation in 7.2.9.1(3) shall be permitted to be increased to ten persons.

12.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

12.2.2.12 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

12.2.3 Capacity of Means of Egress.

12.2.3.1 General. The capacity of means of egress shall be in accordance with one of the following:

(1) Section 7.3 for other than theater-type seating or smoke-protected assembly seating
(2) 12.2.3.2 for rooms with theater-type seating or similar seating arranged in rows
(3) 12.4.2 for smoke-protected assembly seating

12.2.3.2* Theater-Type Seating. Minimum clear widths of aisles and other means of egress serving theater-type seating, or similar seating arranged in rows, shall be in accordance with Table 12.2.3.2.

Table 12.2.3.2 Capacity Factors

	Clear Width per Seat Served			
	Stairs		Passageways, Ramps, and Doorways	
No. of Seats	in.	mm	in.	mm
Unlimited	0.3 *AB*	7.6 *AB*	0.22 *C*	5.6 *C*

12.2.3.3 Width Modifications. The minimum clear widths shown in Table 12.2.3.2 shall be modified in accordance with all of the following:

(1) If risers exceed 7 in. in height, the stair width in Table 12.2.3.2 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 7}{5} \qquad \textbf{[12.2.3.3(1)]}$$

(2) If risers exceed 178 mm in height, the stair width in Table 12.2.3.2 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 178}{125} \qquad \textbf{[12.2.3.3(2)]}$$

(3) Stairs not having a handrail within a 30 in. (760 mm) horizontal distance shall be 25 percent wider than otherwise calculated; that is, their width shall be multiplied by factor *B*, where *B* equals the following:

$$B = 1.25 \qquad \textbf{[12.2.3.3(3)]}$$

(4) Ramps steeper than 1 in 10 slope where used in ascent shall have their width increased by 10 percent; that is, their width shall be multiplied by factor *C*, where *C* equals the following:

$$C = 1.10 \qquad \textbf{[12.2.3.3(4)]}$$

12.2.3.4 Lighting and Access Catwalks. The requirements of 12.2.3.2 and 12.2.3.3 shall not apply to lighting and access catwalks as permitted by 12.4.6.9.

12.2.3.5 Reserved.

12.2.3.6 Main Entrance/Exit.

12.2.3.6.1 Every assembly occupancy shall be provided with a main entrance/exit.

12.2.3.6.2 The main entrance/exit width shall be as follows:

(1) The main entrance/exit shall be of a width that accommodates two-thirds of the total occupant load in the following assembly occupancies:
  (a) Dance halls
  (b) Discotheques
  (c) Nightclubs
  (d) Assembly occupancies with festival seating
(2) In assembly occupancies, other than those listed in 12.2.3.6.2(1), the main entrance/exit shall be of a width that accommodates one-half of the total occupant load.

12.2.3.6.3 The main entrance/exit shall be at the level of exit discharge or shall connect to a stairway or ramp leading to a street.

12.2.3.6.4 Access to the main entrance/exit shall be as follows:

(1) Each level of the assembly occupancy shall have access to the main entrance/exit, and such access shall have the capacity to accommodate two-thirds of the occupant load of such levels in the following assembly occupancies:
  (a) Dance halls
  (b) Discotheques
  (c) Nightclubs
  (d) Assembly occupancies with festival seating
(2) In assembly occupancies, other than those listed in 12.2.3.6.4(1), each level of the assembly occupancy shall have access to the main entrance/exit, and such access shall have the capacity to accommodate one-half of the occupant load of such levels.

12.2.3.6.5 Where the main entrance/exit from an assembly occupancy is through a lobby or foyer, the aggregate capacity of all exits from the lobby or foyer shall be permitted to provide the required capacity of the main entrance/exit, regardless of whether all such exits serve as entrances to the building.

12.2.3.6.6* In assembly occupancies where there is no well-defined main entrance/exit, exits shall be permitted to be distributed around the perimeter of the building, provided that the total exit width furnishes not less than 100 percent of the width needed to accommodate the permitted occupant load.

12.2.3.7 Other Exits. Each level of an assembly occupancy shall have access to the main entrance/exit and shall be provided with additional exits of a width to accommodate not less than one-half of the total occupant load served by that level.

12.2.3.7.1 Additional exits shall discharge in accordance with 12.2.7.

12.2.3.7.2 Additional exits shall be located as far apart as practicable and as far from the main entrance/exit as practicable.

12.2.3.7.3 Additional exits shall be accessible from a cross aisle or a side aisle.

12.2.3.7.4 In assembly occupancies where there is no well-defined main entrance/exit, exits shall be permitted to be distributed around the perimeter of the building, provided that the total exit width furnishes not less than 100 percent of the width required to accommodate the permitted occupant load.

12.2.3.8 Minimum Corridor Width. The width of any exit access corridor serving 50 or more persons shall be not less than 44 in. (1120 mm).

12.2.4* Number of Means of Egress.

12.2.4.1 The number of means of egress shall be in accordance with Section 7.4, other than exits for fenced outdoor assembly occupancies in accordance with 12.2.4.4.

12.2.4.2 Reserved.

12.2.4.3 Reserved.

12.2.4.4 A fenced outdoor assembly occupancy shall have not less than two remote means of egress from the enclosure in accordance with 7.5.1.3, unless otherwise required by one of the following:

(1) If more than 6000 persons are to be served by such means of egress, there shall be not less than three means of egress.
(2) If more than 9000 persons are to be served by such means of egress, there shall be not less than four means of egress.

12.2.4.5 Balconies or mezzanines having an occupant load not exceeding 50 shall be permitted to be served by a single means of egress, and such means of egress shall be permitted to lead to the floor below.

12.2.4.6 Balconies or mezzanines having an occupant load exceeding 50, but not exceeding 100, shall have not less than two remote means of egress, but both such means of egress shall be permitted to lead to the floor below.

12.2.4.7 Balconies or mezzanines having an occupant load exceeding 100 shall have means of egress as described in 7.4.1.

12.2.4.8 A second means of egress shall not be required from lighting and access catwalks, galleries, and gridirons where a means of escape to a floor or a roof is provided. Ladders, alternating tread devices, or spiral stairs shall be permitted in such means of escape.

12.2.5 Arrangement of Means of Egress.

12.2.5.1 General.

12.2.5.1.1 Means of egress shall be arranged in accordance with Section 7.5.

12.2.5.1.2 A common path of travel shall be permitted for the first 20 ft (6100 mm) from any point where the common path serves any number of occupants, and for the first 75 ft (23 m) from any point where the common path serves not more than 50 occupants.

12.2.5.1.3 Dead-end corridors shall not exceed 20 ft (6100 mm).

12.2.5.2 Access Through Hazardous Areas. Means of egress from a room or space for assembly purposes shall not be permitted through kitchens, storerooms, restrooms, closets, platforms, stages, projection rooms, or hazardous areas as described in 12.3.2.

12.2.5.3 Auditorium and Arena Floors. Where the floor area of auditoriums and arenas is used for assembly occupancy activities/events, not less than 50 percent of the occupant load shall have means of egress provided without passing through adjacent fixed seating areas.

12.2.5.4 General Requirements for Access and Egress Routes Within Assembly Areas.

12.2.5.4.1 Festival seating, as defined in 3.3.239.1, shall be prohibited within a building, unless otherwise permitted by one of the following:

(1) Festival seating shall be permitted in assembly occupancies having occupant loads of 250 or less.
(2) Festival seating shall be permitted in assembly occupancies where occupant loads exceed 250, provided that an approved life safety evaluation has been performed. *(See 12.4.1.)*

12.2.5.4.2* Access and egress routes shall be maintained so that any individual is able to move without undue hindrance, on personal initiative and at any time, from an occupied position to the exits.

12.2.5.4.3* Access and egress routes shall be maintained so that crowd management, security, and emergency medical personnel are able to reach any individual at any time, without undue hindrance.

12.2.5.4.4* The width of aisle accessways and aisles shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle accessway or aisle in accordance with 12.2.3.2, or for smoke-protected assembly seating in accordance with 12.4.2.

12.2.5.4.5 Where aisle accessways or aisles converge to form a single path of egress travel, the required egress capacity of that path shall be not less than the combined required capacity of the converging aisle accessways and aisles.

12.2.5.4.6 Those portions of aisle accessways and aisles where egress is possible in either of two directions shall be uniform in required width, unless otherwise permitted by 12.2.5.4.7.

12.2.5.4.7 The requirement of 12.2.5.4.6 shall not apply to those portions of aisle accessways where the required width, not including the seat space described by 12.2.5.7.3, does not exceed 12 in. (305 mm).

12.2.5.4.8 In the case of side boundaries for aisle accessways or aisles, other than those for nonfixed seating at tables, the clear width shall be measured to boundary elements such as walls, guardrails, handrails, edges of seating, tables, and side edges of treads, and said measurement shall be made horizontally to the vertical projection of the elements, resulting in the smallest width measured perpendicularly to the line of travel.

12.2.5.5* Aisle Accessways Serving Seating Not at Tables.

12.2.5.5.1* The required clear width of aisle accessways between rows of seating shall be determined as follows:

(1) Horizontal measurements shall be made, between vertical planes, from the back of one seat to the front of the most forward projection of the seat immediately behind it.
(2) Where the entire row consists of automatic- or self-rising seats that comply with ASTM F 851, *Standard Test Method for Self-Rising Seat Mechanisms*, the measurement shall be permitted to be made with the seats in the up position.

12.2.5.5.2 The aisle accessway between rows of seating shall have a clear width of not less than 12 in. (305 mm), and this minimum shall be increased as a function of row length in accordance with 12.2.5.5.4, 12.2.5.5.5, and 12.2.5.5.6.

12.2.5.5.3 If used by not more than four persons, no minimum clear width shall be required for the portion of an aisle accessway having a length not exceeding 6 ft (1830 mm), measured from the center of the seat farthest from the aisle.

12.2.5.5.4 The increase in aisle accessway width required by 12.2.5.5.2 shall not apply to grandstands, bleachers, and folding and telescopic seating, provided that the number of seats between the farthest seat and an aisle does not exceed that shown in Table 12.4.9.2.5.

12.2.5.5.5* Rows of seating served by aisles or doorways at both ends shall not exceed 100 seats per row.

12.2.5.5.5.1 The 12 in. (305 mm) minimum clear width of aisle accessway specified in 12.2.5.5.2 shall be increased by 0.3 in. (7.6 mm) for every seat over a total of 14 but shall not be required to exceed 22 in. (560 mm).

12.2.5.5.5.2 The requirement of 12.2.5.5.5.1 shall not apply to smoke-protected assembly seating as permitted by 12.4.2.7.

12.2.5.5.6 Rows of seating served by an aisle or doorway at one end only shall have a path of travel not exceeding 30 ft (9.1 m) in length from any seat to an aisle.

12.2.5.5.6.1 The 12 in. (305 mm) minimum clear width of aisle accessway specified in 12.2.5.5.2 shall be increased by 0.6 in. (15 mm) for every seat over a total of seven.

12.2.5.5.6.2 The requirements of 12.2.5.5.5 and 12.2.5.5.5.1 shall not apply to smoke-protected assembly seating as permitted by 12.4.2.8 and 12.4.2.9.

12.2.5.5.7 Rows of seating using tablet-arm chairs shall be permitted only if the clear width of aisle accessways complies with the requirements of 12.2.5.5 when measured under one of the following conditions:

(1) The clear width is measured with the tablet arm in the usable position.
(2) The clear width is measured with the tablet arm in the stored position where the tablet arm automatically returns to the stored position when raised manually to a vertical position in one motion and falls to the stored position by force of gravity.

12.2.5.5.8 The depth of seat boards shall be not less than 9 in. (230 mm) where the same level is not used for both seat boards and footboards.

12.2.5.5.9 Footboards, independent of seats, shall be provided so that there is no horizontal opening that allows the passage of a ½ in. (13 mm) diameter sphere.

12.2.5.6 Aisles Serving Seating Not at Tables.

12.2.5.6.1 General.

12.2.5.6.1.1 Aisles shall be provided so that the number of seats served by the nearest aisle is in accordance with 12.2.5.5.2 through 12.2.5.5.5, unless otherwise permitted by 12.2.5.6.1.2.

12.2.5.6.1.2 Aisles shall not be required in bleachers, provided that all of the following conditions are met:

(1) Egress from the front row shall not be obstructed by a rail, a guard, or other obstruction.
(2) The row spacing shall be 28 in. (710 mm) or less.
(3) The rise per row, including the first row, shall be 6 in. (150 mm) or less.
(4) The number of rows shall not exceed 16.
(5) The seat spaces shall not be physically defined.
(6) Seat boards that are also used as stepping surfaces for descent shall provide a walking surface with a width not less than 12 in. (305 mm), and, where a depressed footboard exists, the gap between seat boards of adjacent rows shall not exceed 12 in. (305 mm), measured horizontally.
(7) The leading edges of seat boards used as stepping surfaces shall be provided with a contrasting marking stripe so that the location of the leading edge is readily apparent, particularly where viewed in descent, and the following shall also apply:
    (a) The marking stripe shall be not less than 1 in. (25 mm) wide and shall not exceed 2 in. (51 mm) in width.
    (b) The marking stripe shall not be required where bleacher surfaces and environmental conditions, under all conditions of use, are such that the location of each leading edge is readily apparent, particularly when viewed in descent.

12.2.5.6.2 Dead-End Aisles. Dead-end aisles shall not exceed 20 ft (6100 mm) in length, unless otherwise permitted by one of the following:

(1) A dead-end aisle shall be permitted to exceed 20 ft (6100 mm) in length where seats served by the dead-end aisle are not more than 24 seats from another aisle, measured along a row of seats having a clear width of not less than 12 in. (305 mm) plus 0.6 in. (15 mm) for each additional seat over a total of 7 in the row.
(2) A 16-row, dead-end aisle shall be permitted in folding and telescopic seating and grandstands.
(3) Aisle termination in accordance with 12.4.2.11 for smoke-protected assembly seating shall be permitted.

12.2.5.6.3* Minimum Aisle Width. The minimum clear width of aisles shall be sufficient to provide egress capacity in accordance with 12.2.3.1 but shall be not less than the following:

(1) 48 in. (1220 mm) for stairs having seating on each side, or 36 in. (915 mm) where the aisle does not serve more than 50 seats

(2) 36 in. (915 mm) for stairs having seating on only one side
(3) 23 in. (585 mm) between a handrail and seating, or between a guardrail and seating where the aisle is subdivided by a handrail
(4) 42 in. (1065 mm) for level or ramped aisles having seating on both sides, or 36 in. (915 mm) where the aisle does not serve more than 50 seats
(5) 36 in. (915 mm) for level or ramped aisles having seating on only one side
(6) 23 in. (585 mm) between a handrail or a guardrail and seating where the aisle does not serve more than five rows on one side

12.2.5.6.4 Aisle Stairs and Aisle Ramps.

12.2.5.6.4.1* The following shall apply to aisle stairs and aisle ramps:

(1) Aisles having a gradient steeper than 1 in 20, but not steeper than 1 in 8, shall consist of an aisle ramp.
(2) Aisles having a gradient steeper than 1 in 8 shall consist of an aisle stair.

12.2.5.6.4.2 Aisle stairs shall comply with 7.2.2 except as otherwise addressed by this chapter.

12.2.5.6.4.3 Table 7.2.2.2.1.1(a) and Table 7.2.2.2.1.1(b) shall not apply to aisle stairs.

12.2.5.6.5 Aisle Stair Treads. Aisle stair treads shall meet all of the following criteria:

(1) There shall be no variation in the depth of adjacent treads that exceeds 3⁄16 in. (4.8 mm), unless otherwise permitted by 12.2.5.6.5(2).
(2) Construction-caused nonuniformities in tread depth shall be permitted, provided that both of the following criteria are met:
    (a) The nonuniformity does not exceed 3⁄8 in. (10 mm).
    (b) The aisle tread depth is 22 in. (560 mm) or greater.
(3)*Tread depth shall be not less than 11 in. (280 mm).
(4) All treads shall extend the full width of the aisle.

12.2.5.6.6 Aisle Stair Risers. Aisle stair risers shall meet all of the following criteria:

(1) Riser heights shall be not less than 4 in. (100 mm) in aisle stairs, unless aisle stairs are those in folding and telescopic seating.
(2) The riser height of aisle stairs in folding and telescopic seating shall be permitted to be not less than 3½ in. (90 mm).
(3) Riser heights shall not exceed 8 in. (205 mm), unless otherwise permitted by 12.2.5.6.6(4) or 12.2.5.6.6(5).
(4) The riser height of aisle stairs in folding and telescopic seating shall be permitted to be not more than 11 in. (280 mm).
(5) Where the gradient of an aisle is steeper than 8 in. (205 mm) in rise in 11 in. (280 mm) of run for the purpose of maintaining necessary sight lines in the adjoining seating area, the riser height shall be permitted to exceed 8 in. (205 mm) but shall not exceed 9 in. (230 mm).
(6) Riser heights shall be designed to be uniform in each aisle, and the construction-caused nonuniformities shall not exceed 3⁄16 in. (4.8 mm) between adjacent risers, unless the conditions of 12.2.5.6.6(7) or 12.2.5.6.6(8) are met.
(7) Riser height shall be permitted to be nonuniform where both of the following criteria are met:
    (a) The nonuniformity shall be only for the purpose of accommodating changes in gradient necessary to maintain sight lines within a seating area, in which case the nonuniformity shall be permitted to exceed 3⁄16 in. (4.8 mm) but shall not be greater than ½ in. (13 mm) between adjacent risers.
    (b) **Reserved.**
    (c) Where nonuniformities exceed 3⁄16 in. (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated by a distinctive marking stripe on each tread at the nosing or leading edge adjacent to the nonuniform risers.
(8) Construction-caused nonuniformities in riser height shall be permitted to exceed 3⁄16 in. (4.8 mm) where all of the following criteria are met:
    (a) The riser height shall be designed to be nonuniform.
    (b) The construction-caused nonuniformities shall not exceed 3⁄8 in. (10 mm) where the aisle tread depth is less than 22 in. (560 mm).
    (c) The construction-caused nonuniformities shall not exceed ¾ in. (19 mm) where the aisle tread depth is 22 in. (560 mm) or greater.
    (d) Where nonuniformities exceed 3⁄16 in. (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated by a distinctive marking stripe on each tread at the nosing or leading edge adjacent to the nonuniform risers.

12.2.5.6.7 Aisle Stair Profile. Aisle stairs shall comply with all of the following:

(1) Aisle risers shall be vertical or sloped under the tread projection at an angle not to exceed 30 degrees from vertical.
(2) Tread projection not exceeding 1½ in. (38 mm) shall be permitted.
(3) Tread projection shall be uniform in each aisle, except as otherwise permitted by 12.2.5.6.7(4).
(4) Construction-caused projection nonuniformities not exceeding ¼ in. (6.4 mm) shall be permitted.

12.2.5.6.8 Aisle Landings. Where the path of travel on a stair, an aisle stair, or aisle ramp continues to another stair of different rise or tread depth, another aisle stair of different rise or tread depth, or another aisle ramp of different slope, there shall be a landing whose depth is equal to or greater than the width of the aisle stair or ramp, unless otherwise permitted by one of the following:

(1) No landing shall be required within aisle stairs with nonuniform risers, as permitted by 12.2.5.6.6(7).
(2) No landing shall be required between aisle ramps of different slopes.
(3) No landing shall be required between an aisle ramp and an aisle accessway or between an aisle stair and an aisle accessway.
(4) A minimum 30 in. (760 mm) deep landing shall be permitted between an aisle stair and a stair with the same tread depths or between an aisle stair and another aisle stair with the same tread depths.
(5) A minimum 30 in. (760 mm) deep landing shall be permitted between an aisle stair and a stair with greater tread depth in the descending direction and between an aisle stair and another aisle stair with greater tread depth in the descending direction.

(6) A minimum 30 in. (760 mm) deep landing shall be permitted between an aisle stair and a stair with less tread depth in the descending direction and between an aisle stair and another aisle stair with less tread depth in the descending direction.
(7) A minimum 22 in. (560 mm) deep landing shall be permitted between an aisle ramp and a stair and between an aisle ramp and an aisle stair.
(8) No landing depth shall be required to exceed 48 in. (1220 mm).

12.2.5.6.9* Aisle Handrails.

12.2.5.6.9.1 Ramped aisles having a gradient exceeding 1 in 20 and aisle stairs shall be provided with handrails at one side or along the centerline and shall also be in accordance with 7.2.2.4.5.1, 7.2.2.4.5.5, and 7.2.2.4.5.6.

12.2.5.6.9.2 Where seating exists on both sides of the aisle, the handrails shall be noncontinuous with gaps or breaks at intervals not exceeding five rows to facilitate access to seating and to allow crossing from one side of the aisle to the other.

12.2.5.6.9.3 The gaps or breaks permitted by 12.2.5.6.9.1 shall have a clear width of not less than 22 in. (560 mm) and shall not exceed 36 in. (915 mm), measured horizontally, and the handrail shall have rounded terminations or bends.

12.2.5.6.9.4 Where handrails are provided in the middle of aisle stairs, an additional intermediate rail shall be located approximately 12 in. (305 mm) below the main handrail.

12.2.5.6.9.5 Where an aisle transition stair does not have seating at its sides, a handrail shall be provided on both sides of the aisle, and the provision of 12.2.5.6.9.6 shall also apply.

12.2.5.6.9.6 Where an aisle stair leading to the aisle transition stair is provided with a center handrail and the aisle landing is less than 48 in. (1220 mm) in the direction of travel, a center handrail shall also be provided on the aisle transition stair.

12.2.5.6.9.7 Handrails shall not be required where otherwise permitted by one of the following:

(1) Handrails shall not be required for ramped aisles having a gradient not steeper than 1 in 8 and having seating on both sides where the aisle does not serve as an accessible route.
(2) The requirement for a handrail shall be satisfied by the use of a guard provided with a rail that complies with the graspability requirements for handrails and is located at a consistent height between 34 in. and 42 in. (865 mm and 1065 mm), measured as follows:
    (a) Vertically from the top of the rail to the leading edge (nosing) of stair treads
    (b) Vertically from the top of the rail to the adjacent walking surface in the case of a ramp

12.2.5.6.10* Aisle Marking.

12.2.5.6.10.1 A contrasting marking stripe shall be provided on each tread at the nosing or leading edge so that the location of such tread is readily apparent, particularly when viewed in descent.

12.2.5.6.10.2 The marking stripe shall be not less than 1 in. (25 mm) wide and shall not exceed 2 in. (51 mm) in width.

12.2.5.6.10.3 The marking stripe shall not be required where tread surfaces and environmental conditions, under all conditions of use, are such that the location of each tread is readily apparent, particularly when viewed in descent.

12.2.5.7* Aisle Accessways Serving Seating at Tables.

12.2.5.7.1 The required clear width of an aisle accessway shall be not less than 12 in. (305 mm) where measured in accordance with 12.2.5.7.3 and shall be increased as a function of length in accordance with 12.2.5.7.4, unless otherwise permitted by 12.2.5.7.2.

12.2.5.7.2* If used by not more than four persons, no minimum clear width shall be required for the portion of an aisle accessway having a length not exceeding 6 ft (1830 mm) and located farthest from an aisle.

12.2.5.7.3* Where nonfixed seating is located between a table and an aisle accessway or aisle, the measurement of required clear width of the aisle accessway or aisle shall be made to a line 19 in. (485 mm), measured perpendicularly to the edge of the table, away from the edge of said table.

12.2.5.7.4* The minimum required clear width of an aisle accessway, measured in accordance with 12.2.5.4.8 and 12.2.5.7.3, shall be increased beyond the 12 in. (305 mm) requirement of 12.2.5.7.1 by ½ in. (13 mm) for each additional 12 in. (305 mm) or fraction thereof beyond 12 ft (3660 mm) of aisle accessway length, where measured from the center of the seat farthest from an aisle.

12.2.5.7.5 The path of travel along the aisle accessway shall not exceed 36 ft (11 m) from any seat to the closest aisle or egress doorway.

12.2.5.8 Aisles Serving Seating at Tables.

12.2.5.8.1* Aisles that contain steps or that are ramped, such as aisles serving dinner theater–style configurations, shall comply with the requirements of 12.2.5.6.

12.2.5.8.2* The width of aisles serving seating at tables shall be not less than 44 in. (1120 mm) where serving an occupant load exceeding 50, and 36 in. (915 mm) where serving an occupant load of 50 or fewer.

12.2.5.8.3* Where nonfixed seating is located between a table and an aisle, the measurement of required clear width of the aisle shall be made to a line 19 in. (485 mm), measured perpendicularly to the edge of the table, away from the edge of said table.

12.2.5.9 Approval of Layouts.

12.2.5.9.1 Where required by the authority having jurisdiction, plans drawn to scale showing the arrangement of furnishings or equipment shall be submitted to the authority by the building owner, manager, or authorized agent to substantiate conformance with the provisions of 12.2.5.

12.2.5.9.2 The layout plans shall constitute the only acceptable arrangement, unless one of the following criteria is met:

(1) The plans are revised.
(2) Additional plans are submitted and approved.
(3) Temporary deviations from the specifications of the approved plans are used, provided that the occupant load is not increased and the intent of 12.2.5.9 is maintained.

12.2.6 Travel Distance to Exits.

12.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

12.2.6.2 Exits shall be arranged so that the total length of travel from any point to reach an exit shall not exceed 200 ft

(61 m) in any assembly occupancy, unless otherwise permitted by one of the following:

(1) The travel distance shall not exceed 250 ft (76 m) in assembly occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) The travel distance requirement shall not apply to smoke-protected assembly seating as permitted by 12.4.2.12, 12.4.2.13, and 12.4.2.14.

12.2.7 Discharge from Exits.

12.2.7.1 Exit discharge shall comply with Section 7.7.

12.2.7.2 The level of exit discharge shall be measured at the point of principal entrance to the building.

12.2.7.3 Where the principal entrance to an assembly occupancy is via a terrace, either raised or depressed, such terrace shall be permitted to be considered to be the first story in height for the purposes of Table 12.1.6 where all of the following criteria are met:

(1) The terrace is at least as long, measured parallel to the building, as the total width of the exit(s) it serves but not less than 60 in. (1525 mm) long.
(2) The terrace is at least as wide, measured perpendicularly to the building, as the exit(s) it serves but not less than 10 ft (3050 mm) wide.
(3) Required stairs leading from the terrace to the finished ground level are protected in accordance with 7.2.2.6.3 or are not less than 10 ft (3050 mm) from the building.

12.2.8 Illumination of Means of Egress. Means of egress, other than for private party tents not exceeding 1200 ft^2 (112 m^2), shall be illuminated in accordance with Section 7.8.

12.2.9 Emergency Lighting.

12.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9.

12.2.9.2 Private party tents not exceeding 1200 ft^2 (112 m^2) shall not be required to have emergency lighting.

12.2.10 Marking of Means of Egress.

12.2.10.1 Means of egress shall be provided with signs in accordance with Section 7.10.

12.2.10.2 Exit markings shall not be required on the seating side of vomitories from seating areas where exit marking is provided in the concourse and where such marking is readily apparent from the vomitories.

12.2.10.3 Evacuation diagrams in accordance with 7.10.8.5 shall be provided.

12.2.11 Special Means of Egress Features.

12.2.11.1 Guards and Railings.

12.2.11.1.1* Sight Line–Constrained Rail Heights. Unless subject to the requirements of 12.2.11.1.2, a fasciae or railing system complying with the guard requirements of 7.2.2.4, and having a height of not less than 26 in. (660 mm), shall be provided where the floor or footboard elevation is more than 30 in. (760 mm) above the floor or the finished ground level below, and where the fasciae or railing system would otherwise interfere with the sight lines of immediately adjacent seating.

12.2.11.1.2 At Foot of Aisles.

12.2.11.1.2.1 A fasciae or railing system complying with the guard requirements of 7.2.2.4 shall be provided for the full width of the aisle where the foot of the aisle is more than 30 in. (760 mm) above the floor or the finished ground level below.

12.2.11.1.2.2 The fasciae or railing shall be not less than 36 in. (915 mm) high and shall provide not less than 42 in. (1065 mm), measured diagonally, between the top of the rail and the nosing of the nearest tread.

12.2.11.1.3 At Cross Aisles. Guards and railings at cross aisles shall meet the following criteria:

(1) Cross aisles located behind seating rows shall be provided with railings not less than 26 in. (660 mm) above the adjacent floor of the aisle.
(2) The requirement of 12.2.11.1.3(1) shall not apply where the backs of seats located at the front of the aisle project 24 in. (610 mm) or more above the adjacent floor of the aisle.
(3) Where cross aisles exceed 30 in. (760 mm) above the floor or the finished ground level below, guards shall be provided in accordance with 7.2.2.4.

12.2.11.1.4 At Side and Back of Seating Areas. Guards complying with the guard requirements of 7.2.2.4 shall be provided with a height not less than 42 in. (1065 mm) above the aisle, aisle accessway, or footboard where the floor elevation exceeds 30 in. (760 mm) above the floor or the finished ground level to the side or back of seating.

12.2.11.1.5 Below Seating. Openings between footboards and seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

12.2.11.1.6 Locations Not Requiring Guards.

12.2.11.1.6.1 Guards shall not be required in the following locations:

(1) On the audience side of stages, raised platforms, and other raised floor areas such as runways, ramps, and side stages used for entertainment or presentations
(2) At vertical openings in the performance area of stages
(3) Where the side of an elevated walking surface is required to be open for the normal functioning of special lighting or for access and use of other special equipment.

12.2.11.1.6.2* Where a guard is ordinarily required but not provided in accordance with 12.2.11.1.6(1) or (2), a written plan shall be developed and maintained to mitigate the fall hazards of unguarded raised floor areas and vertical openings on stages.

12.2.11.2 Lockups. Lockups in assembly occupancies shall comply with the requirements of 22.4.5.

12.3 Protection.

12.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by one of the following:

(1)*Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.
(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.

(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with 8.6.5.
(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall be permitted to have convenience stair openings in accordance with 8.6.9.2.

12.3.2 Protection from Hazards.

12.3.2.1 Service Equipment, Hazardous Operations or Processes, and Storage Facilities.

12.3.2.1.1 Rooms containing high-pressure boilers, refrigerating machinery of other than the domestic refrigerator type, large transformers, or other service equipment subject to explosion shall meet both of the following requirements:

(1) Such rooms shall not be located directly under or abutting required exits.
(2) Such rooms shall be separated from other parts of the building by fire barriers in accordance with Section 8.3 having a minimum 1-hour fire resistance rating or shall be protected by automatic extinguishing systems in accordance with Section 8.7.

12.3.2.1.2 Rooms or spaces for the storage, processing, or use of materials specified in 12.3.2.1.2(1) through (3) shall be protected in accordance with one of the following:

(1) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating or protection of such rooms by automatic extinguishing systems as specified in Section 8.7 in the following areas:
    (a) Boiler and furnace rooms, unless otherwise permitted by one of the following:
        i. The requirement of 12.3.2.1.2(1)(a) shall not apply to rooms enclosing furnaces, heating and air-handling equipment, or compressor equipment with a total aggregate input rating less than 200,000 Btu (211 MJ), provided that such rooms are not used for storage.
        ii. The requirement of 12.3.2.1.2(1)(a) shall not apply to attic locations of the rooms addressed in 12.3.2.1.2(1)(a)(i), provided that such rooms comply with the draftstopping requirements of 8.6.11.
    (b) Rooms or spaces used for the storage of combustible supplies in quantities deeme d hazardous by the authority having jurisdiction
    (c) Rooms or spaces used for the storage of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
(2) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating and protection of such rooms by automatic extinguishing systems as specified in Section 8.7 in the following areas:
    (a) Laundries
    (b) Maintenance shops, including woodworking and painting areas
    (c) Rooms or spaces used for processing or use of combustible supplies deemed hazardous by the authority having jurisdiction
    (d) Rooms or spaces used for processing or use of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
(3) Protection as permitted in accordance with 9.7.1.2 where automatic extinguishing is used to meet the requirements of 12.3.2.1.2(1) or (2)

12.3.2.2 Cooking Equipment. Cooking equipment shall be protected in accordance with 9.2.3, unless the cooking equipment is one of the following types:

(1) Outdoor equipment
(2) Portable equipment not flue-connected
(3) Equipment used only for food warming

12.3.3 Interior Finish.

12.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

12.3.3.2 Corridors, Lobbies, and Enclosed Stairways. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in all corridors and lobbies and shall be Class A in enclosed stairways.

12.3.3.3 Assembly Areas. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in general assembly areas having occupant loads of more than 300 and shall be Class A, Class B, or Class C in assembly areas having occupant loads of 300 or fewer.

12.3.3.4 Screens. Screens on which pictures are projected shall comply with requirements of Class A or Class B interior finish in accordance with Section 10.2.

12.3.3.5 Interior Floor Finish.

12.3.3.5.1 Interior floor finish shall comply with Section 10.2.

12.3.3.5.2 Interior floor finish in exit enclosures and exit access corridors and in spaces not separated from them by walls complying with 12.3.6 shall be not less than Class II.

12.3.3.5.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

12.3.4 Detection, Alarm, and Communications Systems.

12.3.4.1 General.

12.3.4.1.1 Assembly occupancies with occupant loads of more than 300 and all theaters with more than one audience-viewing room shall be provided with an approved fire alarm system in accordance with 9.6.1 and 12.3.4, unless otherwise permitted by 12.3.4.1.2.

12.3.4.1.2 Assembly occupancies that are a part of a multiple occupancy protected as a mixed occupancy *(see 6.1.14)* shall be permitted to be served by a common fire alarm system, provided that the individual requirements of each occupancy are met.

12.3.4.2 Initiation.

12.3.4.2.1 Initiation of the required fire alarm system shall be by both of the following means:

(1) Manual means in accordance with 9.6.2.1(1), unless otherwise permitted by one of the following:
    (a) The requirement of 12.3.4.2.1(1) shall not apply where initiation is by means of an approved automatic fire detection system in accordance with 9.6.2.1(2) that provides fire detection throughout the building.

(b) The requirement of 12.3.4.2.1(1) shall not apply where initiation is by means of an approved automatic sprinkler system in accordance with 9.6.2.1(3) that provides fire detection and protection throughout the building.

(2) Where automatic sprinklers are provided, initiation of the fire alarm system by sprinkler system waterflow, even where manual fire alarm boxes are provided in accordance with 12.3.4.2.1(1)

12.3.4.2.2 The initiating device shall be capable of transmitting an alarm to a receiving station, located within the building, that is constantly attended when the assembly occupancy is occupied.

12.3.4.2.3* In assembly occupancies with occupant loads of more than 300, automatic detection shall be provided in all hazardous areas that are not normally occupied, unless such areas are protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

12.3.4.3 Notification. The required fire alarm system shall activate an audible and visible alarm in a constantly attended receiving station within the building when occupied for purposes of initiating emergency action.

12.3.4.3.1 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

12.3.4.3.2 Reserved.

12.3.4.3.3 Occupant notification shall be by means of voice announcements in accordance with 9.6.3.9, initiated by the person in the constantly attended receiving station.

12.3.4.3.4 Occupant notification shall be by means of visible signals in accordance with 9.6.3.5, initiated by the person in the constantly attended receiving station, unless otherwise permitted by 12.3.4.3.5.

12.3.4.3.5* Visible signals shall not be required in the assembly seating area, or the floor area used for the contest, performance, or entertainment, where the occupant load exceeds 1000 and an approved, alternative visible means of occupant notification is provided. *(See 9.6.3.5.7.)*

12.3.4.3.6 The announcement shall be permitted to be made via a voice communication or public address system in accordance with 9.6.3.9.2.

12.3.4.3.7 Where the authority having jurisdiction determines that a constantly attended receiving station is impractical, both of the following shall be provided:

(1) Automatically transmitted evacuation or relocation instructions shall be provided in accordance with *NFPA 72, National Fire Alarm and Signaling Code.*
(2) The system shall be monitored by a supervising station in accordance with *NFPA 72.*

12.3.5 Extinguishment Requirements.

12.3.5.1 The following assembly occupancies shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1):

(1) Dance halls
(2) Discotheques
(3) Nightclubs
(4) Assembly occupancies with festival seating

12.3.5.2 Any building containing one or more assembly occupancies where the aggregate occupant load of the assembly occupancies exceeds 300 shall be protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 as follows *(see also 12.1.6, 12.2.6, 12.3.2, and 12.3.6)*:

(1) Throughout the story containing the assembly occupancy
(2) Throughout all stories below the story containing the assembly occupancy
(3) In the case of an assembly occupancy located below the level of exit discharge, throughout all stories intervening between that story and the level of exit discharge, including the level of exit discharge

12.3.5.3 The requirements of 12.3.5.2 shall not apply to the following:

(1)*Assembly occupancies consisting of a single multipurpose room of less than 12,000 ft^2 (1115 m^2) that are not used for exhibition or display and are not part of a mixed occupancy
(2) Gymnasiums, skating rinks, and swimming pools used exclusively for participant sports with no audience facilities for more than 300 persons
(3)*Locations in stadia and arenas as follows:
   (a) Over the floor areas used for contest, performance, or entertainment, provided that the roof construction is more than 50 ft (15 m) above the floor level, and use is restricted to low fire hazard uses
   (b) Over the seating areas, provided that use is restricted to low fire hazard uses
   (c) Over open-air concourses where an approved engineering analysis substantiates the ineffectiveness of the sprinkler protection due to building height and combustible loading
(4) Locations in unenclosed stadia and arenas as follows:
   (a) Press boxes of less than 1000 ft^2 (93 m^2)
   (b) Storage facilities of less than 1000 ft^2 (93 m^2) if enclosed with not less than 1-hour fire resistance–rated construction
   (c) Enclosed areas underneath grandstands that comply with 12.4.9.5

12.3.5.4 Where another provision of this chapter requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with 9.7.1.1(1).

12.3.6 Corridors. Interior corridors and lobbies shall be constructed in accordance with 7.1.3.1 and Section 8.3, unless otherwise permitted by one of the following:

(1) Corridor and lobby protection shall not be required where assembly rooms served by the corridor or lobby have at least 50 percent of their exit capacity discharging directly to the outside, independent of corridors and lobbies.
(2) Corridor and lobby protection shall not be required in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(3) Lobbies serving only one assembly area that meet the requirements for intervening rooms *(see 7.5.1.6)* shall not be required to have a fire resistance rating.
(4) Where the corridor ceiling is an assembly having a 1-hour fire resistance rating where tested as a wall, the corridor walls shall be permitted to terminate at the corridor ceiling.
(5) Corridor and lobby protection shall not be required in buildings protected throughout by an approved, total (complete) coverage smoke detection system providing occupant notification and installed in accordance with Section 9.6.

12.4 Special Provisions.

Subsection 12.4.1 was revised by a tentative interim amendment. (TIA). See page 1.

12.4.1 Life Safety Evaluation.

12.4.1.1* General. Where a life safety evaluation is required by other provisions of this *Code*, it shall comply with the following:

(1) The life safety evaluation shall be performed by persons acceptable to the AHJ.
(2) The life safety evaluation shall include a written assessment of safety measures for conditions listed in 12.4.1.2 and of the building systems and facility management in accordance with 12.4.1.3.
(3) The life safety evaluation shall be approved annually by the AHJ and shall be updated for special or unusual conditions in accordance with the provisions of 13.4.1 for existing assembly occupancies.

12.4.1.2 Conditions to Be Assessed. Life safety evaluations shall include an assessment of all of the following conditions and related appropriate safety measures:

(1) Nature of the events and the participants and attendees
(2) Access and egress movement, including crowd density problems
(3) Medical emergencies
(4) Fire hazards
(5) Permanent and temporary structural systems
(6) Severe weather conditions
(7) Earthquakes
(8) Civil or other disturbances
(9) Hazardous materials incidents within and near the facility
(10) Relationships among facility management, event participants, emergency response agencies, and others having a role in the events accommodated in the facility

12.4.1.3* Building Systems and Facility Management Assessments. Life safety evaluations shall include assessments of both building systems and facility management upon which reliance is placed for the safety of facility occupants, and such assessments shall consider scenarios appropriate to the facility.

12.4.1.3.1 Building Systems. Prior to issuance of the building permit, the design team shall provide the AHJ with building systems documentation in accordance with 12.4.1.4.

12.4.1.3.2 Facility Management. Prior to issuance of the certificate of occupancy, the facility management shall provide the AHJ with facility management documentation in accordance with 12.4.1.5.

12.4.1.3.3 Life Safety Evaluation.

12.4.1.3.3.1 Prior to issuance of the building permit, the persons performing the life safety evaluation shall confirm that the building systems provide appropriate safety measures.

12.4.1.3.3.2 Prior to issuance of the certificate of occupancy, the persons performing the life safety evaluation shall confirm that the facility management and operational plans provide appropriate safety measures.

12.4.1.3.3.3 The AHJ shall approve the acceptable persons performing the life safety evaluation in a timely manner to enable the design team and facility management to resolve concerns to the satisfaction of the persons performing the life safety evaluation prior to their submission.

12.4.1.4 Life Safety Building Systems Document. The AHJ shall be provided with a life safety building systems document providing the information required in 12.4.1.4.2 through 12.4.1.4.4.

12.4.1.4.1 Document Distribution. The persons performing the life safety evaluation, the AHJ, the A/E design team, and the building owner shall receive a copy of the life safety building systems document prior to issuance of the building permit.

12.4.1.4.2 Life Safety Narrative. A life safety narrative shall be provided describing the following:

(1) Building occupancy, construction type, and intended uses and events
(2) Building area and population capacity of the proposed facility
(3) Principal fire and life safety features/strategies for the building, including — as applicable — the following:
    (a) Egress
    (b) Access control
    (c) Fire barriers, smoke barriers, and smoke partitions
    (d) Fire suppression systems
    (e) Smoke control/protection
    (f) Fire detection and alarm
    (g) PA system
    (h) Emergency elevator operation
    (i) Emergency power and lighting
    (j) Provisions for patrons with disabilities
    (k) Fire department access
    (l) Fire/emergency command center
(4) Exterior construction design parameters used/applied

12.4.1.4.3 Life Safety Floor Plans. Life safety floor plans of each level shall be provided — as applicable — with the following:

(1) Occupant load, exit location, egress capacity, main entrance/exit, horizontal exits, travel distance, and exit discharge
(2) Fire barriers, smoke barriers, and smoke partitions
(3) Areas of smoke-protected assembly occupancy
(4) Separate smoke-protected areas or zones
(5) Areas of other occupancy type and separations
(6) Unprotected vertical openings
(7) Event plans for each anticipated type of event depicting the following:
    (a) Seating configuration
    (b) Exhibit booth layout
    (c) Stage location
    (d) Occupant load, egress capacity required, exits provided, and travel distance
    (e) Any floor or stage use restrictions
    (f) Plan and/or section drawing indicating areas where the roof construction is more than 50 ft (15 m) above floor level and areas where sprinkler protection is omitted
    (g) Areas of refuge — interior and exterior

12.4.1.4.4 Engineering Analysis and Calculations. An engineering analysis shall be provided with the following:

(1) Smoke protection analysis to substantiate the use of smoke-protected assembly seating as follows:
    (a) Performance-based design methods approved by the AHJ

(b) Smoke control requirements per NFPA 92, *Standard for Smoke Control Systems*
(c) Smoke control assumptions, such as fire scenario description, fire size quantification, and smoke development/smoke movement analysis
(d) Proposed testing protocol for smoke control system and pass/fail criteria
(e) Timed egress analysis and assumed flow rates and travel speeds

(2) Sprinkler protection calculations, including an engineering analysis substantiating locations in accordance with 12.3.5.3 where sprinkler protection would be ineffective due to height and combustible loading
(3) Load diagram of rigging/load capacity of gridiron, fly loft, or long-span roof structure used for hanging overhead objects

12.4.1.5 Life Safety Management Document. The AHJ shall be provided with a life safety management document providing the information required in 12.4.1.5.2 through 12.4.1.5.7.

12.4.1.5.1 Document Distribution. The persons performing the life safety evaluation, the AHJ, the A/E design team, and the building owner shall receive a copy of the life safety management document prior to issuance of the certificate of occupancy.

12.4.1.5.2 Facility Management and Operational Plans. Facility management and operational plans shall address the following:

(1) Best practices adopted or recognized
(2) Emergency plans
(3) Evacuation plans
(4) Shelter-in-place plans, including capacities and protection considerations
(5) Crowd management training plan
(6) Safety plans, which include the following:
  (a) Training plans
  (b) Safety equipment plans
(7) Fire alarm, smoke control system protocol, and testing plans
(8) First aid or medical treatment plans, which include the following:
  (a) Defined levels of service
  (b) Standing orders adopted
  (c) Supply and equipment plan
(9) Housekeeping plans — biological, medical, hazardous materials cleaning
(10) Emergency communication plans, which include the following:
  (a) Chain of authority and incident command system employed
  (b) Contact information for the following:
    i. Venue personnel
    ii. Emergency management and response organizations (such as fire, police, medical, utility, transportation, and key stakeholders)
  (c) Communication systems
  (d) Standard announcement for incidents or emergency situations
(11) Risk and threat assessment for venue and surrounding area for the following:
  (a) Severe weather
  (b) Hazardous materials
  (c) Terrorism
  (d) Hostile intruder
(12) Operating procedures and protocols for risks, such as the following:
  (a) Severe weather preparedness and monitoring plans
  (b) Hazardous materials incidence response plans
  (c) Terrorism response plans
  (d) Hostile intruder response plans
(13) First responder response/arrival routes plans
(14) Alcohol management plans
(15) Food safety plans
(16) Rigging and temporary performance structure, which includes the following:
  (a) Design and safety review plans
  (b) Emergency action plans
(17) Chemical and hazardous materials information and data
(18) Barrier and wall protection plans for motor sports or similar events

12.4.1.5.3 Records. Records of the facility management plans, including procedures and location, shall be maintained for the following:

(1) Crowd management training
(2) Safety training
(3) Fire alarm, smoke control system maintenance, and test records
(4) First aid or medical treatment and regulation compliance

12.4.1.5.4 Building Systems Reference Guide. A building systems reference guide shall be provided in accordance with 12.4.1.5.4.1 through 12.4.1.5.4.3.

12.4.1.5.4.1 A basic life safety building systems reference guide shall be developed and maintained.

12.4.1.5.4.2 The life safety building systems reference guide shall contain the important and key information for the venue management's use when planning events/activities for the safety of patrons, performers/participants, employees, and vendors.

12.4.1.5.4.3 The life safety building systems document in accordance with 12.4.1.4 shall be permitted to be used, and additionally the life safety building systems reference guide shall include the following:

(1) Occupant capacity of every space/room
(2) Egress flow diagrams, including assumed flow rates, and capacities of all aisles and hallways, including public and nonpublic areas
(3) Capacities of all exterior doors and/or choke points in immediate perimeter areas
(4) Limitations or assumptions for ingress control that could be in place during an emergency egress/evacuation, including control gates, queuing barriers, and turnstiles
(5) Capacities of immediate perimeter exterior walkways, including assumed flow rates for exterior areas
(6) Assumed egress paths for normal conditions — transportation modes
(7) Management level sequencing charts for alarm and emergency communication systems, the manual, or override options/instructions that include the following:
  (a) List of codes or alarm signals
  (b) Location of manual overrides
  (c) Description of sequence of operations during an alarm, such as exhaust fans operate or doors open
(8) Principal fire and life safety features/strategies, such as sprinklers, smoke control, fire alarm notifications, PA system, emergency power, and fire department access

(9) Assumptions when developing occupancy plans for venue floor, open areas, and nonevent spaces, such as the following:
   (a) Event floor plans/setup diagrams for each typical event/activity
   (b) Fire sprinkler and smoke protection capabilities
(10) Severe weather shelter areas, locations, structure considerations (limitations), capacities (occupancy and density factor)
(11) Command center, which includes the following:
   (a) Location (formal or informal)
   (b) Structural integrity considerations
   (c) Redundant locations and/or capabilities
   (d) Jurisdictional rights — assumed and/or applied
(12) Locations and capacities of wheelchair and mobility-impaired seating
(13) Locations and capacities of areas of refuge and other safe areas
(14) Rigging or structural load capacities of grids, truss structure, fly lofts, ceilings, floors, ramps, and staging
(15) List of locations of emergency equipment, such as fire extinguishers, fire hose cabinets, fire hydrants, and AEDs.
(16) Sequencing of electrical service, such as the following:
   (a) Emergency generators and charts of all areas illuminated during power outages
   (b) Multiple electrical feed capabilities
(17) List of mechanical, movable equipment in the facility
(18) Potential hazards in the surrounding neighborhood, including train tracks and propane stations
(19) Assumptions or accommodations considered and used in design

12.4.1.5.5 The facility management plans shall be maintained and adjusted as necessary for changes to the venue structure, operating purposes and style, and event occupancy.

12.4.1.5.6 Facility management and operational plans shall be submitted to the AHJ annually.

12.4.1.5.7 For events and activities at the venue that are outside the normal operating conditions or vary from the normal facility management plans, the following shall apply:

(1) Facility management shall perform an event/activity-specific facility management plan for the AHJ to review.
(2) Approval of the AHJ for the specific facility management plan shall occur prior to such event.

12.4.2* Smoke-Protected Assembly Seating.

12.4.2.1 To be considered smoke protected, an assembly seating facility shall comply with both of the following:

(1) All enclosed areas with walls and ceilings in buildings or structures containing smoke-protected assembly seating shall be protected with an approved, supervised automatic sprinkler system in accordance with Section 9.7, unless otherwise permitted by one of the following:
   (a) The requirement of 12.4.2.1(1) shall not apply to the floor area used for contest, performance, or entertainment, provided that the roof construction is more than 50 ft (15 m) above the floor level and use is restricted to low fire hazard uses.
   (b) Sprinklers shall not be required to be located over the floor area used for contest, performance, or entertainment and over the seating areas where an approved engineering analysis substantiates the ineffectiveness of the sprinkler protection due to building height and combustible loading.
(2) All means of egress serving a smoke-protected assembly seating area shall be provided with smoke-actuated ventilation facilities or natural ventilation designed in accordance with both of the following criteria:
   (a) The ventilation system shall be designed to maintain the level of smoke at not less than 6 ft (1830 mm) above the floor of the means of egress.
   (b) The ventilation system shall be in accordance with NFPA 92, *Standard for Smoke Control Systems*.

12.4.2.2 To use the provisions of smoke-protected assembly seating, a facility shall be subject to a life safety evaluation in accordance with 12.4.1.

12.4.2.3 Minimum clear widths of aisles and other means of egress serving smoke-protected assembly seating shall be in accordance with Table 12.4.2.3.

Table 12.4.2.3 Capacity Factors for Smoke-Protected Assembly Seating

No. of Seats	Clear Width per Seat Served: Stairs in.	Stairs mm	Passageways, Ramps, and Doorways in.	Passageways, Ramps, and Doorways mm
2,000	0.300 *AB*	7.6 *AB*	0.220 *C*	5.6 *C*
5,000	0.200 *AB*	5.1 *AB*	0.150 *C*	3.8 *C*
10,000	0.130 *AB*	3.3 *AB*	0.100 *C*	2.5 *C*
15,000	0.096 *AB*	2.4 *AB*	0.070 *C*	1.8 *C*
20,000	0.076 *AB*	1.9 *AB*	0.056 *C*	1.4 *C*
≥25,000	0.060 *AB*	1.5 *AB*	0.044 *C*	1.1 *C*

12.4.2.4 Outdoor Smoke-Protected Assembly Seating.

12.4.2.4.1 Where smoke-protected assembly seating and its means of egress are located wholly outdoors, capacity shall be permitted to be provided in accordance with Table 12.4.2.4.1 and the provision of 12.4.2.4.2 shall apply.

Table 12.4.2.4.1 Capacity Factors for Outdoor Smoke-Protected Assembly Seating

Feature	Clear Width per Seat Served: Stairs in.	Stairs mm	Passageways, Ramps, and Doorways in.	Passageways, Ramps, and Doorways mm
Outdoor smoke-protected assembly seating	0.08 *AB*	2.0 *AB*	0.06 *C*	1.5 *C*

12.4.2.4.2 Where the number of seats in outdoor smoke-protected assembly seating exceeds 20,000, the capacity factors of Table 12.4.2.3 shall be permitted to be used.

12.4.2.5 Where using Table 12.4.2.3, the number of seats specified shall be within a single assembly space, and interpolation shall be permitted between the specific values shown. A single seating space shall be permitted to have multiple levels, floors, or mezzanines.

12.4.2.6 The minimum clear widths shown in Table 12.4.2.3 and Table 12.4.2.4.1 shall be modified in accordance with all of the following:

(1) If risers exceed 7 in. in height, the stair width in Table 12.4.2.3 and Table 12.4.2.4.1 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 7}{5} \qquad \textbf{[12.4.2.6(1)]}$$

(2) If risers exceed 178 mm in height, the stair width in Table 12.4.2.3 and shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 178}{125} \qquad \textbf{[12.4.2.6(2)]}$$

(3) Stairs not having a handrail within a 30 in. (760 mm) horizontal distance shall be 25 percent wider than otherwise calculated; that is, their width shall be multiplied by factor *B*, where *B* equals the following:

$$B = 1.25 \qquad \textbf{[12.4.2.6(3)]}$$

(4) Ramps steeper than 1 in 10 slope where used in ascent shall have their width increased by 10 percent; that is, their width shall be multiplied by factor *C*, where *C* equals the following:

$$C = 1.10 \qquad \textbf{[12.4.2.6(4)]}$$

12.4.2.7 Where smoke-protected assembly seating conforms to the requirements of 12.4.2, for rows of seats served by aisles or doorways at both ends, the number of seats per row shall not exceed 100, and the clear width of not less than 12 in. (305 mm) for aisle accessways shall be increased by 0.3 in. (7.6 mm) for every additional seat beyond the number stipulated in Table 12.4.2.7; however, the minimum clear width shall not be required to exceed 22 in. (560 mm).

12.4.2.8 Where smoke-protected assembly seating conforms to the requirements of 12.4.2, for rows of seats served by an aisle or doorway at one end only, the aisle accessway clear width of not less than 12 in. (305 mm) shall be increased by 0.6 in. (15 mm) for every additional seat beyond the number stipulated in Table 12.4.2.7; however, the minimum clear width shall not be required to exceed 22 in. (560 mm).

12.4.2.9 Smoke-protected assembly seating conforming with the requirements of 12.4.2 shall be permitted to have a common path of travel of 50 ft (15 m) from any seat to a point where a person has a choice of two directions of egress travel.

12.4.2.10 Aisle accessways shall be permitted to serve as one or both of the required exit accesses addressed in 12.4.2.9, provided that the aisle accessway has a minimum width of 12 in. (305 mm) plus 0.3 in. (7.6 mm) for every additional seat over a total of 7 in a row.

Table 12.4.2.7 Smoke-Protected Assembly Seating Aisle Accessways

	Number of Seats per Row Permitted to Have a Clear Width Aisle Accessway of Not Less than 12 in. (305 mm)	
Total Number of Seats in the Space	**Aisle or Doorway at Both Ends of Row**	**Aisle or Doorway at One End of Row**
<4,000	14	7
4,000–6,999	15	7
7,000–9,999	16	8
10,000–12,999	17	8
13,000–15,999	18	9
16,000–18,999	19	9
19,000–21,999	20	10
≥22,000	21	11

12.4.2.11 Where smoke-protected assembly seating conforms to the requirements of 12.4.2, the dead ends in aisle stairs shall not exceed a distance of 21 rows, unless both of the following criteria are met:

(1) The seats served by the dead-end aisle are not more than 40 seats from another aisle.
(2) The 40-seat distance is measured along a row of seats having an aisle accessway with a clear width of not less than 12 in. (305 mm) plus 0.3 in. (7.6 mm) for each additional seat above 7 in the row.

12.4.2.12 Where smoke-protected assembly seating conforms to the requirements of 12.4.2, the travel distance from each seat to the nearest entrance to an egress vomitory or egress concourse shall not exceed 400 ft (122 m).

12.4.2.13 Where smoke-protected assembly seating conforms to the requirements of 12.4.2, the travel distance from the entrance to the vomitory or from the egress concourse to an approved egress stair, ramp, or walk at the building exterior shall not exceed 200 ft (61 m).

12.4.2.14 The travel distance requirements of 12.4.2.12 and 12.4.2.13 shall not apply to outdoor assembly seating facilities of Type I or Type II construction where all portions of the means of egress are essentially open to the outside.

12.4.3 Limited Access or Underground Buildings.

12.4.3.1 Limited access or underground buildings shall comply with 12.4.3 and Section 11.7.

12.4.3.2 Underground buildings or portions of buildings having a floor level more than 30 ft (9.1 m) below the level of exit discharge shall comply with the requirements of 12.4.3.3 through 12.4.3.5, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to areas within buildings used only for service to the building, such as boiler/heater rooms, cable vaults, and dead storage.
(2) This requirement shall not apply to auditoriums without intervening occupiable levels.

12.4.3.3 Each level more than 30 ft (9.1 m) below the level of exit discharge shall be divided into not less than two smoke compartments by a smoke barrier complying with Section 8.5 and shall have a minimum 1-hour fire resistance rating.

12.4.3.3.1 Smoke compartments shall comply with both of the following:

(1) Each smoke compartment shall have access to not less than one exit without passing through the other required compartment.
(2) Any doors connecting required compartments shall be tight-fitting, minimum 1-hour-rated fire door assemblies designed and installed to minimize smoke leakage and to close and latch automatically upon detection of smoke.

12.4.3.3.2 Each smoke compartment shall be provided with a mechanical means of moving people vertically, such as an elevator or escalator.

12.4.3.3.3 Each smoke compartment shall have an independent air supply and exhaust system capable of smoke control or smoke exhaust functions. The system shall be in accordance with NFPA 92, *Standard for Smoke Control Systems*.

12.4.3.3.4 Throughout each smoke compartment shall be provided an automatic smoke detection system designed such that the activation of any two detectors causes the smoke control system to operate and the building voice alarm to sound.

12.4.3.4 Any required smoke control or exhaust system shall be provided with a standby power system complying with Article 701 of *NFPA 70, National Electrical Code*.

12.4.3.5 The building shall be provided with an approved, supervised voice alarm system, in accordance with Section 9.6, that complies with 9.6.3.9 and provides a prerecorded evacuation message.

12.4.4 High-Rise Buildings. High-rise assembly occupancy buildings and high-rise mixed occupancy buildings that house assembly occupancies in the high-rise portions of the building shall comply with Section 11.8.

12.4.5 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

12.4.6 Stages and Platforms. See 3.3.264 and 3.3.211.

12.4.6.1 Materials and Design.

12.4.6.1.1 Materials used in the construction of platforms and stages shall conform to the applicable requirements of the local building code.

12.4.6.1.2 Stage stairs shall be permitted to be of combustible materials, regardless of building construction type.

12.4.6.2 Platform Construction.

12.4.6.2.1 Temporary platforms shall be permitted to be constructed of any materials.

12.4.6.2.2 The space between the floor and the temporary platform above shall not be used for any purpose other than the electrical wiring to platform equipment.

12.4.6.2.3 Permanent platforms shall be of the materials required for the building construction type in which the permanent platform is located, except that the finish floor shall be permitted to be of wood in all types of construction.

12.4.6.2.4 Where the space beneath the permanent platform is used for storage or any purpose other than equipment wiring or plumbing, the floor construction shall not be less than 1-hour fire resistive.

12.4.6.3 Stage Construction.

12.4.6.3.1 Regular stages shall be of the materials required for the building construction type in which they are located. In all cases, the finish floor shall be permitted to be of wood.

12.4.6.3.2 Legitimate stages shall be constructed of materials required for Type I buildings, except that the area extending from the proscenium opening to the back wall of the stage, and for a distance of 6 ft (1830 mm) beyond the proscenium opening on each side, shall be permitted to be constructed of steel or heavy timber covered with a wood floor not less than 1½ in. (38 mm) in actual thickness.

12.4.6.3.3 Openings through stage floors shall be equipped with tight-fitting traps with approved safety locks, and such traps shall comply with one of the following:

(1) The traps shall be of wood having an actual thickness of not less than 1½ in. (38 mm).
(2) The traps shall be of a material that provides fire and heat resistance at least equivalent to that provided by wood traps having an actual thickness of not less than 1½ in. (38 mm).

12.4.6.4 Accessory Rooms.

12.4.6.4.1 Workshops, storerooms, permanent dressing rooms, and other accessory spaces contiguous to stages shall be separated from each other and other building areas by 1-hour fire resistance–rated construction and protected openings.

12.4.6.4.2 The separation requirements of 12.4.6.4.1 shall not be required for stages having a floor area not exceeding 1000 ft^2 (93 m^2).

12.4.6.5 Ventilators. Regular stages in excess of 1000 ft^2 (93 m^2) and legitimate stages shall be provided with emergency ventilation to provide a means of removing smoke and combustion gases directly to the outside in the event of a fire, and such ventilation shall be achieved by one or a combination of the methods specified in 12.4.6.5.1 through 12.4.6.5.3.

12.4.6.5.1 Smoke Control.

12.4.6.5.1.1 A means complying with Section 9.3 shall be provided to maintain the smoke level at not less than 6 ft (1830 mm) above the highest level of assembly seating or above the top of the proscenium opening where a proscenium wall and opening protection are provided.

12.4.6.5.1.2 Smoke control systems used for compliance with 12.4.6.5.1.1 shall be in accordance with NFPA 92, *Standard for Smoke Control Systems*.

12.4.6.5.1.3 The smoke control system shall be activated independently by each of the following:

(1) Activation of the sprinkler system in the stage area
(2) Activation of smoke detectors over the stage area
(3) Activation by manually operated switch at an approved location

12.4.6.5.1.4 The emergency ventilation system shall be supplied by both normal and standby power.

12.4.6.5.1.5 The fan(s) power wiring and ducts shall be located and properly protected to ensure a minimum of 20 minutes of operation in the event of activation.

12.4.6.5.2 Roof Vents.

12.4.6.5.2.1 Two or more vents shall be located near the center of and above the highest part of the stage area.

12.4.6.5.2.2 The vents shall be raised above the roof and shall provide a net free vent area equal to 5 percent of the stage area.

12.4.6.5.2.3 Vents shall be constructed to open automatically by approved heat-activated devices, and supplemental means shall be provided for manual operation and periodic testing of the ventilator from the stage floor.

12.4.6.5.2.4 Vents shall be labeled.

12.4.6.5.3 Other Means. Approved, alternate means of removing smoke and combustion gases shall be permitted.

12.4.6.6 Proscenium Walls. Legitimate stages shall be completely separated from the seating area by a proscenium wall of not less than 2-hour fire-resistive, noncombustible construction.

12.4.6.6.1 The proscenium wall shall extend not less than 48 in. (1220 mm) above the roof of the auditorium in combustible construction.

12.4.6.6.2 All openings in the proscenium wall of a legitimate stage shall be protected by a fire assembly having a minimum 1½-hour fire protection rating.

12.4.6.6.3 The main proscenium opening used for viewing performances shall be provided with proscenium opening protection as described in 12.4.6.7.

12.4.6.6.4 Proscenium walls shall not be required in smoke-protected assembly seating facilities constructed and operated in accordance with 12.4.2.

12.4.6.7 Proscenium Opening Protection.

12.4.6.7.1 Where required by 12.4.6.6, the proscenium opening shall be protected by a listed, minimum 20-minute opening protective assembly, a fire curtain complying with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, or an approved water curtain complying with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

12.4.6.7.2 Proscenium opening protection provided by other than a fire curtain shall activate upon automatic detection of a fire and upon manual activation.

12.4.6.8 Gridiron, Fly Galleries, and Pinrails.

12.4.6.8.1 Structural framing designed only for the attachment of portable or fixed theater equipment, gridirons, galleries, and catwalks shall be constructed of materials consistent with the building construction type, and a fire resistance rating shall not be required.

12.4.6.8.2 Fire–retardant-treated wood shall be permitted for fly galleries and pinrails of all types of construction.

12.4.6.8.3 Combustible materials shall be permitted to be used for the floors of galleries and catwalks of all construction types.

12.4.6.9 Catwalks. The clear width of lighting and access catwalks and the means of egress from galleries and gridirons shall be not less than 22 in. (560 mm).

12.4.6.10 Fire Protection. Every stage shall be protected by an approved, supervised automatic sprinkler system in compliance with Section 9.7.

12.4.6.10.1 Protection shall be provided throughout the stage and in storerooms, workshops, permanent dressing rooms, and other accessory spaces contiguous to stages.

12.4.6.10.2 Sprinklers shall not be required for stages 1000 ft^2 (93 m^2) or less in area and 50 ft (15 m) or less in height where both of the following criteria are met:

(1) Curtains, scenery, or other combustible hangings are not retractable vertically.
(2) Combustible hangings are limited to borders, legs, a single main curtain, and a single backdrop.

12.4.6.10.3 Sprinklers shall not be required under stage areas less than 48 in. (1220 mm) in clear height that are used exclusively for chair or table storage and lined on the inside with ⅝ in. (16 mm) Type X gypsum wallboard or the approved equivalent.

12.4.6.11 Flame-Retardant Requirements.

12.4.6.11.1 Combustible scenery of cloth, film, vegetation (dry), and similar materials shall comply with one of the following:

(1) They shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(2) They shall exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.

12.4.6.11.2 Foamed plastics *(see definition of cellular or foamed plastic in 3.3.41)* shall be permitted to be used if they exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source or by specific approval of the authority having jurisdiction.

12.4.6.11.3 Scenery and stage properties not separated from the audience by proscenium opening protection shall be of noncombustible materials, limited-combustible materials, or fire–retardant-treated wood.

12.4.6.11.4 In theaters, motion picture theaters, and television stage settings, with or without horizontal projections, and in simulated caves and caverns of foamed plastic, any single fuel package shall have a heat release rate not to exceed 100 kW where tested in accordance with one of the following:

(1) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

12.4.6.12* Standpipes.

12.4.6.12.1 Regular stages over 1000 ft^2 (93 m^2) in area and all legitimate stages shall be equipped with 1½ in. (38 mm) hose lines for first aid fire fighting at each side of the stage.

12.4.6.12.2 Hose connections shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, unless Class II or Class III standpipes in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, are used.

12.4.7 Projection Rooms.

12.4.7.1 Projection rooms shall comply with 12.4.7.2 through 12.4.7.10.

12.4.7.2 Where cellulose nitrate film is used, the projection room shall comply with NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*.

12.4.7.3 Film or video projectors or spotlights utilizing light sources that produce particulate matter or toxic gases, or light sources that produce hazardous radiation, without protective shielding shall be located within a projection room complying with 12.3.2.1.2.

12.4.7.4 Every projection room shall be of permanent construction consistent with the building construction type in which the projection room is located and shall comply with the following:

(1) Openings shall not be required to be protected.
(2) The room shall have a floor area of not less than 80 ft^2 (7.4 m^2) for a single machine and not less than 40 ft^2 (3.7 m^2) for each additional machine.
(3) Each motion picture projector, floodlight, spotlight, or similar piece of equipment shall have a clear working space of not less than 30 in. (760 mm) on each side and at its rear, but only one such space shall be required between adjacent projectors.

12.4.7.5 The projection room and the rooms appurtenant to it shall have a ceiling height of not less than 7 ft 6 in. (2285 mm).

12.4.7.6 Each projection room for safety film shall have not less than one out-swinging, self-closing door not less than 30 in. (760 mm) wide and 6 ft 8 in. (2030 mm) high.

12.4.7.7 The aggregate of ports and openings for projection equipment shall not exceed 25 percent of the area of the wall between the projection room and the auditorium, and all openings shall be provided with glass or other approved material so as to completely close the opening.

12.4.7.8 Projection room ventilation shall comply with 12.4.7.8.1 and 12.4.7.8.2.

12.4.7.8.1 Supply Air.

12.4.7.8.1.1 Each projection room shall be provided with adequate air supply inlets arranged to provide well-distributed air throughout the room.

12.4.7.8.1.2 Air inlet ducts shall provide an amount of air equivalent to the amount of air being exhausted by projection equipment.

12.4.7.8.1.3 Air shall be permitted to be taken from the outside; from adjacent spaces within the building, provided that the volume and infiltration rate is sufficient; or from the building air-conditioning system, provided that it is arranged to supply sufficient air whether or not other systems are in operation.

12.4.7.8.2 Exhaust Air.

12.4.7.8.2.1 Projection booths shall be permitted to be exhausted through the lamp exhaust system.

12.4.7.8.2.2 The lamp exhaust system shall be positively interconnected with the lamp so that the lamp cannot operate unless there is sufficient airflow required for the lamp.

12.4.7.8.2.3 Exhaust air ducts shall terminate at the exterior of the building in such a location that the exhaust air cannot be readily recirculated into any air supply system.

12.4.7.8.2.4 The projection room ventilation system shall be permitted also to serve appurtenant rooms, such as the generator room and the rewind room.

12.4.7.9 Each projection machine shall be provided with an exhaust duct that draws air from each lamp and exhausts it directly to the outside of the building.

12.4.7.9.1 The lamp exhaust shall be permitted to exhaust air from the projection room to provide room air circulation.

12.4.7.9.2 Lamp exhaust ducts shall be of rigid materials, except for a flexible connector approved for the purpose.

12.4.7.9.3 The projection lamp and projection room exhaust systems shall be permitted to be combined but shall not be interconnected with any other exhaust system or return-air system within the buildings.

12.4.7.9.4 Specifications for electric arc and xenon projection equipment shall comply with 12.4.7.9.4.1 and 12.4.7.9.4.2.

12.4.7.9.4.1 Electric Arc Projection Equipment. The exhaust capacity shall be 200 ft^3/min (0.09 m^3/s) for each lamp connected to the lamp exhaust system, or as recommended by the equipment manufacturer, and auxiliary air shall be permitted to be introduced into the system through a screened opening to stabilize the arc.

12.4.7.9.4.2 Xenon Projection Equipment. The lamp exhaust system shall exhaust not less than 300 ft^3/min (0.14 m^3/s) per lamp, or not less than the exhaust volume required or recommended by the equipment manufacturer, whichever is greater.

12.4.7.10 Miscellaneous equipment and storage shall be protected as follows:

(1) Each projection room shall be provided with rewind and film storage facilities.
(2) Flammable liquids containers shall be permitted in projection rooms, provided that all of the following criteria are met:
    (a) There are not more than four containers per projection room.
    (b) No container has a capacity exceeding 16 oz (0.5 L).
    (c) The containers are of a nonbreakable type.
(3) Appurtenant electrical equipment, such as rheostats, transformers, and generators, shall be permitted to be located within the booth or in a separate room of equivalent construction.

12.4.8* Special Amusement Buildings.

12.4.8.1* General. Special amusement buildings, regardless of occupant load, shall meet the requirements for assembly occupancies in addition to the requirements of 12.4.8, unless the special amusement building is a multilevel play structure that is not more than 10 ft (3050 mm) in height and has aggregate horizontal projections not exceeding 160 ft^2 (15 m^2).

12.4.8.2* Automatic Sprinklers. Every special amusement building, other than buildings or structures not exceeding 10 ft (3050 mm) in height and not exceeding 160 ft^2 (15 m^2) in aggregate horizontal projection, shall be protected throughout by an approved, supervised automatic sprinkler system installed and maintained in accordance with Section 9.7.

12.4.8.3 Temporary Water Supply. Where the special amusement building required to be sprinklered by 12.4.8.2 is movable or portable, the sprinkler water supply shall be permitted to be provided by an approved temporary means.

12.4.8.4 Smoke Detection. Where the nature of the special amusement building is such that it operates in reduced lighting levels, the building shall be protected throughout by an approved automatic smoke detection system in accordance with Section 9.6.

12.4.8.5 Alarm Initiation. Actuation of any smoke detection system device shall sound an alarm at a constantly attended location on the premises.

12.4.8.6 Illumination. Actuation of the automatic sprinkler system, or any other suppression system, or actuation of a smoke detection system having an approved verification or cross-zoning operation capability shall provide for both of the following:

(1) Increase in illumination in the means of egress to that required by Section 7.8
(2) Termination of any conflicting or confusing sounds and visuals

12.4.8.7 Exit Marking.

12.4.8.7.1 Exit marking shall be in accordance with Section 7.10.

12.4.8.7.2 Floor proximity exit signs shall be provided in accordance with 7.10.1.6.

12.4.8.7.3* In special amusement buildings where mazes, mirrors, or other designs are used to confound the egress path, approved directional exit marking that becomes apparent in an emergency shall be provided.

12.4.8.8 Interior Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A throughout.

12.4.9 Grandstands.

12.4.9.1 General. Grandstands shall comply with the provisions of this chapter as modified by 12.4.9.

12.4.9.2 Seating.

12.4.9.2.1 Where grandstand seating without backs is used indoors, rows of seats shall be spaced not less than 22 in. (560 mm) back-to-back.

12.4.9.2.2 The depth of footboards and seat boards in grandstands shall be not less than 9 in. (230 mm); where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

12.4.9.2.3 Seats and footrests of grandstands shall be supported securely and fastened in such a manner that they cannot be displaced inadvertently.

12.4.9.2.4 Individual seats or chairs shall be permitted only if secured in rows in an approved manner, unless seats do not exceed 16 in number and are located on level floors and within railed-in enclosures, such as boxes.

12.4.9.2.5 The maximum number of seats permitted between the farthest seat and an aisle in grandstands and bleachers shall not exceed that shown in Table 12.4.9.2.5.

Table 12.4.9.2.5 Maximum Number of Seats Between Farthest Seat and an Aisle

Application	Outdoors	Indoors
Grandstands	11	6
Bleachers *(See 12.2.5.6.1.2.)*	20	9

12.4.9.3 Special Requirements — Wood Grandstands.

12.4.9.3.1 An outdoor wood grandstand shall be erected within not less than two-thirds of its height, and, in no case, within not less than 10 ft (3050 mm), of a building, unless otherwise permitted by one of the following:

(1) The distance requirement shall not apply to buildings having minimum 1-hour fire resistance–rated construction with openings protected against the fire exposure hazard created by the grandstand.
(2) The distance requirement shall not apply where a wall having minimum 1-hour fire resistance–rated construction separates the grandstand from the building.

12.4.9.3.2 An outdoor wood grandstand unit shall not exceed 10,000 ft^2 (929 m^2) in finished ground level area or 200 ft (61 m) in length, and all of the following requirements also shall apply:

(1) Grandstand units of the maximum size shall be placed not less than 20 ft (6100 mm) apart or shall be separated by walls having a minimum 1-hour fire resistance rating.
(2) The number of grandstand units erected in any one group shall not exceed three.
(3) Each group of grandstand units shall be separated from any other group by a wall having minimum 2-hour fire resistance–rated construction extending 24 in. (610 mm) above the seat platforms or by an open space of not less than 50 ft (15 m).

12.4.9.3.3 The finished ground level area or length required by 12.4.9.3.2 shall be permitted to be doubled where one of the following criteria is met:

(1) Where the grandstand is constructed entirely of labeled fire-retardant–treated wood that has passed the standard rain test, ASTM D 2898, *Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*
(2) Where the grandstand is constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)]

12.4.9.3.4 The highest level of seat platforms above the finished ground level or the surface at the front of any wood grandstand shall not exceed 20 ft (6100 mm).

12.4.9.3.5 The highest level of seat platforms above the finished ground level, or the surface at the front of a portable grandstand within a tent or membrane structure, shall not exceed 12 ft (3660 mm).

12.4.9.3.6 The height requirements specified in 12.4.9.3.4 and 12.4.9.3.5 shall be permitted to be doubled where constructed entirely of labeled fire-retardant-treated wood that has passed the standard rain test, ASTM D 2898, *Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*, or where constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)].

12.4.9.4 Special Requirements — Portable Grandstands.

12.4.9.4.1 Portable grandstands shall conform to the requirements of 12.4.9 for grandstands and the requirements of 12.4.9.4.2 through 12.4.9.4.7.

12.4.9.4.2 Portable grandstands shall be self-contained and shall have within them all necessary parts to withstand and restrain all forces that might be developed during human occupancy.

12.4.9.4.3 Portable grandstands shall be designed and manufactured so that, if any structural members essential to the strength and stability of the structure have been omitted during erection, the presence of unused connection fittings shall make the omissions self-evident.

12.4.9.4.4 Portable grandstand construction shall be skillfully accomplished to produce the strength required by the design.

12.4.9.4.5 Portable grandstands shall be provided with base plates, sills, floor runners, or sleepers of such area that the permitted bearing capacity of the supporting material is not exceeded.

12.4.9.4.6 Where a portable grandstand rests directly on a base of such character that it is incapable of supporting the load without appreciable settlement, mud sills of suitable material, having sufficient area to prevent undue or dangerous settlement, shall be installed under base plates, runners, or sleepers.

12.4.9.4.7 All bearing surfaces of portable grandstands shall be in contact with each other.

12.4.9.5 Spaces Underneath Grandstands. Spaces underneath a grandstand shall be kept free of flammable or combustible materials, unless protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 or unless otherwise permitted by one of the following:

(1) This requirement shall not apply to accessory uses of 300 ft^2 (28 m^2) or less, such as ticket booths, toilet facilities, or concession booths, where constructed of noncombustible or fire-resistive construction in otherwise nonsprinklered facilities.
(2) This requirement shall not apply to rooms that are enclosed in not less than 1-hour fire resistance–rated construction and are less than 1000 ft^2 (93 m^2) in otherwise nonsprinklered facilities.

12.4.9.6 Guards and Railings.

12.4.9.6.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are more than 48 in. (1220 mm) above the floor or the finished ground level.

12.4.9.6.2 The requirement of 12.4.9.6.1 shall not apply where an adjacent wall or fence affords equivalent safeguard.

12.4.9.6.3 Where the front footrest of any grandstand is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided.

12.4.9.6.4 The railings required by 12.4.9.6.3 shall be permitted to be not less than 26 in. (660 mm) high in grandstands or where the front row of seats includes backrests.

12.4.9.6.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle.

12.4.9.6.6 The railings specified by 12.4.9.6.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle.

12.4.9.6.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

12.4.9.6.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above the finished ground level shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

12.4.10 Folding and Telescopic Seating.

12.4.10.1 General. Folding and telescopic seating shall comply with the provisions of this chapter as modified by 12.4.10.

12.4.10.2 Seating.

12.4.10.2.1 The horizontal distance of seats, measured back-to-back, shall be not less than 22 in. (560 mm) for seats without backs, and all of the following requirements shall also apply:

(1) There shall be a space of not less than 12 in. (305 mm) between the back of each seat and the front of each seat immediately behind it.
(2) If seats are of the chair type, the 12 in. (305 mm) dimension shall be measured to the front edge of the rear seat in its normal unoccupied position.
(3) All measurements shall be taken between plumb lines.

12.4.10.2.2 The depth of footboards (footrests) and seat boards in folding and telescopic seating shall be not less than 9 in. (230 mm).

12.4.10.2.3 Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

12.4.10.2.4 Individual chair-type seats shall be permitted in folding and telescopic seating only if firmly secured in groups of not less than three.

12.4.10.2.5 The maximum number of seats permitted between the farthest seat in an aisle in folding and telescopic seating shall not exceed that shown in Table 12.4.9.2.5.

12.4.10.3 Guards and Railings.

12.4.10.3.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest, or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all folding and telescopic seating where the seats are more than 48 in. (1220 mm) above the floor or the finished ground level.

12.4.10.3.2 The requirement of 12.4.10.3.1 shall not apply where an adjacent wall or fence affords equivalent safeguard.

12.4.10.3.3 Where the front footrest of folding or telescopic seating is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided.

12.4.10.3.4 The railings required by 12.4.10.3.3 shall be permitted to be not less than 26 in. (660 mm) high where the front row of seats includes backrests.

12.4.10.3.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle.

12.4.10.3.6 The railings specified by 12.4.10.3.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle.

12.4.10.3.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

12.4.10.3.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above the finished ground level shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

12.4.11 Airport Loading Walkways.

12.4.11.1 Airport loading walkways shall conform to NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*, and the provisions of 12.4.11.2 and 12.4.11.3.

12.4.11.2 Doors in the egress path from the aircraft through the airport loading walkway into the airport terminal building shall meet both of the following criteria:

(1) They shall swing in the direction of egress from the aircraft.
(2)*They shall not be permitted to have delayed-egress locks.

12.4.11.3 Exit access shall be unimpeded from the airport loading walkway to the nonsecured public areas of the airport terminal building.

12.5 Building Services.

12.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

12.5.2 Heating, Ventilating, and Air-Conditioning Equipment. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

12.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

12.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

12.6 Reserved.

12.7 Operating Features.

12.7.1 Means of Egress Inspection.

12.7.1.1 The building owner or agent shall inspect the means of egress to ensure it is maintained free of obstructions, and correct any deficiencies found, prior to each opening of the building to the public.

12.7.1.2 The building owner or agent shall prepare and maintain records of the date and time of each inspection on approved forms, listing any deficiencies found and actions taken to correct them.

12.7.1.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

12.7.2 Special Provisions for Food Service Operations.

12.7.2.1 All devices in connection with the preparation of food shall be installed and operated to avoid hazard to the safety of occupants.

12.7.2.2 All devices in connection with the preparation of food shall be of an approved type and shall be installed in an approved manner.

12.7.2.3 Food preparation facilities shall be protected in accordance with 9.2.3 and shall not be required to have openings protected between food preparation areas and dining areas.

12.7.2.4 Portable cooking equipment that is not flue-connected shall be permitted only as follows:

(1) Equipment fueled by small heat sources that can be readily extinguished by water, such as candles or alcohol-burning equipment, including solid alcohol, shall be permitted to be used, provided that precautions satisfactory to the AHJ are taken to prevent ignition of any combustible materials.
(2) Candles shall be permitted to be used on tables used for food service where securely supported on substantial noncombustible bases located to avoid danger of ignition of combustible materials and only where approved by the AHJ.
(3) Candle flames shall be protected.
(4) "Flaming sword" or other equipment involving open flames and flamed dishes, such as cherries jubilee or crêpes suzette, shall be permitted to be used, provided that precautions subject to the approval of the AHJ are taken.
(5) Listed and approved LP-Gas commercial food service appliances shall be permitted to be used where in accordance with NFPA 58, *Liquefied Petroleum Gas Code*.

12.7.3 Open Flame Devices and Pyrotechnics. No open flame devices or pyrotechnic devices shall be used in any assembly occupancy, unless otherwise permitted by one of the following:

(1) Pyrotechnic special effect devices shall be permitted to be used on stages before proximate audiences for ceremonial or religious purposes, as part of a demonstration in exhibits, or as part of a performance, provided that both of the following criteria are met:
    (a) Precautions satisfactory to the authority having jurisdiction are taken to prevent ignition of any combustible material.
    (b) Use of the pyrotechnic device complies with NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*.
(2) Flame effects before an audience shall be permitted in accordance with NFPA 160, *Standard for the Use of Flame Effects Before an Audience*.
(3) Open flame devices shall be permitted to be used in the following situations, provided that precautions satisfactory to the authority having jurisdiction are taken to prevent ignition of any combustible material or injury to occupants:
    (a)*For ceremonial or religious purposes
    (b) On stages and platforms where part of a performance
    (c) Where candles on tables are securely supported on substantial noncombustible bases and candle flame is protected
(4) The requirement of 12.7.3 shall not apply to heat-producing equipment complying with 9.2.2.
(5) The requirement of 12.7.3 shall not apply to food service operations in accordance with 12.7.2.
(6) Gas lights shall be permitted to be used, provided that precautions are taken, subject to the approval of the authority having jurisdiction, to prevent ignition of any combustible materials.

12.7.4 Furnishings, Decorations, and Scenery.

12.7.4.1* Fabrics and films used for decorative purposes, all draperies and curtains, and similar furnishings shall be in accordance with the provisions of 10.3.1.

12.7.4.2 The authority having jurisdiction shall impose controls on the quantity and arrangement of combustible contents in assembly occupancies to provide an adequate level of safety to life from fire.

12.7.4.3 Exposed foamed plastic materials and unprotected materials containing foamed plastic used for decorative purposes or stage scenery shall have a heat release rate not exceeding 100 kW where tested in accordance with one of the following:

(1) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

12.7.4.4 The requirement of 12.7.4.3 shall not apply to individual foamed plastic items and items containing foamed plastic where the foamed plastic does not exceed 1 lb (0.45 kg) in weight.

12.7.5 Special Provisions for Exposition Facilities.

12.7.5.1 General. No display or exhibit shall be installed or operated to interfere in any way with access to any required exit or with the visibility of any required exit or required exit sign; nor shall any display block access to fire-fighting equipment.

12.7.5.2 Materials Not On Display. A storage room having an enclosure consisting of a smoke barrier having a minimum 1-hour fire resistance rating and protected by an automatic extinguishing system shall be provided for combustible materials not on display, including combustible packing crates used to ship exhibitors' supplies and products.

12.7.5.3 Exhibits.

12.7.5.3.1 Exhibits shall comply with 12.7.5.3.2 through 12.7.5.3.11.

12.7.5.3.2 The travel distance within the exhibit booth or exhibit enclosure to an exit access aisle shall not exceed 50 ft (15 m).

12.7.5.3.3 The upper deck of multilevel exhibits exceeding 300 ft^2 (28 m^2) shall have not less than two remote means of egress.

12.7.5.3.4 Exhibit booth construction materials shall be limited to the following:

(1) Noncombustible or limited-combustible materials
(2) Wood exceeding ¼ in. (6.3 mm) nominal thickness
(3) Wood that is pressure-treated, fire-retardant wood meeting the requirements of NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*
(4) Flame-retardant materials complying with one of the following:
   (a) They shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*
   (b) They shall exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(5) Textile wall coverings, such as carpeting and similar products used as wall or ceiling finishes, complying with the provisions of 10.2.2 and 10.2.4
(6) Plastics limited to those that comply with 12.3.3 and Section 10.2
(7) Foamed plastics and materials containing foamed plastics having a heat release rate for any single fuel package that does not exceed 100 kW where tested in accordance with one of the following:
   (a) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
   (b) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source
(8) Cardboard, honeycombed paper, and other combustible materials having a heat release rate for any single fuel package that does not exceed 150 kW where tested in accordance with one of the following:
   (a) UL 1975
   (b) NFPA 289, using the 20 kW ignition source

12.7.5.3.5 Curtains, drapes, and decorations shall comply with 10.3.1.

12.7.5.3.6 Acoustical and decorative material including, but not limited to, cotton, hay, paper, straw, moss, split bamboo, and wood chips shall be flame-retardant treated to the satisfaction of the authority having jurisdiction.

12.7.5.3.6.1 Materials that cannot be treated for flame retardancy shall not be used.

12.7.5.3.6.2 Foamed plastics, and materials containing foamed plastics and used as decorative objects such as, but not limited to, mannequins, murals, and signs, shall have a heat release rate for any single fuel package that does not exceed 150 kW where tested in accordance with one of the following:

(1) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

12.7.5.3.6.3 Where the aggregate area of acoustical and decorative materials is less than 10 percent of the individual floor or wall area, such materials shall be permitted to be used subject to the approval of the authority having jurisdiction.

12.7.5.3.7 The following shall be protected by automatic extinguishing systems:

(1) Single-level exhibit booths exceeding 300 ft^2 (28 m^2) and covered with a ceiling
(2) Each level of multilevel exhibit booths, including the uppermost level where the uppermost level is covered with a ceiling

12.7.5.3.7.1 The requirements of 12.7.5.3.7 shall not apply where otherwise permitted by the following:

(1) Ceilings that are constructed of open grate design or listed dropout ceilings in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be considered ceilings within the context of 12.7.5.3.7.
(2) Vehicles, boats, and similar exhibited products having over 100 ft^2 (9.3 m^2) of roofed area shall be provided with smoke detectors acceptable to the authority having jurisdiction.

(3)*The requirement of 12.7.5.3.7(2) shall not apply where fire protection of multilevel exhibit booths is consistent with the criteria developed through a life safety evaluation of the exhibition hall in accordance with 12.4.1, subject to approval of the authority having jurisdiction.

12.7.5.3.7.2 A single exhibit or group of exhibits with ceilings that do not require sprinklers shall be separated by a distance of not less than 10 ft (3050 mm) where the aggregate ceiling exceeds 300 ft^2 (28 m^2).

12.7.5.3.7.3 The water supply and piping for the sprinkler system shall be permitted to be of an approved temporary means that is provided by a domestic water supply, a standpipe system, or a sprinkler system.

12.7.5.3.8 Open flame devices within exhibit booths shall comply with 12.7.3.

12.7.5.3.9 Cooking and food-warming devices in exhibit booths shall comply with 12.7.2 and all of the following:

(1) Gas-fired devices shall comply with the following:
   (a) Natural gas-fired devices shall comply with 9.1.1.
   (b) The requirement of 12.7.5.3.9(1)(a) shall not apply to compressed natural gas where permitted by the authority having jurisdiction.
   (c) The use of LP-Gas cylinders shall be prohibited.
   (d) Nonrefillable LP-Gas cylinders shall be approved for use where permitted by the authority having jurisdiction.
(2) The devices shall be isolated from the public by not less than 48 in. (1220 mm) or by a barrier between the devices and the public.
(3) Multi-well cooking equipment using combustible oils or solids shall comply with 9.2.3.
(4) Single-well cooking equipment using combustible oils or solids shall meet all of the following criteria:
   (a) The equipment shall have lids available for immediate use.
   (b) The equipment shall be limited to 2 ft^2 (0.2 m^2) of cooking surface.
   (c) The equipment shall be placed on noncombustible surface materials.
   (d) The equipment shall be separated from each other by a horizontal distance of not less than 24 in. (610 mm).
   (e) The requirement of 12.7.5.3.9(4)(d) shall not apply to multiple single-well cooking equipment where the aggregate cooking surface area does not exceed 2 ft^2 (0.2 m^2).
   (f) The equipment shall be kept at a horizontal distance of not less than 24 in. (610 mm) from any combustible material.
(5) A portable fire extinguisher in accordance with Section 9.9 shall be provided within the booth for each device, or an approved automatic extinguishing system shall be provided.

12.7.5.3.10 Combustible materials within exhibit booths shall be limited to a one-day supply. Storage of combustible materials behind the booth shall be prohibited. *(See 12.7.4.2 and 12.7.5.2.)*

12.7.5.3.11 Plans for the exposition, in an acceptable form, shall be submitted to the authority having jurisdiction for approval prior to setting up any exhibit.

12.7.5.3.11.1 The plan shall show all details of the proposed exposition.

12.7.5.3.11.2 No exposition shall occupy any exposition facility without approved plans.

12.7.5.4 Vehicles. Vehicles on display within an exposition facility shall comply with 12.7.5.4.1 through 12.7.5.4.5.

12.7.5.4.1 All fuel tank openings shall be locked and sealed in an approved manner to prevent the escape of vapors; fuel tanks shall not contain in excess of one-half their capacity or contain in excess of 10 gal (38 L) of fuel, whichever is less.

12.7.5.4.2 At least one battery cable shall be removed from the batteries used to start the vehicle engine, and the disconnected battery cable shall then be taped.

12.7.5.4.3 Batteries used to power auxiliary equipment shall be permitted to be kept in service.

12.7.5.4.4 Fueling or defueling of vehicles shall be prohibited.

12.7.5.4.5 Vehicles shall not be moved during exhibit hours.

12.7.5.5 Prohibited Materials.

12.7.5.5.1 The following items shall be prohibited within exhibit halls:

(1) Compressed flammable gases
(2) Flammable or combustible liquids
(3) Hazardous chemicals or materials
(4) Class II or greater lasers, blasting agents, and explosives

12.7.5.5.2 The authority having jurisdiction shall be permitted to allow the limited use of any items specified in 12.7.5.5.1 under special circumstances.

12.7.5.6 Alternatives. See Section 1.4.

12.7.6 Crowd Managers.

12.7.6.1 Assembly occupancies shall be provided with a minimum of one trained crowd manager or crowd manager supervisor. Where the occupant load exceeds 250, additional trained crowd managers or crowd manager supervisors shall be provided at a ratio of one crowd manager or crowd manager supervisor for every 250 occupants, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to assembly occupancies used exclusively for religious worship with an occupant load not exceeding 500.
(2) The ratio of trained crowd managers to occupants shall be permitted to be reduced where, in the opinion of the AHJ, the existence of an approved, supervised automatic sprinkler system and the nature of the event warrant.

12.7.6.2* The crowd manager and crowd manager supervisor shall receive approved training in crowd management techniques.

12.7.6.3 Duties and responsibilities for the crowd manager and crowd manager supervisor shall be documented within a written emergency plan as required by 12.7.13.

12.7.6.4* The training for the duties and responsibilities of crowd managers shall include the following:

(1) Understanding crowd manager roles and responsibilities
(2) Understanding safety and security hazards that can endanger public assembly
(3) Understanding crowd management techniques
(4) Introduction to fire safety and fire safety equipment
(5) Understanding methods of evacuation and movement
(6) Understanding procedures for reporting emergencies

(7) Understanding crowd management emergency response procedures
(8) Understanding the paths of travel and exits, facility evacuation and emergency response procedures and, where provided, facility shelter-in-place procedures
(9) Familiarization with the venue and guest services training
(10) Other specific event-warranted training

12.7.6.5 The training for the duties and responsibilities of crowd manager supervisors shall include the following:

(1) The duties described in 12.7.6.4
(2) Understanding crowd manager supervisor roles and responsibilities
(3) Understanding incident management procedures
(4) Understanding the facility evacuation plan
(5) Understanding the facility command structure

12.7.7* Drills.

12.7.7.1 The employees or attendants of assembly occupancies shall be trained and drilled in the duties they are to perform in case of fire, panic, or other emergency to effect orderly exiting.

12.7.7.2 Employees or attendants of assembly occupancies shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment where provided.

12.7.7.3* In the following assembly occupancies, an audible announcement shall be made, or a projected image shall be shown, prior to the start of each program that notifies occupants of the location of the exits to be used in case of a fire or other emergency:

(1) Theaters
(2) Motion picture theaters
(3) Auditoriums
(4) Other similar assembly occupancies with occupant loads exceeding 300 where there are noncontinuous programs

12.7.7.4 The requirement of 12.7.7.3 shall not apply to assembly occupancies in schools where used for nonpublic events.

12.7.8 Smoking.

12.7.8.1 Smoking in assembly occupancies shall be regulated by the authority having jurisdiction.

12.7.8.2 In rooms or areas where smoking is prohibited, plainly visible signs shall be posted that read as follows:

NO SMOKING

12.7.8.3 No person shall smoke in prohibited areas that are so posted, unless permitted by the authority having jurisdiction under both of the following conditions:

(1) Smoking shall be permitted on a stage only where it is a necessary and rehearsed part of a performance.
(2) Smoking shall be permitted only where the smoker is a regular performing member of the cast.

12.7.8.4 Where smoking is permitted, suitable ashtrays or receptacles shall be provided in convenient locations.

12.7.9 Seating.

12.7.9.1 Secured Seating.

12.7.9.1.1 Seats in assembly occupancies accommodating more than 200 persons shall be securely fastened to the floor, except where fastened together in groups of not less than three and as permitted by 12.7.9.1.2 and 12.7.9.2.

12.7.9.1.2 Balcony and box seating areas that are separated from other areas by rails, guards, partial-height walls, or other physical barriers and have a maximum of 14 seats shall be exempt from the requirement of 12.7.9.1.1.

12.7.9.2 Unsecured Seating.

12.7.9.2.1 Seats not secured to the floor shall be permitted in restaurants, night clubs, and other occupancies where fastening seats to the floor might be impracticable.

12.7.9.2.2 Unsecured seats shall be permitted, provided that, in the area used for seating, excluding such areas as dance floors and stages, there is not more than one seat for each 15 ft^2 (1.4 m^2) of net floor area, and adequate aisles to reach exits are maintained at all times.

12.7.9.2.3 Seating diagrams shall be submitted for approval by the authority having jurisdiction to permit an increase in occupant load per 7.3.1.3.

12.7.9.3 Occupant Load Posting.

12.7.9.3.1 Every room constituting an assembly occupancy and not having fixed seats shall have the occupant load of the room posted in a conspicuous place near the main exit from the room.

12.7.9.3.2 Approved signs shall be maintained in a legible manner by the owner or authorized agent.

12.7.9.3.3 Signs shall be durable and shall indicate the number of occupants permitted for each room use.

12.7.10 Maintenance of Outdoor Grandstands.

12.7.10.1 The owner shall provide for not less than annual inspection and required maintenance of each outdoor grandstand to ensure safe conditions.

12.7.10.2 At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

12.7.10.3 Where required by the authority having jurisdiction, the owner shall provide a copy of the inspection report and certification that the inspection required by 12.7.10.2 has been performed.

12.7.11 Maintenance and Operation of Folding and Telescopic Seating.

12.7.11.1 Instructions in both maintenance and operation shall be transmitted to the owner by the manufacturer of the seating or his or her representative.

12.7.11.2 Maintenance and operation of folding and telescopic seating shall be the responsibility of the owner or his or her duly authorized representative and shall include all of the following:

(1) During operation of the folding and telescopic seats, the opening and closing shall be supervised by responsible personnel who shall ensure that the operation is in accordance with the manufacturer's instructions.
(2) Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.
(3) An annual inspection and required maintenance of each grandstand shall be performed to ensure safe conditions.

(4) At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

12.7.12 Clothing. Clothing and personal effects shall not be stored in corridors, and spaces not separated from corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) This requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by a smoke detection system in accordance with Section 9.6.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

12.7.13 Emergency Action Plans.

12.7.13.1 Emergency action plans shall be provided in accordance with Section 4.8.

12.7.13.2 Where assembly occupancies are located in the high-rise portion of a building, the emergency action plan shall include egress procedures, methods, and preferred evacuation routes for each event considered to be a life safety hazard that could impact the building, including the appropriateness of the use of elevators.

Chapter 13 Existing Assembly Occupancies

13.1 General Requirements.

13.1.1 Application.

13.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as assembly occupancies, unless otherwise specified by 13.1.1.4. *(See 3.3.190.2 for definition of assembly occupancy.)*

13.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

13.1.1.3 General. The provisions of Chapter 4, General, shall apply.

13.1.1.4 An existing building housing an assembly occupancy established prior to the effective date of this *Code* shall be permitted to be approved for continued use if it conforms to, or is made to conform to, the provisions of this *Code* to the extent that, in the opinion of the authority having jurisdiction, reasonable life safety against the hazards of fire, explosion, and panic is provided and maintained.

13.1.1.5 Additions to existing buildings shall conform to the requirements of 4.6.7.

13.1.1.6 Existing portions of buildings shall be upgraded if the addition results in an increase in the required minimum number of separate means of egress in accordance with 7.4.1.2.

13.1.1.7 Existing portions of the structure shall not be required to be modified, provided that both of the following criteria are met:

(1) The new construction has not diminished the fire safety features of the facility.
(2) The addition does not result in an increase in the required minimum number of separate means of egress in accordance with 7.4.1.2.

13.1.1.8 An assembly occupancy in which an occupant load increase results in an increase in the required minimum number of separate means of egress, in accordance with 7.4.1.2, shall meet the requirements for new construction.

13.1.2* Classification of Occupancy. See 6.1.2.

13.1.3 Multiple Occupancies.

13.1.3.1 General. Multiple occupancies shall be in accordance with 6.1.14.

13.1.3.2 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

13.1.3.3* Simultaneous Occupancy. Exits shall be sufficient for simultaneous occupancy of both the assembly occupancy and other parts of the building, except where the authority having jurisdiction determines that the conditions are such that simultaneous occupancy will not occur.

13.1.3.4 Assembly and Mercantile Occupancies in Mall Buildings.

13.1.3.4.1 The provisions of Chapter 13 shall apply to the assembly occupancy tenant space.

13.1.3.4.2 The provisions of 37.4.4 shall be permitted to be used outside the assembly occupancy tenant space.

13.1.4 Definitions.

13.1.4.1 General. For definitions, see Chapter 3, Definitions.

13.1.4.2* Special Definitions. The following is a list of special terms used in this chapter:

(1) **Aisle Accessway.** *(See 3.3.11.)*
(2) **Aisle Stair.** *(See 3.3.265.1.)*
(3) **Exhibit.** *(See 3.3.79.)*
(4) **Exhibitor.** *(See 3.3.80.)*
(5) **Exposition.** *(See 3.3.86.)*
(6) **Exposition Facility.** *(See 3.3.90.1.)*
(7) **Festival Seating.** *(See 3.3.239.1.)*
(8) **Flow Time.** *(See 3.3.117.)*
(9) **Fly Gallery.** *(See 3.3.118.)*
(10) **Gridiron.** *(See 3.3.128.)*
(11) **Legitimate Stage.** *(See 3.3.264.1.)*
(12) **Life Safety Evaluation.** *(See 3.3.160.)*
(13) **Multilevel Play Structure.** *(See 3.3.272.5.)*
(14) **Pinrail.** *(See 3.3.210.)*
(15) **Platform.** *(See 3.3.211.)*
(16) **Proscenium Wall.** *(See 3.3.288.2.)*
(17) **Regular Stage.** *(See 3.3.264.2.)*
(18) **Smoke-Protected Assembly Seating.** *(See 3.3.239.4.)*
(19) **Special Amusement Building.** *(See 3.3.36.10.)*
(20) **Stage.** *(See 3.3.264.)*
(21) **Temporary Platform.** *(See 3.3.211.1.)*

13.1.5 Classification of Hazard of Contents. Contents of assembly occupancies shall be classified in accordance with the provisions of Section 6.2.

13.1.6 Minimum Construction Requirements. Assembly occupancies shall be limited to the building construction types specified in Table 13.1.6, based on the number of stories in height as defined in 4.6.3, unless otherwise permitted by the following *(see 8.2.1)*:

(1) This requirement shall not apply to outdoor grandstands of Type I or Type II construction.
(2) This requirement shall not apply to outdoor grandstands of Type III, Type IV, or Type V construction that meet the requirements of 13.4.9.
(3) This requirement shall not apply to grandstands of noncombustible construction supported by the floor in a building meeting the construction requirements of Table 13.1.6.
(4) This requirement shall not apply to assembly occupancies within mall buildings in accordance with 37.4.4.

13.1.7 Occupant Load.

13.1.7.1* General. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

13.1.7.1.1 In areas not in excess of 10,000 ft^2 (930 m^2), the occupant load shall not exceed one person in 5 ft^2 (0.46 m^2).

13.1.7.1.2 In areas in excess of 10,000 ft^2 (930 m^2), the occupant load shall not exceed one person in 7 ft^2 (0.65 m^2).

13.1.7.1.3 The authority having jurisdiction shall be permitted to establish the occupant load as the number of persons for which the existing means of egress is adequate, provided that measures are established to prevent occupancy by a greater number of persons.

13.1.7.2 Waiting Spaces. In theaters and other assembly occupancies where persons are admitted to the building at times when seats are not available, or when the permitted occupant load has been reached based on 13.1.7.1 and persons are allowed to wait in a lobby or similar space until seats or space is available, all of the following requirements shall apply:

(1) Such use of a lobby or similar space shall not encroach upon the required clear width of exits.
(2) The waiting spaces shall be restricted to areas other than the required means of egress.
(3) Exits shall be provided for the waiting spaces on the basis of one person for each 3 ft^2 (0.28 m^2) of waiting space area.
(4) Exits for waiting spaces shall be in addition to the exits specified for the main auditorium area and shall conform in construction and arrangement to the general rules for exits given in this chapter.

13.1.7.3 Life Safety Evaluation. Where the occupant load of an assembly occupancy exceeds 6000, a life safety evaluation shall be performed in accordance with 13.4.1.

13.1.7.4 Outdoor Facilities. In outdoor facilities, where approved by the authority having jurisdiction, the number of occupants who are each provided with not less than 15 ft^2 (1.4 m^2) of lawn surface shall be permitted to be excluded from the maximum occupant load of 6000 of 13.1.7.3 in determining the need for a life safety evaluation.

13.2 Means of Egress Requirements.

13.2.1 General. All means of egress shall be in accordance with Chapter 7 and this chapter.

13.2.2 Means of Egress Components.

13.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 13.2.2.2 through 13.2.2.12.

13.2.2.2 Doors.

13.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

13.2.2.2.2 Assembly occupancies with occupant loads of 300 or less in malls *(see 37.4.4.2(4)* shall be permitted to have horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) on the main entrance/exits.

13.2.2.2.3 Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to delayed-egress locks as permitted in 13.2.2.2.5.
(2) This requirement shall not apply to access-controlled egress doors as permitted in 13.2.2.2.6.

13.2.2.2.4 Locking devices complying with 7.2.1.5.5 shall be permitted to be used on a single door or a single pair of doors if both of the following conditions apply:

(1) The door or pair of doors serve as the main exit from assembly occupancies having an occupant load not greater than 600.
(2) Any latching devices on such a door(s) from an assembly occupancy having an occupant load of 100 or more are released by panic hardware or fire exit hardware.

13.2.2.2.5 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted on doors other than main entrance/exit doors.

13.2.2.2.6 Doors in the means of egress shall be permitted to be equipped with an approved access control system complying with 7.2.1.6.2, and such doors shall not be locked from the egress side when the assembly occupancy is occupied. *(See 7.2.1.1.3.)*

13.2.2.2.7 Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

13.2.2.2.8 Revolving doors complying with the requirements of 7.2.1.10 for new construction shall be permitted.

13.2.2.2.9 The provisions of 7.2.1.11.1.1 to permit turnstiles where revolving doors are permitted shall not apply.

13.2.2.2.10 No turnstiles or other devices that restrict the movement of persons shall be installed in any assembly occupancy in such a manner as to interfere with required means of egress facilities.

Table 13.1.6 Construction Type Limitations

Construction Type	Sprinklered[a]	Stories Below	Stories in Height[b] 1	2	3	4	≥5
I (442)[c, d]	Yes	X	X	X	X	X	X
	No	NP	X	X	X	X	X3
I (332)[c, d]	Yes	X	X	X	X	X	X
	No	NP	X	X	X	X	X3
II (222)[c, d]	Yes	X	X	X	X	X	X
	No	NP	X	X	X	X	X3
II (111)[c, d]	Yes	X1	X	X	X	X3	NP
	No	NP	X	X	X3	NP	NP
II (000)	Yes	X2	X	X4	NP	NP	NP
	No	NP	X3	NP	NP	NP	NP
III (211)	Yes	X1	X	X	X	X3	NP
	No	NP	X	X	X4	NP	NP
III (200)	Yes	X2	X	X4	NP	NP	NP
	No	NP	X3	NP	NP	NP	NP
IV (2HH)	Yes	X1	X	X	X	X3	NP
	No	NP	X	X	X4	NP	NP
V (111)	Yes	X1	X	X	X	X3	NP
	No	NP	X	X	X4	NP	NP
V (000)	Yes	X2	X	X4	NP	NP	NP
	No	NP	X3	NP	NP	NP	NP

X: Permitted for assembly of any occupant load.
X1: Permitted for assembly of any occupant load, but limited to one story below the level of exit discharge.
X2: Permitted for assembly limited to an occupant load of 1000 or less, and limited to one story below the level of exit discharge.
X3: Permitted for assembly limited to an occupant load of 1000 or less.
X4: Permitted for assembly limited to an occupant load of 300 or less.
NP: Not permitted.
[a]Protected by an approved automatic sprinkler system in accordance with Section 9.7 in the following locations:
(1) Throughout the story of the assembly occupancy
(2) Throughout all stories intervening between the story of the assembly occupancy and the level of exit discharge
(3) Throughout the level of exit discharge if there are any openings between the level of exit discharge and the exits serving the assembly occupancy
[b]See 4.6.3.
[c]Where every part of the structural framework of roofs in Type I or Type II construction is 20 ft (6100 mm) or more above the floor immediately below, omission of all fire protection of the structural members is permitted, including protection of trusses, roof framing, decking, and portions of columns above 20 ft (6100 mm).
[d]In open-air fixed seating facilities, including stadia, omission of fire protection of structural members exposed to the outside atmosphere is permitted where substantiated by an approved engineering analysis.

13.2.2.3 Stairs.

13.2.2.3.1 General. Stairs complying with 7.2.2 shall be permitted, unless one of the following criteria applies:

(1)*Stairs serving seating that is designed to be repositioned shall not be required to comply with 7.2.2.3.1.
(2) This requirement shall not apply to stages and platforms as permitted by 13.4.6.
(3) The stairs connecting only a stage or platform and the immediately adjacent assembly seating shall be permitted to have a handrail in the center only or on one side only.
(4) The stairs connecting only a stage or platform and the immediately adjacent assembly seating shall be permitted to omit the guards required by 7.1.8 where both of the following criteria are met:
   (a) The guard would restrict audience sight lines to the stage or platform.
   (b) The height between any part of the stair and the adjacent floor is not more than 42 in. (1065 mm).

13.2.2.3.2 Catwalk, Gallery, and Gridiron Stairs.

13.2.2.3.2.1 Noncombustible grated stair treads and landing floors shall be permitted in means of egress from lighting and access catwalks, galleries, and gridirons.

13.2.2.3.2.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted in means of egress from lighting and access catwalks, galleries, and gridirons.

13.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

13.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

13.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

13.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

13.2.2.8 Escalators and Moving Walks. Escalators and moving walks complying with 7.2.7 shall be permitted.

13.2.2.9 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted.

13.2.2.10 Fire Escape Ladders.

13.2.2.10.1 Fire escape ladders complying with 7.2.9 shall be permitted.

13.2.2.10.2 For ladders serving catwalks, the three-person limitation in 7.2.9.1(3) shall be permitted to be increased to ten persons.

13.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

13.2.2.12 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

13.2.3 Capacity of Means of Egress.

13.2.3.1 General. The capacity of means of egress shall be in accordance with one of the following:

(1) Section 7.3 for other than theater-type seating or smoke-protected assembly seating
(2) 13.2.3.2 for rooms with theater-type seating or similar seating arranged in rows
(3) 13.4.2 for smoke-protected assembly seating

13.2.3.2* Theater-Type Seating. Minimum clear widths of aisles and other means of egress serving theater-type seating, or similar seating arranged in rows, shall be in accordance with Table 13.2.3.2.

Table 13.2.3.2 Capacity Factors

	Clear Width per Seat Served			
	Stairs		Passageways, Ramps, and Doorways	
No. of Seats	in.	mm	in.	mm
Unlimited	0.3 *AB*	7.6 *AB*	0.22 *C*	5.6 *C*

13.2.3.3 Width Modifications. The minimum clear widths shown in Table 13.2.3.2 shall be modified in accordance with all of the following:

(1) If risers exceed 7 in. in height, the stair width in Table 13.2.3.2 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 7}{5} \qquad \textbf{[13.2.3.3(1)]}$$

(2) If risers exceed 178 mm in height, the stair width in Table 13.2.3.2 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 178}{125} \qquad \textbf{[13.2.3.3(2)]}$$

(3) Stairs not having a handrail within a 30 in. (760 mm) horizontal distance shall be 25 percent wider than otherwise calculated; that is, their width shall be multiplied by factor *B*, where *B* equals the following:

$$B = 1.25 \qquad \textbf{[13.2.3.3(3)]}$$

(4) Ramps steeper than 1 in 10 slope where used in ascent shall have their width increased by 10 percent; that is, their width shall be multiplied by factor *C*, where *C* equals the following:

$$C = 1.10 \qquad \textbf{[13.2.3.3(4)]}$$

13.2.3.4 Lighting and Access Catwalks. The requirements of 13.2.3.2 and 13.2.3.3 shall not apply to lighting and access catwalks as permitted by 13.4.6.9.

13.2.3.5 Bleachers Aisles. In seating composed entirely of bleachers for which the row-to-row dimension is 28 in. (710 mm) or less, and from which front egress is not limited, aisles shall not be required to exceed 66 in. (1675 mm) in width.

13.2.3.6 Main Entrance/Exit.

13.2.3.6.1 Every assembly occupancy shall be provided with a main entrance/exit.

13.2.3.6.2 The main entrance/exit shall be of a width that accommodates one-half of the total occupant load.

13.2.3.6.3 The main entrance/exit shall be at the level of exit discharge or shall connect to a stairway or ramp leading to a street.

13.2.3.6.4 Reserved.

13.2.3.6.5 Where the main entrance/exit from an assembly occupancy is through a lobby or foyer, the aggregate capacity of all exits from the lobby or foyer shall be permitted to provide the required capacity of the main entrance/exit, regardless of whether all such exits serve as entrances to the building.

13.2.3.6.6* In assembly occupancies where there is no well-defined main entrance/exit, exits shall be permitted to be distributed around the perimeter of the building, provided that the total exit width furnishes not less than 100 percent of the width needed to accommodate the permitted occupant load.

13.2.3.7 Other Exits. Each level of an assembly occupancy shall have access to the main entrance/exit and shall be provided with additional exits of a width to accommodate not less than one-half of the total occupant load served by that level.

13.2.3.7.1 Additional exits shall discharge in accordance with 13.2.7.

13.2.3.7.2 Additional exits shall be located as far apart as practicable and as far from the main entrance/exit as practicable.

13.2.3.7.3 Additional exits shall be accessible from a cross aisle or a side aisle.

13.2.3.7.4 In assembly occupancies where there is no well-defined main entrance/exit, exits shall be permitted to be distributed around the perimeter of the building, provided that the total exit width furnishes not less than 100 percent of the width required to accommodate the permitted occupant load.

13.2.4* Number of Means of Egress.

13.2.4.1 The number of means of egress shall be in accordance with Section 7.4, other than fenced outdoor assembly occupancies in accordance with 13.2.4.4, unless otherwise permitted by 13.2.4.2 or 13.2.4.3.

13.2.4.2 Assembly occupancies with occupant loads of 600 or fewer shall have two separate means of egress.

13.2.4.3 Assembly occupancies with occupant loads greater than 600 but fewer than 1000 shall have three separate means of egress.

13.2.4.4 A fenced outdoor assembly occupancy shall have not less than two widely separated means of egress from the enclosure, unless otherwise required by one of the following:

(1) If more than 6000 persons are to be served by such means of egress, there shall be not less than three means of egress.
(2) If more than 9000 persons are to be served by such means of egress, there shall be not less than four means of egress.

13.2.4.5 Balconies or mezzanines having an occupant load not exceeding 50 shall be permitted to be served by a single means of egress, and such means of egress shall be permitted to lead to the floor below.

13.2.4.6 Balconies or mezzanines having an occupant load exceeding 50, but not exceeding 100, shall have not less than two remote means of egress, but both such means of egress shall be permitted to lead to the floor below.

13.2.4.7 Balconies or mezzanines having an occupant load exceeding 100 shall have means of egress as described in 7.4.1.

13.2.4.8 A second means of egress shall not be required from lighting and access catwalks, galleries, and gridirons where a means of escape to a floor or a roof is provided. Ladders, alternating tread devices, or spiral stairs shall be permitted in such means of escape.

13.2.5 Arrangement of Means of Egress.

13.2.5.1 General.

13.2.5.1.1 Means of egress shall be arranged in accordance with Section 7.5.

13.2.5.1.2 A common path of travel shall be permitted for the first 20 ft (6100 mm) from any point where the common path serves any number of occupants, and for the first 75 ft (23 m) from any point where the common path serves not more than 50 occupants.

13.2.5.1.3 Dead-end corridors shall not exceed 20 ft (6100 mm).

13.2.5.2 Access Through Hazardous Areas. Means of egress shall not be permitted through kitchens, storerooms, restrooms, closets, platforms, stages, or hazardous areas as described in 13.3.2.

13.2.5.3 Reserved.

13.2.5.4 General Requirements for Access and Egress Routes Within Assembly Areas.

13.2.5.4.1 Festival seating, as defined in 3.3.239.1, shall be prohibited within a building, unless otherwise permitted by one of the following:

(1) Festival seating shall be permitted in assembly occupancies having occupant loads of 250 or less.
(2) Festival seating shall be permitted in assembly occupancies where occupant loads exceed 250, provided that an approved life safety evaluation has been performed. *(See 13.4.1.)*

13.2.5.4.2* Access and egress routes shall be maintained so that any individual is able to move without undue hindrance, on personal initiative and at any time, from an occupied position to the exits.

13.2.5.4.3* Access and egress routes shall be maintained so that crowd management, security, and emergency medical personnel are able to reach any individual at any time, without undue hindrance.

13.2.5.4.4* The width of aisle accessways and aisles shall provide sufficient egress capacity for the number of persons accommodated by the catchment area served by the aisle accessway or aisle in accordance with 13.2.3.2, or for smoke-protected assembly seating in accordance with 13.4.2.

13.2.5.4.5 Where aisle accessways or aisles converge to form a single path of egress travel, the required egress capacity of that path shall be not less than the combined required capacity of the converging aisle accessways and aisles.

13.2.5.4.6 Those portions of aisle accessways and aisles where egress is possible in either of two directions shall be uniform in required width, unless otherwise permitted by 13.2.5.4.7.

13.2.5.4.7 The requirement of 13.2.5.4.6 shall not apply to those portions of aisle accessways where the required width, not including the seat space described by 13.2.5.7.3, does not exceed 12 in. (305 mm).

13.2.5.4.8 In the case of side boundaries for aisle accessways or aisles, other than those for nonfixed seating at tables, the clear width shall be measured to boundary elements such as walls, guardrails, handrails, edges of seating, tables, and side edges of treads, and said measurement shall be made horizontally to the vertical projection of the elements, resulting in the smallest width measured perpendicularly to the line of travel.

13.2.5.5* Aisle Accessways Serving Seating Not at Tables.

13.2.5.5.1* The required clear width of aisle accesses between rows of seating shall be determined as follows:

(1) Horizontal measurements shall be made, between vertical planes, from the back of one seat to the front of the most forward projection of the seat immediately behind it.
(2) Where the entire row consists of automatic- or self-rising seats that comply with ASTM F 851, *Standard Test Method for Self-Rising Seat Mechanisms*, the measurement shall be permitted to be made with the seats in the up position.

13.2.5.5.2 The aisle accessway between rows of seating shall have a clear width of not less than 12 in. (305 mm), and this minimum shall be increased as a function of row length in accordance with 13.2.5.5.4, 13.2.5.5.5, and 13.2.5.5.6.

13.2.5.5.3 If used by not more than four persons, no minimum clear width shall be required for the portion of an aisle accessway having a length not exceeding 6 ft (1830 mm), measured from the center of the seat farthest from the aisle.

13.2.5.5.4 The increase in aisle accessway width required by 13.2.5.5.2 shall not apply to grandstands, bleachers, and folding and telescopic seating, provided that the number of seats between the farthest seat and an aisle does not exceed that shown in Table 13.4.9.2.5.

13.2.5.5.5* Rows of seating served by aisles or doorways at both ends shall not exceed 100 seats per row.

13.2.5.5.5.1 The 12 in. (305 mm) minimum clear width of aisle accessway specified in 13.2.5.5.2 shall be increased by 0.3 in. (7.6 mm) for every seat over a total of 14 but shall not be required to exceed 22 in. (560 mm).

13.2.5.5.5.2 The requirement of 13.2.5.5.5.1 shall not apply to smoke-protected assembly seating as permitted by 13.4.2.7.

13.2.5.5.6 Rows of seating served by an aisle or doorway at one end only shall have a path of travel not exceeding 30 ft (9.1 m) in length from any seat to an aisle.

13.2.5.5.7 The depth of seat boards shall be not less than 9 in. (230 mm) where the same level is not used for both seat boards and footboards.

13.2.5.5.8 Footboards, independent of seats, shall be provided so that there is no horizontal opening that allows the passage of a ½ in. (13 mm) diameter sphere.

13.2.5.6 Aisles Serving Seating Not at Tables.

13.2.5.6.1 General.

13.2.5.6.1.1 Aisles shall be provided so that the number of seats served by the nearest aisle is in accordance with 13.2.5.5.2 through 13.2.5.5.5, unless otherwise permitted by 13.2.5.6.1.2.

13.2.5.6.1.2 Aisles shall not be required in bleachers, provided that all of the following conditions are met:

(1) Egress from the front row shall not be obstructed by a rail, a guard, or other obstruction.
(2) The row spacing shall be 28 in. (710 mm) or less.
(3) The rise per row, including the first row, shall be 6 in. (150 mm) or less.
(4) The number of rows shall not exceed 16.
(5) The seat spaces shall not be physically defined.
(6) Seat boards that are also used as stepping surfaces for descent shall provide a walking surface with a width of not less than 12 in. (305 mm), and, where a depressed footboard exists, the gap between seat boards of adjacent rows shall not exceed 12 in. (305 mm), measured horizontally.
(7) The leading edges of seat boards used as stepping surfaces shall be provided with a contrasting marking stripe so that the location of the leading edge is readily apparent, particularly where viewed in descent, and the following shall also apply:
    (a) The marking stripe shall be not less than 1 in. (25 mm) wide and shall not exceed 2 in. (51 mm) in width.
    (b) The marking stripe shall not be required where bleacher surfaces and environmental conditions, under all conditions of use, are such that the location of each leading edge is readily apparent, particularly when viewed in descent.

13.2.5.6.2 Dead-End Aisles. Dead-end aisles shall not exceed 20 ft (6100 mm) in length, unless otherwise permitted by one of the following:

(1) A dead-end aisle shall be permitted to exceed 20 ft (6100 mm) in length where seats served by the dead-end aisle are not more than 24 seats from another aisle, measured along a row of seats having a clear width of not less than 12 in. (305 mm) plus 0.6 in. (15 mm) for each additional seat over a total of 7 in the row.
(2) A 16-row, dead-end aisle shall be permitted in folding and telescopic seating and grandstands.
(3) Aisle termination in accordance with 13.4.2.11 for smoke-protected assembly seating shall be permitted.
(4) Bleacher aisles in accordance with 13.2.3.5 shall not be considered as dead-end aisles.

13.2.5.6.3* Minimum Aisle Width. The minimum clear width of aisles shall be sufficient to provide egress capacity in accordance with 13.2.3.1 but shall be not less than the following:

(1) 42 in. (1065 mm) for stairs having seating on each side, except that the minimum clear width shall be permitted to be not less than 30 in. (760 mm) for catchment areas having not more than 60 seats
(2) 36 in. (915 mm) for stairs having seating on only one side, or 30 in. (760 mm) for catchment areas having not more than 60 seats
(3) 20 in. (510 mm) between a handrail and seating or between a guardrail and seating where the aisle is subdivided by a handrail
(4) 42 in. (1065 mm) for level or ramped aisles having seating on both sides, except that the minimum clear width shall be not less than 30 in. (760 mm) for catchment areas having not more than 60 seats
(5) 36 in. (915 mm) for level or ramped aisles having seating on only one side, or 30 in. (760 mm) for catchment areas having not more than 60 seats
(6) 23 in. (585 mm) between a handrail or a guardrail and seating where the aisle does not serve more than five rows on one side

13.2.5.6.4 Aisle Stairs and Aisle Ramps.

13.2.5.6.4.1* The following shall apply to aisle stairs and aisle ramps:

(1) Aisles having a gradient steeper than 1 in 20, but not steeper than 1 in 8, shall consist of an aisle ramp.
(2) Aisles having a gradient steeper than 1 in 8 shall consist of an aisle stair.

13.2.5.6.4.2 Aisle stairs, other than approved existing aisle stairs, shall comply with 7.2.2 except as otherwise addressed by this chapter.

13.2.5.6.4.3 Table 7.2.2.2.1.1(a) and Table 7.2.2.2.1.1(b) shall not apply to aisle stairs.

13.2.5.6.4.4 The limitation on height between landings in Table 7.2.5.3(a) and Table 7.2.5.3(b) shall not apply to aisle ramps and landings.

13.2.5.6.5 Aisle Stair Treads. Aisle stair treads shall meet all of the following criteria:

(1) There shall be no variation in the depth of adjacent treads that exceeds 3⁄16 in. (4.8 mm), unless otherwise permitted by 13.2.5.6.5(2), (5), or (6).
(2) Construction-caused nonuniformities in tread depth shall be permitted, provided that both of the following criteria are met:
   (a) The nonuniformity does not exceed 3⁄8 in. (10 mm).
   (b) The aisle tread depth is 22 in. (560 mm) or greater.
(3)*Tread depth shall be not less than 11 in. (280 mm).
(4) All treads shall extend the full width of the aisle.
(5)*In aisle stairs where a single intermediate tread is provided halfway between seating platforms, such intermediate treads shall be permitted to be of a relatively smaller but uniform depth but shall be not less than 13 in. (330 mm).
(6) All of the following shall apply to grandstands, bleachers, and folding and telescopic seating:
   (a) Steps shall not be required to be provided in aisles to overcome differences in level unless the gradient exceeds 1 unit of rise in 10 units of run.
   (b) Where the rise of the seating platform exceeds 11 in. (280 mm), an intermediate step shall be provided for the full width of the aisle and shall be proportioned to provide two steps of equal rise per platform.
   (c) Where the rise of the seating platform exceeds 18 in. (455 mm), two intermediate steps for the full width of the aisle shall be provided and proportioned to provide three steps of equal rise per platform that are uniform and not less than 9 in. (230 mm).
   (d) The full length of the nose of each step in the aisle, as required by 13.2.5.6.5(6)(c), shall be conspicuously marked.

13.2.5.6.6 Aisle Stair Risers. Aisle stair risers shall meet the following criteria:

(1) Riser heights shall be not less than 4 in. (100 mm) in aisle stairs, unless aisle stairs are those in folding and telescopic seating.
(2) The riser height of aisle stairs in folding and telescopic seating shall be permitted to be not less than 3½ in. (90 mm).
(3) Riser heights shall not exceed 8 in. (205 mm), unless otherwise permitted by 13.2.5.6.6(4) or 13.2.5.6.6(5).
(4) The riser height of aisle stairs in folding and telescopic seating shall be permitted to be not more than 11 in. (280 mm).
(5) Where the gradient of an aisle is steeper than 8 in. (205 mm) in rise in 11 in. (280 mm) of run for the purpose of maintaining necessary sight lines in the adjoining seating area, the riser height shall be permitted to exceed 8 in. (205 mm) but shall not exceed 11 in. (280 mm).
(6) Riser heights shall be designed to be uniform in each aisle, and the construction-caused nonuniformities shall not exceed 3⁄16 in. (4.8 mm) between adjacent risers, unless the conditions of 13.2.5.6.6(7) or 13.2.5.6.6(8) are met.
(7) Riser height shall be permitted to be nonuniform where all of the following criteria are met:
   (a) The nonuniformity shall be only for the purpose of accommodating changes in gradient necessary to maintain sight lines within a seating area, in which case the nonuniformity shall be permitted to exceed 3⁄16 in. (4.8 mm) but shall not be greater than ½ in. (13 mm) between adjacent risers.
   (b) Approved existing nonuniformities for the purpose of accommodating changes in gradient necessary to maintain sight lines within a seating area shall be permitted.
   (c) Where nonuniformities exceed 3⁄16 in. (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated by a distinctive marking stripe on each tread at the nosing or leading edge adjacent to the nonuniform risers.
(8) Construction-caused nonuniformities in riser height shall be permitted to exceed 3⁄16 in. (4.8 mm) where all of the following criteria are met:
   (a) The riser height shall be designed to be nonuniform.
   (b) The construction-caused nonuniformities shall not exceed 3⁄8 in. (10 mm) where the aisle tread depth is less than 22 in. (560 mm).
   (c) The construction-caused nonuniformities shall not exceed ¾ in. (19 mm) where the aisle tread depth is 22 in. (560 mm) or greater.
   (d) Where nonuniformities exceed 3⁄16 in. (4.8 mm) between adjacent risers, the exact location of such nonuniformities shall be indicated by a distinctive marking stripe on each tread at the nosing or leading edge adjacent to the nonuniform risers.

13.2.5.6.7 Aisle Stair Profile. Aisle stairs shall comply with all of the following:

(1) Aisle risers shall be vertical or sloped under the tread projection at an angle not to exceed 30 degrees from vertical.
(2) Tread projection not exceeding 1½ in. (38 mm) shall be permitted.
(3) Tread projection shall be uniform in each aisle, except as otherwise permitted by 13.2.5.6.7(4).
(4) Construction-caused projection nonuniformities not exceeding ¼ in. (6.4 mm) shall be permitted.

13.2.5.6.8 Aisle Landings. Where the path of travel on a stair, an aisle stair, or aisle ramp continues to another stair of different rise or tread depth, another aisle stair of different rise or tread depth, or another aisle ramp of different slope, there shall be a landing whose depth is equal to or greater than the width of the aisle stair or ramp, unless otherwise permitted by one of the following:

(1) No landing shall be required within aisle stairs with nonuniform risers as permitted by 13.2.5.6.6(7).
(2) No landing shall be required between aisle ramps of different slopes.

(3) No landing shall be required between an aisle ramp and an aisle accessway or between an aisle stair and an aisle accessway.
(4) A minimum 30 in. (760 mm) deep landing shall be permitted between an aisle stair and a stair with the same tread depths or between an aisle stair and another aisle stair with the same tread depths.
(5) A minimum 30 in. (760 mm) deep landing shall be permitted between an aisle stair and a stair with greater tread depth in the descending direction and between an aisle stair and another aisle stair with greater tread depth in the descending direction.
(6) A minimum 30 in. (760 mm) deep landing shall be permitted between an aisle stair and a stair with less tread depth in the descending direction and between an aisle stair and another aisle stair with less tread depth in the descending direction.
(7) A minimum 22 in. (560 mm) deep landing shall be permitted between an aisle ramp and a stair and between an aisle ramp and an aisle stair.
(8) No landing depth shall be required to exceed 48 in. (1220 mm).
(9) Approved existing installations shall be permitted.

13.2.5.6.9* Aisle Handrails.

13.2.5.6.9.1 Ramped aisles having a gradient exceeding 1 in 12 and aisle stairs shall be provided with handrails at one side or along the centerline and shall also be in accordance with 7.2.2.4.5.1, 7.2.2.4.5.5, and 7.2.2.4.5.6.

13.2.5.6.9.2 Where seating exists on both sides of the aisle, the handrails shall be noncontinuous with gaps or breaks at intervals not exceeding five rows to facilitate access to seating and to allow crossing from one side of the aisle to the other.

13.2.5.6.9.3 The gaps or breaks permitted by 13.2.5.6.9.1 shall have a clear width of not less than 22 in. (560 mm) and shall not exceed 36 in. (915 mm), measured horizontally, and the handrail shall have rounded terminations or bends.

13.2.5.6.9.4 Where handrails are provided in the middle of aisle stairs, an additional intermediate rail shall be located approximately 12 in. (305 mm) below the main handrail.

13.2.5.6.9.5 Where an aisle transition stair does not have seating at its sides, a handrail shall be provided on both sides of the aisle, and the provision of 13.2.5.6.9.6 shall also apply.

13.2.5.6.9.6 Where an aisle stair leading to the aisle transition stair is provided with a center handrail and the aisle landing is less than 48 in. (1220 mm) in the direction of travel, a center handrail shall also be provided on the aisle transition stair.

13.2.5.6.9.7 Handrails shall not be required where otherwise permitted by one of the following:

(1) Handrails shall not be required for ramped aisles having a gradient not steeper than 1 in 8 and having seating on both sides.
(2) The requirement for a handrail shall be satisfied by the use of a guard provided with a rail that complies with the graspability requirements for handrails and is located at a consistent height between 34 in. and 42 in. (865 mm and 1065 mm), measured as follows:
    (a) Vertically from the top of the rail to the leading edge (nosing) of stair treads
    (b) Vertically from the top of the rail to the adjacent walking surface in the case of a ramp
(3) Handrails shall not be required where risers do not exceed 7 in. (180 mm) in height.

13.2.5.6.10* Aisle Marking.

13.2.5.6.10.1 A contrasting marking stripe shall be provided on each tread at the nosing or leading edge so that the location of such tread is readily apparent, particularly when viewed in descent.

13.2.5.6.10.2 The marking stripe shall be not less than 1 in. (25 mm) wide and shall not exceed 2 in. (51 mm) in width.

13.2.5.6.10.3 The marking stripe shall not be required where tread surfaces and environmental conditions, under all conditions of use, are such that the location of each tread is readily apparent, particularly when viewed in descent.

13.2.5.7* Aisle Accessways Serving Seating at Tables.

13.2.5.7.1 The required clear width of an aisle accessway shall be not less than 12 in. (305 mm) where measured in accordance with 13.2.5.7.3 and shall be increased as a function of length in accordance with 13.2.5.7.4, unless otherwise permitted by 13.2.5.7.2.

13.2.5.7.2* If used by not more than four persons, no minimum clear width shall be required for the portion of an aisle accessway having a length not exceeding 6 ft (1830 mm) and located farthest from an aisle.

13.2.5.7.3* Where nonfixed seating is located between a table and an aisle accessway or aisle, the measurement of required clear width of the aisle accessway or aisle shall be made to a line 19 in. (485 mm), measured perpendicularly to the edge of the table, away from the edge of said table.

13.2.5.7.4* The minimum required clear width of an aisle accessway, measured in accordance with 13.2.5.4.8 and 13.2.5.7.3, shall be increased beyond the 12 in. (305 mm) requirement of 13.2.5.7.1 by ½ in. (13 mm) for each additional 12 in. (305 mm) or fraction thereof beyond 12 ft (3660 mm) of aisle accessway length, where measured from the center of the seat farthest from an aisle.

13.2.5.7.5 The path of travel along the aisle accessway shall not exceed 36 ft (11 m) from any seat to the closest aisle or egress doorway.

13.2.5.8 Aisles Serving Seating at Tables.

13.2.5.8.1* Aisles that contain steps or that are ramped, such as aisles serving dinner theater–style configurations, shall comply with the requirements of 13.2.5.6.

13.2.5.8.2* The width of aisles serving seating at tables shall be not less than 44 in. (1120 mm) where serving an occupant load exceeding 50, and 36 in. (915 mm) where serving an occupant load of 50 or fewer.

13.2.5.8.3* Where nonfixed seating is located between a table and an aisle, the measurement of required clear width of the aisle shall be made to a line 19 in. (485 mm), measured perpendicularly to the edge of the table, away from the edge of said table.

13.2.5.9 Approval of Layouts.

13.2.5.9.1 Where required by the authority having jurisdiction, plans drawn to scale showing the arrangement of furnishings or equipment shall be submitted to the authority by the building owner, manager, or authorized agent to substantiate conformance with the provisions of 13.2.5.

13.2.5.9.2 The layout plans shall constitute the only acceptable arrangement, unless one of the following criteria is met:

(1) The plans are revised.
(2) Additional plans are submitted and approved.
(3) Temporary deviations from the specifications of the approved plans are used, provided that the occupant load is not increased and the intent of 13.2.5.9 is maintained.

13.2.6 Travel Distance to Exits.

13.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

13.2.6.2 Exits shall be arranged so that the total length of travel from any point to reach an exit shall not exceed 200 ft (61 m) in any assembly occupancy, unless otherwise permitted by one of the following:

(1) The travel distance shall not exceed 250 ft (76 m) in assembly occupancies protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.
(2) The travel distance requirement shall not apply to smoke-protected assembly seating as permitted by 13.4.2.12, 13.4.2.13, and 13.4.2.14.

13.2.7 Discharge from Exits.

13.2.7.1 Exit discharge shall comply with Section 7.7.

13.2.7.2 The level of exit discharge shall be measured at the point of principal entrance to the building.

13.2.7.3 Where the principal entrance to an assembly occupancy is via a terrace, either raised or depressed, such terrace shall be permitted to be considered to be the first story in height for the purposes of Table 13.1.6 where all of the following criteria are met:

(1) The terrace is at least as long, measured parallel to the building, as the total width of the exit(s) it serves but not less than 60 in. (1525 mm) long.
(2) The terrace is at least as wide, measured perpendicularly to the building, as the exit(s) it serves but not less than 60 in. (1525 mm) wide.
(3) Required stairs leading from the terrace to the finished ground level are protected in accordance with 7.2.2.6.3 or are not less than 10 ft (3050 mm) from the building.

13.2.8 Illumination of Means of Egress. Means of egress, other than for private party tents not exceeding 1200 ft^2 (112 m^2), shall be illuminated in accordance with Section 7.8.

13.2.9 Emergency Lighting.

13.2.9.1 Emergency lighting, other than that permitted by 13.2.9.3, shall be provided in accordance with Section 7.9.

13.2.9.2 Private party tents not exceeding 1200 ft^2 (112 m^2) shall not be required to have emergency lighting.

13.2.9.3 Assembly occupancies with an occupant load not exceeding 300 and used exclusively for a place of worship shall not be required to have emergency lighting.

13.2.10 Marking of Means of Egress.

13.2.10.1 Means of egress shall be provided with signs in accordance with Section 7.10.

13.2.10.2 Exit markings shall not be required on the seating side of vomitories from seating areas where exit marking is provided in the concourse and where such marking is readily apparent from the vomitories.

13.2.10.3 Evacuation diagrams in accordance with 7.10.8.5 shall be provided.

13.2.11 Special Means of Egress Features.

13.2.11.1 Guards and Railings: Boxes, Balconies, and Galleries. Boxes, balconies, and galleries shall meet the following criteria:

(1) The fasciae of boxes, balconies, and galleries shall rise not less than 26 in. (660 mm) above the adjacent floor or shall have substantial railings not less than 26 in. (660 mm) above the adjacent floor.
(2) The height of the rail above footrests on the adjacent floor immediately in front of a row of seats shall be not less than 26 in. (660 mm), and the following also shall apply:
    (a) Railings at the ends of aisles shall be not less than 36 in. (915 mm) high for the full width of the aisle.
    (b) Railings at the end of aisles shall be not less than 36 in. (915 mm) high at the ends of aisles where steps occur.
(3) Aisle accessways adjacent to orchestra pits and vomitories, and all cross aisles, shall be provided with railings not less than 26 in. (660 mm) above the adjacent floor.
(4) The requirement of 13.2.11.1(3) shall not apply where the backs of seats located at the front of the aisle project 24 in. (610 mm) or more above the adjacent floor of the aisle.
(5) Guardrails shall not be required on the audience side of stages, raised platforms, and other raised floor areas such as runways, ramps, and side stages used for entertainment or presentations.
(6) Permanent guardrails shall not be required at vertical openings in the performance area of stages.
(7) Guardrails shall not be required where the side of an elevated walking surface is required to be open for the normal functioning of special lighting or for access and use of other special equipment.
(8) Where a guard is ordinarily required but not provided in accordance with 13.2.11.1(5) or (6), a written plan shall be developed and maintained to mitigate the fall hazards of unguarded raised floor areas and vertical openings on stages.

13.2.11.2 Lockups. Lockups in assembly occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

13.3 Protection.

13.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by one of the following:

(1)*Stairs or ramps shall be permitted to be unenclosed between balconies or mezzanines and main assembly areas located below, provided that the balcony or mezzanine is open to the main assembly area.
(2) Exit access stairs from lighting and access catwalks, galleries, and gridirons shall not be required to be enclosed.
(3) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall be permitted to have unprotected vertical openings between any two adjacent floors, provided that such openings are separated from unprotected vertical openings serving other floors by a barrier complying with 8.6.5.

(4) Assembly occupancies protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 shall be permitted to have convenience stair openings in accordance with 8.6.9.2.
(5) Use of the following alternative materials shall be permitted where assemblies constructed of such materials are in good repair and free of any condition that would diminish their original fire resistance characteristics:
   (a) Existing wood lath and plaster
   (b) Existing ½ in. (13 mm) gypsum wallboard
   (c) Existing installations of ¼ in. (6.3 mm) thick wired glass that are, or are rendered, inoperative and fixed in the closed position
   (d) Other existing materials having similar fire resistance capabilities

13.3.2 Protection from Hazards.

13.3.2.1 Service Equipment, Hazardous Operations or Processes, and Storage Facilities.

13.3.2.1.1 Rooms containing high-pressure boilers, refrigerating machinery of other than the domestic refrigerator type, large transformers, or other service equipment subject to explosion shall meet both of the following requirements:

(1) Such rooms shall not be located directly under or abutting required exits.
(2) Such rooms shall be separated from other parts of the building by fire barriers in accordance with Section 8.3 that have a minimum 1-hour fire resistance rating or shall be protected by automatic extinguishing systems in accordance with Section 8.7.

13.3.2.1.2 Rooms or spaces for the storage, processing, or use of materials specified in 13.3.2.1.2(1) through (3) shall be protected in accordance with the following:

(1) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating or protection of such rooms by automatic extinguishing systems as specified in Section 8.7 in the following areas:
   (a) Boiler and furnace rooms, unless otherwise protected by one of the following:
      i. The requirement of 13.3.2.1.2(1)(a) shall not apply to rooms enclosing furnaces, heating and air-handling equipment, or compressor equipment with a total aggregate input rating less than 200,000 Btu (211 MJ), provided that such rooms are not used for storage.
      ii. The requirement of 13.3.2.1.2(1)(a) shall not apply to attic locations of the rooms addressed in 13.3.2.1.2(1)(a)(i), provided that such rooms comply with the draftstopping requirements of 8.6.11.
   (b) Rooms or spaces used for the storage of combustible supplies in quantities deemed hazardous by the authority having jurisdiction
   (c) Rooms or spaces used for the storage of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
(2) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating and protection of such rooms by automatic extinguishing systems as specified in Section 8.7 in the following areas:
   (a) Laundries
   (b) Maintenance shops, including woodworking and painting areas
   (c) Rooms or spaces used for processing or use of combustible supplies deemed hazardous by the authority having jurisdiction
   (d) Rooms or spaces used for processing or use of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
(3) Protection as permitted in accordance with 9.7.1.2 where automatic extinguishing is used to meet the requirements of 13.3.2.1.2(1) or (2)

13.3.2.2 Cooking Equipment. Cooking equipment shall be protected in accordance with 9.2.3, unless the cooking equipment is one of the following types:

(1) Outdoor equipment
(2) Portable equipment not flue-connected
(3) Equipment used only for food warming

13.3.3 Interior Finish.

13.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

13.3.3.2 Corridors, Lobbies, and Enclosed Stairways. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in all corridors and lobbies and shall be Class A in enclosed stairways.

13.3.3.3 Assembly Areas. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in general assembly areas having occupant loads of more than 300 and shall be Class A, Class B, or Class C in assembly areas having occupant loads of 300 or fewer.

13.3.3.4 Screens. Screens on which pictures are projected shall comply with requirements of Class A or Class B interior finish in accordance with Section 10.2.

13.3.3.5 Interior Floor Finish. (No requirements.)

13.3.4 Detection, Alarm, and Communications Systems.

13.3.4.1 General.

13.3.4.1.1 Assembly occupancies with occupant loads of more than 300 and all theaters with more than one audience-viewing room shall be provided with an approved fire alarm system in accordance with 9.6.1 and 13.3.4, unless otherwise permitted by 13.3.4.1.2, 13.3.4.1.3, or 13.3.4.1.4.

13.3.4.1.2 Assembly occupancies that are a part of a multiple occupancy protected as a mixed occupancy *(see 6.1.14)* shall be permitted to be served by a common fire alarm system, provided that the individual requirements of each occupancy are met.

13.3.4.1.3 Voice communication or public address systems complying with 13.3.4.3.6 shall not be required to comply with 9.6.1.

13.3.4.1.4 The requirement of 13.3.4.1.1 shall not apply to assembly occupancies where, in the judgment of the authority having jurisdiction, adequate alternative provisions exist or are provided for the discovery of a fire and for alerting the occupants promptly.

13.3.4.2 Initiation.

13.3.4.2.1 Initiation of the required fire alarm system shall be by both of the following means, and the system shall be provided with an emergency power source:

(1) Manual means in accordance with 9.6.2.1(1), unless otherwise permitted by one of the following:

(a) The requirement of 13.3.4.2.1(1) shall not apply where initiation is by means of an approved automatic fire detection system in accordance with 9.6.2.1(2) that provides fire detection throughout the building.
(b) The requirement of 13.3.4.2.1(1) shall not apply where initiation is by means of an approved automatic sprinkler system in accordance with 9.6.2.1(3) that provides fire detection and protection throughout the building.

(2) Where automatic sprinklers are provided, initiation of the fire alarm system by sprinkler system waterflow, even where manual fire alarm boxes are provided in accordance with 13.3.4.2.1(1)

13.3.4.2.2 The initiating device shall be capable of transmitting an alarm to a receiving station, located within the building, that is constantly attended when the assembly occupancy is occupied.

13.3.4.2.3* In assembly occupancies with occupant loads of more than 300, automatic detection shall be provided in all hazardous areas that are not normally occupied, unless such areas are protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

13.3.4.3 Notification. The required fire alarm system shall activate an audible alarm in a constantly attended receiving station within the building when occupied for purposes of initiating emergency action.

13.3.4.3.1 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

13.3.4.3.2 A presignal system in accordance with 9.6.3.3 shall be permitted.

13.3.4.3.3 Occupant notification shall be by means of voice announcements in accordance with 9.6.3.9 initiated by the person in the constantly attended receiving station.

13.3.4.3.4 Reserved.

13.3.4.3.5 Reserved.

13.3.4.3.6 The announcement shall be permitted to be made via a voice communication or public address system in accordance with 9.6.3.9.2.

13.3.4.3.7 Where the authority having jurisdiction determines that a constantly attended receiving station is impractical, automatically transmitted evacuation or relocation instructions shall be provided in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

13.3.5 Extinguishment Requirements. See also 13.1.6, 13.2.6, and 13.3.2.

13.3.5.1 Where the occupant load exceeds 100, the following assembly occupancies shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1):

(1) Dance halls
(2) Discotheques
(3) Nightclubs
(4) Assembly occupancies with festival seating

13.3.5.2 Any assembly occupancy used or capable of being used for exhibition or display purposes shall be protected throughout by an approved automatic sprinkler system in accordance with Section 9.7 where the exhibition or display area exceeds 15,000 ft^2 (1400 m^2).

13.3.5.3 The sprinklers specified by 13.3.5.2 shall not be required where otherwise permitted in the following locations:

(1) Locations in stadia and arenas as follows:
(a) Over the floor areas used for contest, performance, or entertainment
(b) Over the seating areas
(c) Over open-air concourses where an approved engineering analysis substantiates the ineffectiveness of the sprinkler protection due to building height and combustible loading

(2) Locations in unenclosed stadia and arenas as follows:
(a) Press boxes of less than 1000 ft^2 (93 m^2)
(b) Storage facilities of less than 1000 ft^2 (93 m^2) if enclosed with not less than 1-hour fire resistance–rated construction
(c) Enclosed areas underneath grandstands that comply with 13.4.9.5

13.3.5.4 Where another provision of this chapter requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with 9.7.1.1(1).

13.3.6 Corridors. (No requirements.)

13.4 Special Provisions.

Subsection 13.4.1 was revised by a tentative interim amendment. (TIA). See page 1.

13.4.1 Life Safety Evaluation.

13.4.1.1* General. Where a life safety evaluation is required by other provisions of this *Code*, it shall comply with the following:

(1) The life safety evaluation shall be performed by persons acceptable to the AHJ.
(2) The life safety evaluation shall include a written assessment of safety measures for conditions listed in 13.4.1.2 and of the building systems and facility management in accordance with 13.4.1.3.
(3) The life safety evaluation shall be approved annually by the AHJ and shall be updated for special or unusual conditions in accordance with the provisions of 13.4.1 for existing assembly occupancies.

13.4.1.2 Conditions to Be Assessed. Life safety evaluations shall include an assessment of all of the following conditions and related appropriate safety measures:

(1) Nature of the events and the participants and attendees
(2) Access and egress movement, including crowd density problems
(3) Medical emergencies
(4) Fire hazards
(5) Permanent and temporary structural systems
(6) Severe weather conditions
(7) Earthquakes
(8) Civil or other disturbances
(9) Hazardous materials incidents within and near the facility
(10) Relationships among facility management, event participants, emergency response agencies, and others having a role in the events accommodated in the facility

13.4.1.3* Building Systems and Facility Management Assessments. Life safety evaluations shall include assessments of both building systems and facility management upon which reliance is placed for the safety of facility occupants, and such assessments shall consider scenarios appropriate to the facility.

13.4.1.3.1 Building Systems. Documentation of the building systems in accordance with 13.4.1.4 shall be provided upon request of the AHJ.

13.4.1.3.2 Facility Management. Facility management shall provide the AHJ with facility management documentation in accordance with 13.4.1.5 upon request of the AHJ.

13.4.1.3.3 Life Safety Evaluation. The life safety evaluation shall confirm that the building systems and the facility management and operational plans provide appropriate safety measures.

13.4.1.4 Life Safety Building Systems Document. The AHJ shall be provided with a life safety building systems document providing the information required in 13.4.1.4.2 through 13.4.1.4.4.

13.4.1.4.1 Reserved.

13.4.1.4.2 Life Safety Narrative. A life safety narrative shall be provided describing the following:

(1) Building occupancy, construction type, and intended uses and events
(2) Building area and population capacity of the proposed facility
(3) Principal fire and life safety features/strategies for the building, including — as applicable — the following:
    (a) Egress
    (b) Access control
    (c) Fire barriers, smoke barriers, and smoke partitions
    (d) Fire suppression systems
    (e) Smoke control/protection
    (f) Fire detection and alarm
    (g) PA system
    (h) Emergency elevator operation
    (i) Emergency power and lighting
    (j) Provisions for patrons with disabilities
    (k) Fire department access
    (l) Fire/emergency command center
(4) Exterior construction design parameters used/applied

13.4.1.4.3 Life Safety Floor Plans. Life safety floor plans of each level shall be provided — as applicable — with the following:

(1) Occupant load, exit location, egress capacity, main entrance/exit, horizontal exits, travel distance, and exit discharge
(2) Fire barriers, smoke barriers, and smoke partitions
(3) Areas of smoke-protected assembly occupancy
(4) Separate smoke-protected areas or zones
(5) Areas of other occupancy type and separations
(6) Unprotected vertical openings
(7) Event plans for each anticipated type of event depicting the following:
    (a) Seating configuration
    (b) Exhibit booth layout
    (c) Stage location
    (d) Occupant load, egress capacity required, exits provided, and travel distance
    (e) Any floor or stage use restrictions
    (f) Plan and/or section drawing indicating areas where the roof construction is more than 50 ft (15 m) above floor level and areas where sprinkler protection is omitted
    (g) Areas of refuge — interior and exterior

13.4.1.4.4 Engineering Analysis and Calculations. An engineering analysis shall be provided with the following:

(1) Smoke protection analysis to substantiate the use of smoke-protected assembly seating as follows:
    (a) Performance-based design methods approved by the AHJ
    (b) Smoke control requirements per NFPA 92, *Standard for Smoke Control Systems*
    (c) Smoke control assumptions, such as fire scenario description, fire size quantification, and smoke development/smoke movement analysis
    (d) Proposed testing protocol for smoke control system and pass/fail criteria
    (e) Timed egress analysis and assumed flow rates and travel speeds
(2) Sprinkler protection calculations, including an engineering analysis substantiating locations in accordance with 13.3.5.3 where sprinkler protection would be ineffective due to height and combustible loading
(3) Load diagram of rigging/load capacity of gridiron, fly loft, or long-span roof structure used for hanging overhead objects

13.4.1.5 Life Safety Management Document. The AHJ shall be provided with a life safety management document providing the information required in 13.4.1.5.2 through 13.4.1.5.7.

13.4.1.5.1 Reserved.

13.4.1.5.2 Facility Management and Operational Plans. Facility management and operational plans shall address the following:

(1) Best practices adopted or recognized
(2) Emergency plans
(3) Evacuation plans
(4) Shelter-in-place plans including capacities and protection considerations
(5) Crowd management training plans
(6) Safety plans, which include the following:
    (a) Training plans
    (b) Safety equipment plans
(7) Fire alarm, smoke control system protocol, and testing plans
(8) First aid or medical treatment plans, which include the following:
    (a) Defined levels of service
    (b) Standing orders adopted
    (c) Supply and equipment plan
(9) Housekeeping plans — biological, medical, hazardous materials cleaning
(10) Emergency communication plans, which include the following:
    (a) Chain of authority and incident command system employed

(b) Contact information for the following:
i. Venue personnel
ii. Emergency management and response organizations (such as fire, police, medical, utility, transportation, and key stakeholders)

(c) Communication systems
(d) Standard announcement for incidents or emergency situations

(11) Risk and threat assessment for venue and surrounding area for the following:
(a) Severe weather
(b) Hazardous materials
(c) Terrorism
(d) Hostile intruder

(12) Operating procedures and protocols for risks, such as the following:
(a) Severe weather preparedness and monitoring plans
(b) Hazardous materials incidence response plans
(c) Terrorism response plans
(d) Hostile intruder response plans

(13) First responder response/arrival routes plans
(14) Alcohol management plans
(15) Food safety plans
(16) Rigging and temporary performance structure, which includes the following:
(a) Design and safety review plans
(b) Emergency action plans

(17) Chemical and hazardous materials information and data
(18) Barrier and wall protection plans for motor sports or similar events

13.4.1.5.3 Records. Records of the facility management plans, including procedures and location, shall be maintained for the following:

(1) Crowd management training
(2) Safety training
(3) Fire alarm, smoke control system maintenance, and test records
(4) First aid or medical treatment and regulation compliance

13.4.1.5.4 Building Systems Reference Guide. A building systems reference guide shall be provided in accordance with 13.4.1.5.4.1 through 13.4.1.5.4.3.

13.4.1.5.4.1 A basic life safety building systems reference guide shall be developed and maintained.

13.4.1.5.4.2 The life safety building systems reference guide shall contain the important and key information for the venue management's use when planning events/activities for the safety of patrons, performers/participants, employees, and vendors.

13.4.1.5.4.3 The life safety building systems document in accordance with 13.4.1.4 shall be permitted to be used, and additionally the life safety building systems reference guide shall include the following:

(1) Occupant capacity of every space/room
(2) Egress flow diagrams, including assumed flow rates, and capacities of all aisles and hallways, including public and nonpublic areas
(3) Capacities of all exterior doors and/or choke points in immediate perimeter areas
(4) Limitations or assumptions for ingress control that could be in place during an emergency egress/evacuation, including control gates, queuing barriers, and turnstiles
(5) Capacities of immediate perimeter exterior walkways, including assumed flow rates for exterior areas
(6) Assumed egress paths for normal conditions — transportation modes
(7) Management level sequencing charts for alarm and emergency communication systems, the manual, or override options/instructions that include the following:
(a) List of codes or alarm signals
(b) Location of manual overrides
(c) Description of sequence of operations during an alarm, such as exhaust fans operate or doors open

(8) Principal fire and life safety features/strategies, such as sprinklers, smoke control, fire alarm notifications, PA system, emergency power, and fire department access
(9) Assumptions when developing occupancy plans for venue floor, open areas, and nonevent spaces
(a) Event floor plans/setup diagrams for each typical event/activity
(b) Fire sprinkler and smoke protection capabilities

(10) Severe weather shelter areas, locations, structure considerations (limitations), capacities (occupancy and density factor)
(11) Command center, which includes the following:
(a) Location (formal or informal)
(b) Structural integrity considerations
(c) Redundant locations and/or capabilities
(d) Jurisdictional rights — assumed and/or applied

(12) Locations and capacities of wheelchair and mobility-impaired seating
(13) Locations and capacities of areas of refuge and other safe areas
(14) Rigging or structural load capacities of grids, truss structure, fly lofts, ceilings, floors, ramps, and staging
(15) List of locations of emergency equipment (such as fire extinguishers, fire hose cabinets, fire hydrants, and AEDs)
(16) Sequencing of electrical service, such as the following:
(a) Emergency generators and charts of all areas illuminated during power outages
(b) Multiple electrical feed capabilities

(17) List of mechanical, movable equipment in the facility
(18) Potential hazards in the surrounding neighborhood, including train tracks and propane stations
(19) Assumptions or accommodations considered and used in design

13.4.1.5.5 The facility management plans shall be maintained and adjusted as necessary for changes to the venue structure, operating purposes and style, and event occupancy.

13.4.1.5.6 Facility management and operational plans shall be submitted to the AHJ annually.

13.4.1.5.7 For events and activities at the venue that are outside the normal operating conditions or vary from the normal facility management plans, the following shall apply:

(1) Facility management shall perform an event/activity-specific facility management plan for the AHJ to review.
(2) Approval of the AHJ for the specific facility management plan shall occur prior to such event.

13.4.2* Smoke-Protected Assembly Seating.

13.4.2.1 To be considered smoke protected, an assembly seating facility shall comply with both of the following:

(1) All enclosed areas with walls and ceilings in buildings or structures containing smoke-protected assembly seating shall be protected with an approved automatic sprinkler system in accordance with Section 9.7, unless otherwise permitted by one of the following:
   (a) The requirement of 13.4.2.1(1) shall not apply to the floor area used for contest, performance, or entertainment, provided that the roof construction is more than 50 ft (15 m) above the floor level and use is restricted to low fire hazard uses.
   (b) Sprinklers shall not be required to be located over the floor area used for contest, performance, or entertainment and over the seating areas where an approved engineering analysis substantiates the ineffectiveness of the sprinkler protection due to building height and combustible loading.

(2) All means of egress serving a smoke-protected assembly seating area shall be provided with smoke-actuated ventilation facilities or natural ventilation designed to maintain the level of smoke at not less than 6 ft (1830 m) above the floor of the means of egress.

13.4.2.2 To use the provisions of smoke-protected assembly seating, a facility shall be subject to a life safety evaluation in accordance with 13.4.1.

13.4.2.3 Minimum clear widths of aisles and other means of egress serving smoke-protected assembly seating shall be in accordance with Table 13.4.2.3.

Table 13.4.2.3 Capacity Factors for Smoke-Protected Assembly Seating

Number of Seats	Clear Width per Seat Served: Stairs in.	Stairs mm	Passageways, Ramps, and Doorways in.	Passageways, Ramps, and Doorways mm
2,000	0.300 *AB*	7.6 *AB*	0.220 *C*	5.6 *C*
5,000	0.200 *AB*	5.1 *AB*	0.150 *C*	3.8 *C*
10,000	0.130 *AB*	3.3 *AB*	0.100 *C*	2.5 *C*
15,000	0.096 *AB*	2.4 *AB*	0.070 *C*	1.8 *C*
20,000	0.076 *AB*	1.9 *AB*	0.056 *C*	1.4 *C*
≥25,000	0.060 *AB*	1.5 *AB*	0.044 *C*	1.1 *C*

13.4.2.4 Outdoor Smoke-Protected Assembly Seating.

13.4.2.4.1 Where smoke-protected assembly seating and its means of egress are located wholly outdoors, capacity shall be permitted to be provided in accordance with Table 13.4.2.4.1 and the provision of 13.4.2.4.2 shall apply.

13.4.2.4.2 Where the number of seats in outdoor smoke-protected assembly seating exceeds 20,000, the capacity factors of Table 13.4.2.3 shall be permitted to be used.

13.4.2.5 Where using Table 13.4.2.3, the number of seats specified shall be within a single assembly space, and interpolation shall be permitted between the specific values shown. A single seating space shall be permitted to have multiple levels, floors, or mezzanines.

Table 13.4.2.4.1 Capacity Factors for Outdoor Smoke-Protected Assembly Seating

Feature	Clear Width per Seat Served: Stairs in.	Stairs mm	Passageways, Ramps, and Doorways in.	Passageways, Ramps, and Doorways mm
Outdoor smoke-protected assembly seating	0.08 *AB*	2.0 *AB*	0.06 *C*	1.5 *C*

13.4.2.6 The minimum clear widths shown in Table 13.4.2.3 and Table 13.4.2.4.1 shall be modified in accordance with all of the following:

(1) If risers exceed 7 in. in height, the stair width in Table 13.4.2.3 and Table 13.4.2.4.1 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 7}{5} \qquad \textbf{[13.4.2.6(1)]}$$

(2) If risers exceed 178 mm in height, the stair width in Table 13.4.2.3 and Table 13.4.2.4.1 shall be multiplied by factor *A*, where *A* equals the following:

$$A = 1 + \frac{\text{riser height} - 178}{125} \qquad \textbf{[13.4.2.6(2)]}$$

(3) Stairs not having a handrail within a 30 in. (760 mm) horizontal distance shall be 25 percent wider than otherwise calculated; that is, their width shall be multiplied by factor *B*, where *B* equals the following:

$$B = 1.25 \qquad \textbf{[13.4.2.6(3)]}$$

(4) Ramps steeper than 1 in 10 slope used in ascent shall have their width increased by 10 percent; that is, their width shall be multiplied by factor *C*, where *C* equals the following:

$$C = 1.10 \qquad \textbf{[13.4.2.6(4)]}$$

13.4.2.7 Where smoke-protected assembly seating conforms to the requirements of 13.4.2, for rows of seats served by aisles or doorways at both ends, the number of seats per row shall not exceed 100, and the clear width of not less than 12 in. (305 mm) for aisle accessways shall be increased by 0.3 in. (7.6 mm) for every additional seat beyond the number stipulated in Table 13.4.2.7; however, the minimum clear width shall not be required to exceed 22 in. (560 mm).

13.4.2.8 Where smoke-protected assembly seating conforms to the requirements of 13.4.2, for rows of seats served by an aisle or doorway at one end only, the aisle accessway clear width of not less than 12 in. (305 mm) shall be increased by 0.6 in. (15 mm) for every additional seat beyond the number stipulated in Table 13.4.2.7; however, the minimum clear width shall not be required to exceed 22 in. (560 mm).

Table 13.4.2.7 Smoke-Protected Assembly Seating Aisle Accessways

Total Number of Seats in the Space	Number of Seats per Row Permitted to Have a Clear Width Aisle Accessway of Not Less than 12 in. (305 mm): Aisle or Doorway at Both Ends of Row	Aisle or Doorway at One End of Row
<4,000	14	7
4,000–6,999	15	7
7,000–9,999	16	8
10,000–12,999	17	8
13,000–15,999	18	9
16,000–18,999	19	9
19,000–21,999	20	10
≥22,000	21	11

13.4.2.9 Smoke-protected assembly seating conforming with the requirements of 13.4.2 shall be permitted to have a common path of travel of 50 ft (15 m) from any seat to a point where a person has a choice of two directions of egress travel.

13.4.2.10 Aisle accessways shall be permitted to serve as one or both of the required exit accesses addressed in 12.4.2.9, provided that the aisle accessway has a minimum width of 12 in. (305 mm) plus 0.3 in. (7.6 mm) for every additional seat over a total of 7 in a row.

13.4.2.11 Where smoke-protected assembly seating conforms to the requirements of 13.4.2, the dead ends in aisle stairs shall not exceed a distance of 21 rows, unless both of the following criteria are met:

(1) The seats served by the dead-end aisle are not more than 40 seats from another aisle.
(2) The 40-seat distance is measured along a row of seats having an aisle accessway with a clear width of not less than 12 in. (305 mm) plus 0.3 in. (7.6 mm) for each additional seat above 7 in the row.

13.4.2.12 Where smoke-protected assembly seating conforms to the requirements of 13.4.2, the travel distance from each seat to the nearest entrance to an egress vomitory or egress concourse shall not exceed 400 ft (122 m).

13.4.2.13 Where smoke-protected assembly seating conforms to the requirements of 13.4.2, the travel distance from the entrance to the vomitory or from the egress concourse to an approved egress stair, ramp, or walk at the building exterior shall not exceed 200 ft (61 m).

13.4.2.14 The travel distance requirements of 13.4.2.12 and 13.4.2.13 shall not apply to outdoor assembly seating facilities of Type I or Type II construction where all portions of the means of egress are essentially open to the outside.

13.4.3 Limited Access or Underground Buildings. Limited access or underground buildings shall comply with Section 11.7.

13.4.4 High-Rise Buildings. Existing high-rise buildings that house assembly occupancies in high-rise portions of the building shall have the highest level of the assembly occupancy and all levels below protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7. *(See also 13.1.6.)*

13.4.5 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

13.4.6 Stages and Platforms. See 3.3.264 and 3.3.211.

13.4.6.1 Materials and Design.

13.4.6.1.1 Reserved.

13.4.6.1.2 Stage stairs shall be permitted to be of combustible materials, regardless of building construction type.

13.4.6.2 Platform Construction. (Reserved)

13.4.6.3 Stage Construction. (Reserved)

13.4.6.4 Accessory Rooms. (Reserved)

13.4.6.5 Ventilators. Regular stages in excess of 1000 ft^2 (93 m^2) and legitimate stages shall be provided with emergency ventilation to provide a means of removing smoke and combustion gases directly to the outside in the event of a fire, and such ventilation shall be achieved by one or a combination of the methods specified in 13.4.6.5.1 through 13.4.6.5.3.

13.4.6.5.1 Smoke Control.

13.4.6.5.1.1 A means complying with Section 9.3 shall be provided to maintain the smoke level at not less than 6 ft (1830 mm) above the highest level of assembly seating or above the top of the proscenium opening where a proscenium wall and opening protection are provided.

13.4.6.5.1.2 Reserved.

13.4.6.5.1.3 The smoke control system shall be activated independently by each of the following:

(1) Activation of the sprinkler system in the stage area
(2) Activation of smoke detectors over the stage area
(3) Activation by manually operated switch at an approved location

13.4.6.5.1.4 The emergency ventilation system shall be supplied by both normal and standby power.

13.4.6.5.1.5 The fan(s) power wiring and ducts shall be located and properly protected to ensure a minimum of 20 minutes of operation in the event of activation.

13.4.6.5.2 Roof Vents.

13.4.6.5.2.1 Two or more vents shall be located near the center of and above the highest part of the stage area.

13.4.6.5.2.2 The vents shall be raised above the roof and shall provide a net free vent area equal to 5 percent of the stage area.

13.4.6.5.2.3 Vents shall be constructed to open automatically by approved heat-activated devices, and supplemental means shall be provided for manual operation and periodic testing of the ventilator from the stage floor.

13.4.6.5.2.4 Vents shall be labeled.

13.4.6.5.2.5 Existing roof vents that are not labeled shall be permitted where they open by spring action or force of gravity sufficient to overcome the effects of neglect, rust, dirt, frost, snow, or expansion by heat or warping of the framework, and the following requirements also shall apply:

(1) Glass, if used in vents, shall be protected against falling onto the stage.
(2) A wire screen, if used under the glass, shall be placed so that, if clogged, it does not reduce the required venting

area, interfere with the operating mechanism, or obstruct the distribution of water from an automatic sprinkler.
(3) Vents shall be arranged to open automatically by the use of fusible links.
(4) The fusible links and operating cable shall hold each door closed against a minimum 30 lb (133 N) counterforce that shall be exerted on each door through its entire arc of travel and for not less than 115 degrees.
(5) Vents shall be provided with manual control.
(6) Springs, where employed to actuate vent doors, shall be capable of maintaining full required tension.
(7) Springs shall not be stressed more than 50 percent of their rated capacity and shall not be located directly in the airstream nor exposed to the outside.
(8) A fusible link shall be placed in the cable control system on the underside of the vent at or above the roofline, or as approved by the building official.
(9) The fusible link shall be located so as not to be affected by the operation of an automatic sprinkler system.
(10) Remote, manual, or electric controls shall provide for both opening and closing of the vent doors for periodic testing and shall be located at a point on stage designated by the authority having jurisdiction.
(11) Where remote control vents are electrical, power failure shall not affect instant operation of the vent in the event of fire.
(12) Hand winches shall be permitted to be employed to facilitate operation of manually controlled vents.

13.4.6.5.3 Other Means. Approved, alternate means of removing smoke and combustion gases shall be permitted.

13.4.6.6 Proscenium Walls. (Reserved)

13.4.6.7 Proscenium Opening Protection.

13.4.6.7.1 On every legitimate stage, the main proscenium opening used for viewing performances shall be provided with proscenium opening protection as follows:

(1) The proscenium opening protection shall comply with 12.4.6.7.
(2) Asbestos shall be permitted in lieu of a listed fabric.
(3) Manual curtains of any size shall be permitted.

13.4.6.7.2 In lieu of the protection required by 13.4.6.7.1(1), all the following shall be provided:

(1) A noncombustible opaque fabric curtain shall be arranged so that it closes automatically.
(2) An automatic, fixed waterspray deluge system shall be located on the auditorium side of the proscenium opening and shall be arranged so that the entire face of the curtain will be wetted, and all of the following requirements also shall apply:
    (a) The system shall be activated by a combination of rate-of-rise and fixed-temperature detectors located on the ceiling of the stage.
    (b) Detectors shall be spaced in accordance with their listing.
    (c) The water supply shall be controlled by a deluge valve and shall be sufficient to keep the curtain completely wet for 30 minutes or until the valve is closed by fire department personnel.
(3) The curtain shall be automatically operated in case of fire by a combination of rate-of-rise and fixed-temperature detectors that also activates the deluge spray system.
(4) Stage sprinklers and vents shall be automatically operated by fusible elements in case of fire.
(5) Operation of the stage sprinkler system or spray deluge valve shall automatically activate the emergency ventilating system and close the curtain.
(6) The curtain, vents, and spray deluge system valve shall also be capable of manual operation.

13.4.6.7.3 Proscenium opening protection provided by other than a fire curtain in accordance with 12.4.6.7 *[see 13.4.6.7.1(1)]* shall activate upon automatic detection of a fire and upon manual activation.

13.4.6.8 Gridirons, Fly Galleries, and Pinrails. (Reserved)

13.4.6.9 Catwalks. The clear width of lighting and access catwalks and the means of egress from galleries and gridirons shall be not less than 22 in. (560 mm).

13.4.6.10 Fire Protection. Every stage shall be protected by an approved automatic sprinkler system in compliance with Section 9.7.

13.4.6.10.1 Protection shall be provided throughout the stage and in storerooms, workshops, permanent dressing rooms, and other accessory spaces contiguous to stages.

13.4.6.10.2 Sprinklers shall not be required for stages 1000 ft^2 (93 m^2) or less in area where both of the following criteria are met:

(1) Curtains, scenery, or other combustible hangings are not retractable vertically.
(2) Combustible hangings are limited to borders, legs, a single main curtain, and a single backdrop.

13.4.6.10.3 Sprinklers shall not be required under stage areas less than 48 in. (1220 mm) in clear height that are used exclusively for chair or table storage and lined on the inside with ⅝ in. (16 mm) Type X gypsum wallboard or the approved equivalent.

13.4.6.11 Flame-Retardant Requirements.

13.4.6.11.1 Combustible scenery of cloth, film, vegetation (dry), and similar materials shall comply with one of the following:

(1) They shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(2) They shall exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.

13.4.6.11.2 Foamed plastics *(see definition of cellular or foamed plastic in 3.3.41)* shall be permitted to be used if they exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source or by specific approval of the authority having jurisdiction.

13.4.6.11.3 Scenery and stage properties not separated from the audience by proscenium opening protection shall be of noncombustible materials, limited-combustible materials, or fire-retardant-treated wood.

13.4.6.11.4 In theaters, motion picture theaters, and television stage settings, with or without horizontal projections, and in simulated caves and caverns of foamed plastic, any single fuel package shall have a heat release rate not to exceed 100 kW where tested in accordance with one of the following:

(1) UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

13.4.6.12* Standpipes.

13.4.6.12.1 Stages over 1000 ft^2 (93 m^2) in area shall be equipped with 1½ in. (38 mm) hose lines for first aid fire fighting at each side of the stage.

13.4.6.12.2 Hose connections shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, unless Class II or Class III standpipes in accordance with NFPA 13, *Standard for the Installation of Standpipe and Hose Systems*, are used.

13.4.7 Projection Rooms.

13.4.7.1 Projection rooms shall comply with 13.4.7.2 through 13.4.7.10.

13.4.7.2 Where cellulose nitrate film is used, the projection room shall comply with NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*.

13.4.7.3 Film or video projectors or spotlights utilizing light sources that produce particulate matter or toxic gases, or light sources that produce hazardous radiation, without protective shielding shall be located within a projection room complying with 13.3.2.1.2.

13.4.7.4 Every projection room shall be of permanent construction consistent with the building construction type in which the projection room is located and shall comply with the following:

(1) Openings shall not be required to be protected.
(2) The room shall have a floor area of not less than 80 ft^2 (7.4 m^2) for a single machine and not less than 40 ft^2 (3.7 m^2) for each additional machine.
(3) Each motion picture projector, floodlight, spotlight, or similar piece of equipment shall have a clear working space of not less than 30 in. (760 mm) on each side and at its rear, but only one such space shall be required between adjacent projectors.

13.4.7.5 The projection room and the rooms appurtenant to it shall have a ceiling height of not less than 7 ft 6 in. (2285 mm).

13.4.7.6 Each projection room for safety film shall have not less than one out-swinging, self-closing door not less than 30 in. (760 mm) wide and 6 ft 8 in. (2030 mm) high.

13.4.7.7 The aggregate of ports and openings for projection equipment shall not exceed 25 percent of the area of the wall between the projection room and the auditorium, and all openings shall be provided with glass or other approved material so as to completely close the opening.

13.4.7.8 Projection room ventilation shall comply with 13.4.7.8.1 and 13.4.7.8.2.

13.4.7.8.1 Supply Air.

13.4.7.8.1.1 Each projection room shall be provided with adequate air supply inlets arranged to provide well-distributed air throughout the room.

13.4.7.8.1.2 Air inlet ducts shall provide an amount of air equivalent to the amount of air being exhausted by projection equipment.

13.4.7.8.1.3 Air shall be permitted to be taken from the outside; from adjacent spaces within the building, provided that the volume and infiltration rate is sufficient; or from the building air-conditioning system, provided that it is arranged to supply sufficient air whether or not other systems are in operation.

13.4.7.8.2 Exhaust Air.

13.4.7.8.2.1 Projection booths shall be permitted to be exhausted through the lamp exhaust system.

13.4.7.8.2.2 The lamp exhaust system shall be positively interconnected with the lamp so that the lamp cannot operate unless there is sufficient airflow required for the lamp.

13.4.7.8.2.3 Exhaust air ducts shall terminate at the exterior of the building in such a location that the exhaust air cannot be readily recirculated into any air supply system.

13.4.7.8.2.4 The projection room ventilation system shall be permitted also to serve appurtenant rooms, such as the generator room and the rewind room.

13.4.7.9 Each projection machine shall be provided with an exhaust duct that draws air from each lamp and exhausts it directly to the outside of the building.

13.4.7.9.1 The lamp exhaust shall be permitted to exhaust air from the projection room to provide room air circulation.

13.4.7.9.2 Lamp exhaust ducts shall be of rigid materials, except for a flexible connector approved for the purpose.

13.4.7.9.3 The projection lamp and projection room exhaust systems shall be permitted to be combined but shall not be interconnected with any other exhaust system or return-air system within the buildings.

13.4.7.9.4 Specifications for electric arc and xenon projection equipment shall comply with 13.4.7.9.4.1 and 13.4.7.9.4.2.

13.4.7.9.4.1 Electric Arc Projection Equipment. The exhaust capacity shall be 200 ft^3/min (0.09 m^3/s) for each lamp connected to the lamp exhaust system or as recommended by the equipment manufacturer, and auxiliary air shall be permitted to be introduced into the system through a screened opening to stabilize the arc.

13.4.7.9.4.2 Xenon Projection Equipment. The lamp exhaust system shall exhaust not less than 300 ft^3/min (0.14 m^3/s) per lamp, or not less than the exhaust volume required or recommended by the equipment manufacturer, whichever is greater.

13.4.7.10 Miscellaneous equipment and storage shall be protected as follows:

(1) Each projection room shall be provided with rewind and film storage facilities.
(2) Flammable liquids containers shall be permitted in projection rooms, provided that all of the following criteria are met:
    (a) There are not more than four containers per projection room.
    (b) No container has a capacity exceeding 16 oz (0.5 L).
    (c) The containers are of a nonbreakable type.
(3) Appurtenant electrical equipment, such as rheostats, transformers, and generators, shall be permitted to be located within the booth or in a separate room of equivalent construction.

13.4.8* Special Amusement Buildings.

13.4.8.1* General. Special amusement buildings, regardless of occupant load, shall meet the requirements for assembly occupancies in addition to the requirements of 13.4.8, unless the special amusement building is a multilevel play structure that is not more than 10 ft (3050 mm) in height and has aggregate horizontal projections not exceeding 160 ft^2 (15 m^2).

13.4.8.2* Automatic Sprinklers. Every special amusement building, other than buildings or structures not exceeding 10 ft (3050 mm) in height and not exceeding 160 ft^2 (15 m^2) in aggregate horizontal projection, shall be protected throughout by an approved, supervised automatic sprinkler system installed and maintained in accordance with Section 9.7.

13.4.8.3 Temporary Water Supply. Where the special amusement building required to be sprinklered by 13.4.8.2 is movable or portable, the sprinkler water supply shall be permitted to be provided by an approved temporary means.

13.4.8.4 Smoke Detection. Where the nature of the special amusement building is such that it operates in reduced lighting levels, the building shall be protected throughout by an approved automatic smoke detection system in accordance with Section 9.6.

13.4.8.5 Alarm Initiation. Actuation of any smoke detection system device shall sound an alarm at a constantly attended location on the premises.

13.4.8.6 Illumination. Actuation of the automatic sprinkler system, or any other suppression system, or actuation of a smoke detection system having an approved verification or cross-zoning operation capability shall provide for both of the following:

(1) Increase in illumination in the means of egress to that required by Section 7.8
(2) Termination of any conflicting or confusing sounds and visuals

13.4.8.7 Exit Marking.

13.4.8.7.1 Exit marking shall be in accordance with Section 7.10.

13.4.8.7.2 Floor proximity exit signs shall be provided in accordance with 7.10.1.6.

13.4.8.7.3* In special amusement buildings where mazes, mirrors, or other designs are used to confound the egress path, approved directional exit marking that becomes apparent in an emergency shall be provided.

13.4.8.8 Interior Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A throughout.

13.4.9 Grandstands.

13.4.9.1 General.

13.4.9.1.1 Grandstands shall comply with the provisions of this chapter as modified by 13.4.9.

13.4.9.1.2 Approved existing grandstands shall be permitted to be continued to be used.

13.4.9.2 Seating.

13.4.9.2.1 Where grandstand seating without backs is used indoors, rows of seats shall be spaced not less than 22 in. (560 mm) back-to-back.

13.4.9.2.2 The depth of footboards and seat boards in grandstands shall be not less than 9 in. (230 mm); where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

13.4.9.2.3 Seats and footrests of grandstands shall be supported securely and fastened in such a manner that they cannot be displaced inadvertently.

13.4.9.2.4 Individual seats or chairs shall be permitted only if secured firmly in rows in an approved manner, unless seats do not exceed 16 in number and are located on level floors and within railed-in enclosures, such as boxes.

13.4.9.2.5 The maximum number of seats permitted between the farthest seat and an aisle in grandstands and bleachers shall not exceed that shown in Table 13.4.9.2.5.

Table 13.4.9.2.5 Maximum Number of Seats Between Farthest Seat and an Aisle

Application	Outdoors	Indoors
Grandstands	11	6
Bleachers *(See 13.2.5.6.1.2.)*	20	9

13.4.9.3 Special Requirements — Wood Grandstands.

13.4.9.3.1 An outdoor wood grandstand shall be erected within not less than two-thirds of its height, and, in no case, within not less than 10 ft (3050 mm), of a building, unless otherwise permitted by one of the following:

(1) The distance requirement shall not apply to buildings having minimum 1-hour fire resistance–rated construction with openings protected against the fire exposure hazard created by the grandstand.
(2) The distance requirement shall not apply where a wall having minimum 1-hour fire resistance–rated construction separates the grandstand from the building.

13.4.9.3.2 An outdoor wood grandstand unit shall not exceed 10,000 ft^2 (929 m^2) in finished ground level area or 200 ft (61 m) in length, and all of the following requirements also shall apply:

(1) Grandstand units of the maximum size shall be placed not less than 20 ft (6100 mm) apart or shall be separated by walls having a minimum 1-hour fire resistance rating.
(2) The number of grandstand units erected in any one group shall not exceed three.
(3) Each group of grandstand units shall be separated from any other group by a wall having minimum 2-hour fire resistance–rated construction extending 24 in. (610 mm) above the seat platforms or by an open space of not less than 50 ft (15 m).

13.4.9.3.3 The finished ground level area or length required by 13.4.9.3.2 shall be permitted to be doubled where one of the following criteria is met:

(1) Where the grandstand is constructed entirely of labeled fire-retardant-treated wood that has passed the standard rain test, ASTM D 2898, *Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*
(2) Where the grandstand is constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)]

13.4.9.3.4 The highest level of seat platforms above the finished ground level or the surface at the front of any wood grandstand shall not exceed 20 ft (6100 mm).

13.4.9.3.5 The highest level of seat platforms above the finished ground level, or the surface at the front of a portable grandstand within a tent or membrane structure, shall not exceed 12 ft (3660 mm).

13.4.9.3.6 The height requirements specified in 13.4.9.3.4 and 13.4.9.3.5 shall be permitted to be doubled where the grandstand is constructed entirely of labeled fire-retardant-treated wood that has passed the standard rain test, ASTM D 2898, *Standard Test Methods for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*, or where constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)].

13.4.9.4 Special Requirements — Portable Grandstands.

13.4.9.4.1 Portable grandstands shall conform to the requirements of 13.4.9 for grandstands and the requirements of 13.4.9.4.2 through 13.4.9.4.7.

13.4.9.4.2 Portable grandstands shall be self-contained and shall have within them all necessary parts to withstand and restrain all forces that might be developed during human occupancy.

13.4.9.4.3 Portable grandstands shall be designed and manufactured so that, if any structural members essential to the strength and stability of the structure have been omitted during erection, the presence of unused connection fittings shall make the omissions self-evident.

13.4.9.4.4 Portable grandstand construction shall be skillfully accomplished to produce the strength required by the design.

13.4.9.4.5 Portable grandstands shall be provided with base plates, sills, floor runners, or sleepers of such area that the permitted bearing capacity of the supporting material is not exceeded.

13.4.9.4.6 Where a portable grandstand rests directly on a base of such character that it is incapable of supporting the load without appreciable settlement, mud sills of suitable material, having sufficient area to prevent undue or dangerous settlement, shall be installed under base plates, runners, or sleepers.

13.4.9.4.7 All bearing surfaces shall be in contact with each other.

13.4.9.5 Spaces Underneath Grandstands. Spaces underneath a grandstand shall be kept free of flammable or combustible materials, unless protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7 or unless otherwise permitted by one of the following:

(1) This requirement shall not apply to accessory uses of 300 ft^2 (28 m^2) or less, such as ticket booths, toilet facilities, or concession booths, where constructed of noncombustible or fire-resistive construction in otherwise nonsprinklered facilities.
(2) This requirement shall not apply to rooms that are enclosed in not less than 1-hour fire resistance–rated construction and are less than 1000 ft^2 (93 m^2) in otherwise nonsprinklered facilities.

13.4.9.6 Guards and Railings.

13.4.9.6.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are in excess of 48 in. (1220 mm) above the floor or the finished ground level.

13.4.9.6.2 The requirement of 13.4.9.6.1 shall not apply where an adjacent wall or fence affords equivalent safeguard.

13.4.9.6.3 Where the front footrest of any grandstand is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided.

13.4.9.6.4 The railings required by 13.4.9.6.3 shall be permitted to be not less than 26 in. (660 mm) high in grandstands or where the front row of seats includes backrests.

13.4.9.6.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle.

13.4.9.6.6 The railings specified by 13.4.9.6.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle.

13.4.9.6.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

13.4.9.6.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above the finished ground level shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

13.4.10 Folding and Telescopic Seating.

13.4.10.1 General.

13.4.10.1.1 Folding and telescopic seating shall comply with the provisions of this chapter as modified by 13.4.10.

13.4.10.1.2 Approved existing folding and telescopic seating shall be permitted to be continued to be used.

13.4.10.2 Seating.

13.4.10.2.1 The horizontal distance of seats, measured back-to-back, shall be not less than 22 in. (560 mm) for seats without backs, and all of the following requirements shall also apply:

(1) There shall be a space of not less than 12 in. (305 mm) between the back of each seat and the front of each seat immediately behind it.
(2) If seats are of the chair type, the 12 in. (305 mm) dimension shall be measured to the front edge of the rear seat in its normal unoccupied position.
(3) All measurements shall be taken between plumb lines.

13.4.10.2.2 The depth of footboards (footrests) and seat boards in folding and telescopic seating shall be not less than 9 in. (230 mm).

13.4.10.2.3 Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided.

13.4.10.2.4 Individual chair-type seats shall be permitted in folding and telescopic seating only if firmly secured in groups of not less than three.

13.4.10.2.5 The maximum number of seats permitted between the farthest seat in an aisle in folding and telescopic seating shall not exceed that shown in Table 13.4.9.2.5.

13.4.10.3 Guards and Railings.

13.4.10.3.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest, or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all folding and telescopic seating where the seats are more than 48 in. (1220 mm) above the floor or the finished ground level.

13.4.10.3.2 The requirement of 13.4.10.3.1 shall not apply where an adjacent wall or fence affords equivalent safeguard.

13.4.10.3.3 Where the front footrest of folding or telescopic seating is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided.

13.4.10.3.4 The railings required by 13.4.10.3.3 shall be permitted to be not less than 26 in. (660 mm) high where the front row of seats includes backrests.

13.4.10.3.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle.

13.4.10.3.6 The railings specified by 13.4.10.3.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle.

13.4.10.3.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

13.4.10.3.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above the finished ground level shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening.

13.4.11 Airport Loading Walkways.

13.4.11.1 Airport loading walkways shall conform to NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*, and the provisions of 13.4.11.2 and 13.4.11.3.

13.4.11.2 Doors in the egress path from the aircraft through the airport loading walkway into the airport terminal building shall meet both of the following criteria:

(1) They shall swing in the direction of egress from the aircraft.
(2)*They shall not be permitted to have delayed-egress locks.

13.4.11.3 Exit access shall be unimpeded from the airport loading walkway to the nonsecured public areas of the airport terminal building.

13.5 Building Services.

13.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

13.5.2 Heating, Ventilating, and Air-Conditioning Equipment. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

13.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

13.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

13.6 Reserved.

13.7 Operating Features.

13.7.1 Means of Egress Inspection.

13.7.1.1 The building owner or agent shall inspect the means of egress to ensure it is maintained free of obstructions, and correct any deficiencies found, prior to each opening of the building to the public.

13.7.1.2 The building owner or agent shall prepare and maintain records of the date and time of each inspection on approved forms, listing any deficiencies found and actions taken to correct them.

13.7.1.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

13.7.2 Special Provisions for Food Service Operations.

13.7.2.1 All devices in connection with the preparation of food shall be installed and operated to avoid hazard to the safety of occupants.

13.7.2.2 All devices in connection with the preparation of food shall be of an approved type and shall be installed in an approved manner.

13.7.2.3 Food preparation facilities shall be protected in accordance with 9.2.3 and shall not be required to have openings protected between food preparation areas and dining areas.

13.7.2.4 Portable cooking equipment that is not flue-connected shall be permitted only as follows:

(1) Equipment fueled by small heat sources that can be readily extinguished by water, such as candles or alcohol-burning equipment, including solid alcohol, shall be permitted to be used, provided that precautions satisfactory to the AHJ are taken to prevent ignition of any combustible materials.
(2) Candles shall be permitted to be used on tables used for food service where securely supported on substantial noncombustible bases located to avoid danger of ignition of combustible materials and only where approved by the AHJ.
(3) Candle flames shall be protected.
(4) "Flaming sword" or other equipment involving open flames and flamed dishes, such as cherries jubilee or crêpes suzette, shall be permitted to be used, provided that precautions subject to the approval of the AHJ are taken.
(5) Listed and approved LP-Gas commercial food service appliances shall be permitted to be used where in accordance with NFPA 58, *Liquefied Petroleum Gas Code*.

13.7.3 Open Flame Devices and Pyrotechnics. No open flame devices or pyrotechnic devices shall be used in any assembly occupancy, unless otherwise permitted by one of the following:

(1) Pyrotechnic special effect devices shall be permitted to be used on stages before proximate audiences for ceremonial or religious purposes, as part of a demonstration in

exhibits, or as part of a performance, provided that both of the following criteria are met:

(a) Precautions satisfactory to the authority having jurisdiction are taken to prevent ignition of any combustible material.
(b) Use of the pyrotechnic device complies with NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*.

(2) Flame effects before an audience shall be permitted in accordance with NFPA 160, *Standard for the Use of Flame Effects Before an Audience*.
(3) Open flame devices shall be permitted to be used in the following situations, provided that precautions satisfactory to the authority having jurisdiction are taken to prevent ignition of any combustible material or injury to occupants:

(a)*For ceremonial or religious purposes
(b) On stages and platforms where part of a performance
(c) Where candles on tables are securely supported on substantial noncombustible bases and candle flame is protected

(4) The requirement of 13.7.3 shall not apply to heat-producing equipment complying with 9.2.2.
(5) The requirement of 13.7.3 shall not apply to food service operations in accordance with 13.7.2.
(6) Gas lights shall be permitted to be used, provided that precautions are taken, subject to the approval of authority having jurisdiction, to prevent ignition of any combustible materials.

13.7.4 Furnishings, Decorations, and Scenery.

13.7.4.1* Fabrics and films used for decorative purposes, all draperies and curtains, and similar furnishings shall be in accordance with the provisions of 10.3.1.

13.7.4.2 The authority having jurisdiction shall impose controls on the quantity and arrangement of combustible contents in assembly occupancies to provide an adequate level of safety to life from fire.

13.7.4.3* Exposed foamed plastic materials and unprotected materials containing foamed plastic used for decorative purposes or stage scenery shall have a heat release rate not exceeding 100 kW where tested in accordance with one of the following:

(1) ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

13.7.4.4 The requirement of 13.7.4.3 shall not apply to individual foamed plastic items and items containing foamed plastic where the foamed plastic does not exceed 1 lb (0.45 kg) in weight.

13.7.5 Special Provisions for Exposition Facilities.

13.7.5.1 General. No display or exhibit shall be installed or operated to interfere in any way with access to any required exit or with the visibility of any required exit or required exit sign; nor shall any display block access to fire-fighting equipment.

13.7.5.2 Materials Not on Display. A storage room having an enclosure consisting of a smoke barrier having a minimum 1-hour fire resistance rating and protected by an automatic extinguishing system shall be provided for combustible materials not on display, including combustible packing crates used to ship exhibitors' supplies and products.

13.7.5.3 Exhibits.

13.7.5.3.1 Exhibits shall comply with 13.7.5.3.2 through 13.7.5.3.11.

13.7.5.3.2 The travel distance within the exhibit booth or exhibit enclosure to an exit access aisle shall not exceed 50 ft (15 m).

13.7.5.3.3 The upper deck of multilevel exhibits exceeding 300 ft^2 (28 m^2) shall have not less than two remote means of egress.

13.7.5.3.4 Exhibit booth construction materials shall be limited to the following:

(1) Noncombustible or limited-combustible materials
(2) Wood exceeding ¼ in. (6.3 mm) nominal thickness
(3) Wood that is pressure-treated, fire-retardant wood meeting the requirements of NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*
(4) Flame-retardant materials complying with one of the following:

(a) They shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(b) They shall exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.

(5) Textile wall coverings, such as carpeting and similar products used as wall or ceiling finishes, complying with the provisions of 10.2.2 and 10.2.4
(6) Plastics limited to those that comply with 13.3.3 and Section 10.2
(7) Foamed plastics and materials containing foamed plastics having a heat release rate for any single fuel package that does not exceed 100 kW where tested in accordance with one of the following:

(a) ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(b) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

(8) Cardboard, honeycombed paper, and other combustible materials having a heat release rate for any single fuel package that does not exceed 150 kW where tested in accordance with one of the following:

(a) ANSI/UL 1975
(b) NFPA 289, using the 20 kW ignition source

13.7.5.3.5 Curtains, drapes, and decorations shall comply with 10.3.1.

13.7.5.3.6 Acoustical and decorative material including, but not limited to, cotton, hay, paper, straw, moss, split bamboo, and wood chips shall be flame-retardant treated to the satisfaction of the authority having jurisdiction.

13.7.5.3.6.1 Materials that cannot be treated for flame retardancy shall not be used.

13.7.5.3.6.2 Foamed plastics, and materials containing foamed plastics and used as decorative objects such as, but not limited to, mannequins, murals, and signs shall have a heat release rate for any single fuel package that does not exceed 150 kW where tested in accordance with one of the following:

(1) ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*
(2) NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source

13.7.5.3.6.3 Where the aggregate area of acoustical and decorative materials is less than 10 percent of the individual floor or wall area, such materials shall be permitted to be used subject to the approval of the authority having jurisdiction.

13.7.5.3.7 The following shall be protected by automatic extinguishing systems:

(1) Single-level exhibit booths exceeding 300 ft^2 (28 m^2) and covered with a ceiling
(2) Each level of multilevel exhibit booths, including the uppermost level where the uppermost level is covered with a ceiling

13.7.5.3.7.1 The requirements of 13.7.5.3.7 shall not apply where otherwise permitted by the following:

(1) Ceilings that are constructed of open grate design or listed dropout ceilings in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be considered ceilings within the context of 13.7.5.3.7.
(2) Vehicles, boats, and similar exhibited products having over 100 ft^2 (9.3 m^2) of roofed area shall be provided with smoke detectors acceptable to the authority having jurisdiction.
(3)*The requirement of 13.7.5.3.7(2) shall not apply where fire protection of multilevel exhibit booths is consistent with the criteria developed through a life safety evaluation of the exhibition hall in accordance with 13.4.1, subject to approval of the authority having jurisdiction.

13.7.5.3.7.2 A single exhibit or group of exhibits with ceilings that do not require sprinklers shall be separated by a distance not less than 10 ft (3050 mm) where the aggregate ceiling exceeds 300 ft^2 (28 m^2).

13.7.5.3.7.3 The water supply and piping for the sprinkler system shall be permitted to be of approved temporary means that is provided by a domestic water supply, a standpipe system, or a sprinkler system.

13.7.5.3.8 Open flame devices within exhibit booths shall comply with 13.7.3.

13.7.5.3.9 Cooking and food-warming devices in exhibit booths shall comply with 13.7.2 and all of the following:

(1) Gas-fired devices shall comply with all of the following:
   (a) Natural gas-fired devices shall comply with 9.1.1.
   (b) The requirement of 13.7.5.3.9(1)(a) shall not apply to compressed natural gas where permitted by the authority having jurisdiction.
   (c) The use of LP-Gas cylinders shall be prohibited.
   (d) Nonrefillable LP-Gas cylinders shall be approved for use where permitted by the authority having jurisdiction.
(2) The devices shall be isolated from the public by not less than 48 in. (1220 mm) or by a barrier between the devices and the public.
(3) Multi-well cooking equipment using combustible oils or solids shall comply with 9.2.3.
(4) Single-well cooking equipment using combustible oils or solids shall meet all of the following criteria:
   (a) The equipment shall have lids available for immediate use.
   (b) The equipment shall be limited to 2 ft^2 (0.2 m^2) of cooking surface.
   (c) The equipment shall be placed on noncombustible surface materials.
   (d) The equipment shall be separated from each other by a horizontal distance of not less than 24 in. (610 mm).
   (e) The requirement of 13.7.5.3.9(4)(d) shall not apply to multiple single-well cooking equipment where the aggregate cooking surface area does not exceed 2 ft^2 (0.2 m^2).
   (f) The equipment shall be kept at a horizontal distance of not less than 24 in. (610 mm) from any combustible material.
(5) A portable fire extinguisher in accordance with Section 9.9 shall be provided within the booth for each device, or an approved automatic extinguishing system shall be provided.

13.7.5.3.10 Combustible materials within exhibit booths shall be limited to a one-day supply. Storage of combustible materials behind the booth shall be prohibited. *(See 13.7.4.2 and 13.7.5.2.)*

13.7.5.3.11 Plans for the exposition, in an acceptable form, shall be submitted to the authority having jurisdiction for approval prior to setting up any exhibit.

13.7.5.3.11.1 The plan shall show all details of the proposed exposition.

13.7.5.3.11.2 No exposition shall occupy any exposition facility without approved plans.

13.7.5.4 Vehicles. Vehicles on display within an exposition facility shall comply with 13.7.5.4.1 through 13.7.5.4.5.

13.7.5.4.1 All fuel tank openings shall be locked and sealed in an approved manner to prevent the escape of vapors; fuel tanks shall not contain in excess of one-half their capacity or contain in excess of 10 gal (38 L) of fuel, whichever is less.

13.7.5.4.2 At least one battery cable shall be removed from the batteries used to start the vehicle engine, and the disconnected battery cable shall then be taped.

13.7.5.4.3 Batteries used to power auxiliary equipment shall be permitted to be kept in service.

13.7.5.4.4 Fueling or defueling of vehicles shall be prohibited.

13.7.5.4.5 Vehicles shall not be moved during exhibit hours.

13.7.5.5 Prohibited Materials.

13.7.5.5.1 The following items shall be prohibited within exhibit halls:

(1) Compressed flammable gases
(2) Flammable or combustible liquids
(3) Hazardous chemicals or materials
(4) Class II or greater lasers, blasting agents, and explosives

13.7.5.5.2 The authority having jurisdiction shall be permitted to allow the limited use of any items specified in 13.7.5.5.1 under special circumstances.

13.7.5.6 Alternatives. See Section 1.4.

13.7.6 Crowd Managers.

13.7.6.1 Assembly occupancies shall be provided with a minimum of one trained crowd manager or crowd manager supervisor. Where the occupant load exceeds 250, additional trained crowd managers or crowd manager supervisors shall be provided at a ratio of one crowd manager or crowd manager supervisor for every 250 occupants, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to assembly occupancies used exclusively for religious worship with an occupant load not exceeding 500.
(2) The ratio of trained crowd managers to occupants shall be permitted to be reduced where, in the opinion of the AHJ, the existence of an approved, supervised automatic sprinkler system and the nature of the event warrant.

13.7.6.2* The crowd manager and crowd manager supervisor shall receive approved training in crowd management techniques.

13.7.6.3 Duties and responsibilities for the crowd manager and crowd manager supervisor shall be documented within a written emergency plan as required by 13.7.13.

13.7.6.4* The training for the duties and responsibilities of crowd managers shall include the following:

(1) Understanding crowd manager roles and responsibilities
(2) Understanding safety and security hazards that can endanger public assembly
(3) Understanding crowd management techniques
(4) Introduction to fire safety and fire safety equipment
(5) Understanding methods of evacuation and movement
(6) Understanding procedures for reporting emergencies
(7) Understanding crowd management emergency response procedures
(8) Understanding the paths of travel and exits, facility evacuation and emergency response procedures and, where provided, facility shelter-in-place procedures
(9) Familiarization with the venue and guest services training
(10) Other specific event-warranted training

13.7.6.5 The training for the duties and responsibilities of crowd manager supervisors shall include the following:

(1) The duties described in 13.7.6.4
(2) Understanding crowd manager supervisor roles and responsibilities
(3) Understanding incident management procedures
(4) Understanding the facility evacuation plan
(5) Understanding the facility command structure

13.7.7* Drills.

13.7.7.1 The employees or attendants of assembly occupancies shall be trained and drilled in the duties they are to perform in case of fire, panic, or other emergency to effect orderly exiting.

13.7.7.2 Employees or attendants of assembly occupancies shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment where provided.

13.7.7.3* In the following assembly occupancies, an audible announcement shall be made, or a projected image shall be shown, prior to the start of each program that notifies occupants of the location of the exits to be used in case of a fire or other emergency:

(1) Theaters
(2) Motion picture theaters
(3) Auditoriums
(4) Other similar assembly occupancies with occupant loads exceeding 300 where there are noncontinuous programs

13.7.7.4 The requirement of 13.7.7.3 shall not apply to assembly occupancies in schools where used for nonpublic events.

13.7.8 Smoking.

13.7.8.1 Smoking in assembly occupancies shall be regulated by the authority having jurisdiction.

13.7.8.2 In rooms or areas where smoking is prohibited, plainly visible signs shall be posted that read as follows:

NO SMOKING

13.7.8.3 No person shall smoke in prohibited areas that are so posted, unless permitted by the authority having jurisdiction under both of the following conditions:

(1) Smoking shall be permitted on a stage only where it is a necessary and rehearsed part of a performance.
(2) Smoking shall be permitted only where the smoker is a regular performing member of the cast.

13.7.8.4 Where smoking is permitted, suitable ashtrays or receptacles shall be provided in convenient locations.

13.7.9 Seating.

13.7.9.1 Secured Seating.

13.7.9.1.1 Seats in assembly occupancies accommodating more than 200 persons shall be securely fastened to the floor, except where fastened together in groups of not less than three and as permitted by 13.7.9.1.2 and 13.7.9.2.

13.7.9.1.2 Balcony and box seating areas that are separated from other areas by rails, guards, partial-height walls, or other physical barriers and have a maximum of 14 seats shall be exempt from the requirement of 13.7.9.1.1.

13.7.9.2 Unsecured Seating.

13.7.9.2.1 Seats not secured to the floor shall be permitted in restaurants, night clubs, and other occupancies where fastening seats to the floor might be impracticable.

13.7.9.2.2 Unsecured seats shall be permitted, provided that, in the area used for seating, excluding such areas as dance floors and stages, there is not more than one seat for each 15 ft^2 (1.4 m^2) of net floor area, and adequate aisles to reach exits are maintained at all times.

13.7.9.2.3 Seating diagrams shall be submitted for approval by the authority having jurisdiction to permit an increase in occupant load per 7.3.1.3.

13.7.9.3 Occupant Load Posting.

13.7.9.3.1 Every room constituting an assembly occupancy and not having fixed seats shall have the occupant load of the room posted in a conspicuous place near the main exit from the room.

13.7.9.3.2 Approved signs shall be maintained in a legible manner by the owner or authorized agent.

13.7.9.3.3 Signs shall be durable and shall indicate the number of occupants permitted for each room use.

13.7.10 Maintenance of Outdoor Grandstands.

13.7.10.1 The owner shall provide for not less than annual inspection and required maintenance of each outdoor grandstand to ensure safe conditions.

13.7.10.2 At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

13.7.10.3 Where required by the authority having jurisdiction, the owner shall provide a copy of the inspection report and certification that the inspection required by 13.7.10.2 has been performed.

13.7.11 Maintenance and Operation of Folding and Telescopic Seating.

13.7.11.1 Instructions in both maintenance and operation shall be transmitted to the owner by the manufacturer of the seating or his or her representative.

13.7.11.2 Maintenance and operation of folding and telescopic seating shall be the responsibility of the owner or his or her duly authorized representative and shall include all of the following:

(1) During operation of the folding and telescopic seats, the opening and closing shall be supervised by responsible personnel who shall ensure that the operation is in accordance with the manufacturer's instructions.
(2) Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.
(3) An annual inspection and required maintenance of each grandstand shall be performed to ensure safe conditions.
(4) At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

13.7.12 Clothing. Clothing and personal effects shall not be stored in corridors, and spaces not separated from corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by an approved automatic sprinkler system in accordance with Section 9.7.
(2) This requirement shall not apply to corridors, and spaces not separated from corridors, that are protected by a smoke detection system in accordance with Section 9.6.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

13.7.13 Emergency Action Plans.

13.7.13.1 Emergency action plans shall be provided in accordance with Section 4.8.

13.7.13.2 Where assembly occupancies are located in the high-rise portion of a building, the emergency action plan shall include egress procedures, methods, and preferred evacuation routes for each event considered to be a life safety hazard that could impact the building, including the appropriateness of the use of elevators.

Chapter 14 New Educational Occupancies

14.1 General Requirements.

14.1.1 Application.

14.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as educational occupancies. *(See 1.3.1.)*

14.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

14.1.1.3 General. The provisions of Chapter 4, General, shall apply.

14.1.1.4 Educational facilities that do not meet the definition of an educational occupancy shall not be required to comply with this chapter but shall comply with the following requirements:

(1) Instructional building — business occupancy
(2) Classrooms under 50 persons — business occupancy
(3) Classrooms, 50 persons and over — assembly occupancy
(4) Laboratories, instructional — business occupancy
(5) Laboratories, noninstructional — industrial occupancy

14.1.2 Classification of Occupancy. See 6.1.3.

14.1.2.1 Educational occupancies shall include all buildings used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week.

14.1.2.2 Educational occupancies shall include preschools, kindergartens, and other schools meeting both of the following criteria:

(1) The purpose is primarily educational, even though the children who attend such schools are of preschool age.
(2) The children are all 24 months of age or older.

14.1.2.3 In cases where instruction is incidental to some other occupancy, the section of this *Code* governing such other occupancy shall apply.

14.1.2.4 Other occupancies associated with educational institutions shall be in accordance with the appropriate parts of this *Code. (See Chapters 18, 20, 26, 28, 30, 40, and 42 and 6.1.14.)*

14.1.3 Multiple Occupancies.

14.1.3.1 General. Multiple occupancies shall be in accordance with 6.1.14.

14.1.3.2 Atrium Walls Used in an Occupancy Separation. Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

14.1.3.3 Assembly and Educational.

14.1.3.3.1 Spaces subject to assembly occupancy shall comply with Chapter 12, including 12.1.3.2, which provides that, where auditorium and gymnasium egress lead through corridors or stairways also serving as egress for other parts of the building, the egress capacity shall be sufficient to allow simultaneous egress from auditorium and classroom sections.

14.1.3.3.2 In the case of an assembly occupancy of a type suitable for use only by the school occupant load, and therefore not subject to simultaneous occupancy, the same egress capacity shall be permitted to serve both sections.

14.1.3.4 Dormitory and Classrooms.

14.1.3.4.1 Any building used for both classroom and dormitory purposes shall comply with the applicable provisions of Chapter 28 in addition to complying with Chapter 14.

14.1.3.4.2 Where classroom and dormitory sections are not subject to simultaneous occupancy, the same egress capacity shall be permitted to serve both sections.

14.1.4 Definitions.

14.1.4.1 General. For definitions, see Chapter 3, Definitions.

14.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Common Atmosphere.** See 3.3.26.1.
(2) **Flexible Plan and Open Plan Educational or Day-Care Building.** See 3.3.36.6.
(3) **Separate Atmosphere.** See 3.3.26.2.

14.1.5 Classification of Hazard of Contents. The contents of educational occupancies shall be classified in accordance with the provisions of Section 6.2.

14.1.6 Minimum Construction Requirements. (Reserved)

14.1.7 Occupant Load.

14.1.7.1 The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

14.1.7.2 The occupant load of an educational occupancy, or a portion thereof, shall be permitted to be modified from that specified in 14.1.7.1 if the necessary aisles and exits are provided.

14.1.7.3 An approved aisle or seating diagram shall be required by the authority having jurisdiction to substantiate the modification permitted in 14.1.7.2.

14.2 Means of Egress Requirements.

14.2.1 General.

14.2.1.1 Means of egress shall be in accordance with Chapter 7 and Section 14.2.

14.2.1.2 Rooms normally occupied by preschool, kindergarten, or first-grade students shall be located on a level of exit discharge, unless otherwise permitted by 14.2.1.4.

14.2.1.3 Rooms normally occupied by second-grade students shall not be located more than one story above a level of exit discharge, unless otherwise permitted by 14.2.1.4.

14.2.1.4 Rooms or areas located on floor levels other than as specified in 14.2.1.2 and 14.2.1.3 shall be permitted to be used where provided with independent means of egress dedicated for use by the preschool, kindergarten, first-grade, or second-grade students.

14.2.2 Means of Egress Components.

14.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 14.2.2.2 through 14.2.2.10.

14.2.2.2 Doors.

14.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

14.2.2.2.2 Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7.

14.2.2.2.3 Special Locking.

14.2.2.2.3.1 Delayed-egress locking systems complying with 7.2.1.6.1 shall be permitted.

14.2.2.2.3.2 Access-controlled egress door assemblies complying with 7.2.1.6.2 shall be permitted.

14.2.2.2.3.3 Elevator lobby exit access door assemblies locking in accordance with 7.2.1.6.3 shall be permitted.

14.2.2.3* Stairs. Stairs complying with 7.2.2 shall be permitted.

14.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

14.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

14.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

14.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

14.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

14.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

14.2.2.10 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

14.2.3 Capacity of Means of Egress.

14.2.3.1 General. Capacity of means of egress shall be in accordance with Section 7.3.

14.2.3.2 Minimum Corridor Width. Exit access corridors shall have not less than 6 ft (1830 mm) of clear width.

14.2.4 Number of Means of Egress.

14.2.4.1 The number of means of egress shall be in accordance with Section 7.4.

14.2.4.2 Not less than two separate exits shall be in accordance with the following criteria:

(1) They shall be provided on every story.
(2) They shall be accessible from every part of every story and mezzanine; however, exit access travel shall be permitted to be common for the distance permitted as common path of travel by 14.2.5.3.

14.2.5 Arrangement of Means of Egress. See also Section 7.5.

14.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

14.2.5.2 No dead-end corridor shall exceed 20 ft (6100 mm), other than in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, in which case dead-end corridors shall not exceed 50 ft (15 m).

14.2.5.3 Limitations on common path of travel shall be in accordance with 14.2.5.3.1 and 14.2.5.3.2.

14.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.2.5.3.2 Common path of travel shall not exceed 75 ft (23 m) in a building not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.2.5.4 Every room or space larger than 1000 ft^2 (93 m^2) or with an occupant load of more than 50 persons shall comply with the following:

(1) The room or space shall have a minimum of two exit access doors.
(2) The doors required by 14.2.5.4(1) shall provide access to separate exits.
(3) The doors required by 14.2.5.4(1) shall be permitted to open onto a common corridor, provided that such corridor leads to separate exits located in opposite directions.

14.2.5.5 Every room that is normally subject to student occupancy shall have an exit access door leading directly to an exit access corridor or exit, unless otherwise permitted by one of the following:

(1) This requirement shall not apply where an exit door opens directly to the outside or to an exterior balcony or corridor as described in 14.2.5.9.
(2) One room shall be permitted to intervene between a normally occupied student room and an exit access corridor, provided that all of the following criteria are met:
   (a) The travel from a room served by an intervening room to the corridor door or exit shall not exceed 75 ft (23 m).
   (b) Clothing, personal effects, or other materials deemed hazardous by the authority having jurisdiction shall be stored in metal lockers, provided that they do not obstruct the exit access, or the intervening room shall be sprinklered in accordance with Section 9.7.
   (c) One of the following means of protection shall be provided:
      i. The intervening room shall have approved fire detection that activates the building alarm.
      ii. The building shall be protected by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.2.5.6 Doors that swing into an exit access corridor shall be arranged to prevent interference with corridor travel. *(See also 7.2.1.4.3.)*

14.2.5.7 Aisles shall be not less than 30 in. (760 mm) wide.

14.2.5.8 The space between parallel rows of seats shall not be subject to the minimum aisle width, provided that the number of seats that intervenes between any seat and an aisle does not exceed six.

14.2.5.9* Exterior exit access shall comply with 7.5.3.

14.2.6 Travel Distance to Exits. Travel distance shall comply with 14.2.6.1 through 14.2.6.3.

14.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

14.2.6.2 Travel distance to an exit shall not exceed 150 ft (46 m) from any point in a building, unless otherwise provided in 14.2.6.3. *(See also Section 7.6.)*

14.2.6.3 Travel distance shall not exceed 200 ft (61 m) in educational occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.2.7 Discharge from Exits. Discharge from exits shall be arranged in accordance with Section 7.7.

14.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

14.2.9 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

14.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

14.2.11 Special Means of Egress Features.

14.2.11.1* Windows for Rescue.

14.2.11.1.1 Every room or space greater than 250 ft^2 (23.2 m^2) and used for classroom or other educational purposes or normally subject to student occupancy shall have not less than one outside window for emergency rescue that complies with all of the following, unless otherwise permitted by 14.2.11.1.2:

(1) Such windows shall be openable from the inside without the use of tools and shall provide a clear opening of not less than 20 in. (510 mm) in width, 24 in. (610 mm) in height, and 5.7 ft^2 (0.5 m^2) in area.
(2) The bottom of the opening shall be not more than 44 in. (1120 mm) above the floor, and any latching device shall be capable of being operated from not more than 54 in. (1370 mm) above the finished floor.
(3) The clear opening shall allow a rectangular solid, with a width and height that provides not less than the required 5.7 ft^2 (0.5 m^2) opening and a depth of not less than 20 in. (510 mm), to pass fully through the opening.
(4) Such windows shall be accessible by the fire department and shall open into an area having access to a public way.

14.2.11.1.2 The requirements of 14.2.11.1.1 shall not apply to any of the following:

(1) Buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(2) Where the room or space has a door leading directly to an exit or directly to the outside of the building
(3) Reserved
(4) Rooms located four or more stories above the finished ground level

14.2.11.2 Lockups. Lockups in educational occupancies shall comply with the requirements of 22.4.5.

14.3 Protection.

14.3.1 Protection of Vertical Openings.

14.3.1.1 Any vertical opening, other than unprotected vertical openings in accordance with 8.6.9.1, shall be enclosed or protected in accordance with Section 8.6.

14.3.1.2 Where the provisions of 8.6.6 are used, the requirements of 14.3.5.4 shall be met.

14.3.2 Protection from Hazards.

14.3.2.1 Rooms or spaces for the storage, processing, or use of materials shall be protected in accordance with the following:

(1) Such rooms or spaces shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating or protected by automatic extinguishing systems as specified in Section 8.7 in the following areas:
   (a) Boiler and furnace rooms, unless such rooms enclose only air-handling equipment

(b) Rooms or spaces used for the storage of combustible supplies in quantities deemed hazardous by the authority having jurisdiction
(c) Rooms or spaces used for the storage of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
(d) Janitor closets *[see also 14.3.2.1(4)]*

(2) Such rooms or spaces shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating and protected by automatic extinguishing systems as specified in Section 8.7 in the following areas:
(a) Laundries
(b) Maintenance shops, including woodworking and painting areas
(c) Rooms or spaces used for processing or use of combustible supplies deemed hazardous by the authority having jurisdiction
(d) Rooms or spaces used for processing or use of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards

(3) Where automatic extinguishing is used to meet the requirements of 14.3.2.1(1) or (2), the protection shall be permitted in accordance with 9.7.1.2.
(4) Where janitor closets addressed in 14.3.2.1(1)(d) are protected in accordance with the sprinkler option of 14.3.2.1(1), the janitor closet doors shall be permitted to have ventilating louvers.

14.3.2.2 Cooking facilities shall be protected in accordance with 9.2.3. Openings shall not be required to be protected between food preparation areas and dining areas.

14.3.2.3 Stages and platforms shall be protected in accordance with Chapter 12.

14.3.2.4 Educational occupancy laboratories using chemicals shall be in accordance with 8.7.4.

14.3.3 Interior Finish.

14.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

14.3.3.2* Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted as follows:

(1) Exits — Class A
(2) Other than exits — Class A or Class B
(3) Low-height partitions not exceeding 60 in. (1525 mm) and used in locations other than exits — Class A, Class B, or Class C

14.3.3.3 Interior Floor Finish.

14.3.3.3.1 Interior floor finish shall comply with Section 10.2.

14.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 14.3.6 shall be not less than Class II.

14.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

14.3.4 Detection, Alarm, and Communications Systems.

14.3.4.1 General.

14.3.4.1.1 Educational occupancies shall be provided with a fire alarm system in accordance with Section 9.6.

14.3.4.1.2 The requirement of 14.3.4.1.1 shall not apply to buildings meeting all of the following criteria:

(1) Buildings having an area not exceeding 1000 ft^2 (93 m^2)
(2) Buildings containing a single classroom
(3) Buildings located not less than 30 ft (9.1 m) from another building

14.3.4.2 Initiation.

14.3.4.2.1 General. Initiation of the required fire alarm system, other than as permitted by 14.3.4.2.3, shall be by manual means in accordance with 9.6.2.1(1).

14.3.4.2.2 Automatic Initiation. In buildings provided with automatic sprinkler protection, the operation of the sprinkler system shall automatically activate the fire alarm system in addition to the initiation means required in 14.3.4.2.1.

14.3.4.2.3 Alternative Protection System. Manual fire alarm boxes shall be permitted to be eliminated in accordance with 14.3.4.2.3.1 or 14.3.4.2.3.2.

14.3.4.2.3.1* Manual fire alarm boxes shall be permitted to be eliminated where all of the following conditions apply:

(1) Interior corridors are protected by smoke detectors in accordance with Section 9.6.
(2) Auditoriums, cafeterias, and gymnasiums are protected by heat-detection devices or other approved detection devices.
(3) Shops and laboratories involving dusts or vapors are protected by heat-detection devices or other approved detection devices.
(4) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

14.3.4.2.3.2* Manual fire alarm boxes shall be permitted to be eliminated where both of the following conditions apply:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

14.3.4.3 Notification.

14.3.4.3.1 Occupant Notification.

14.3.4.3.1.1 Occupant notification shall be accomplished automatically in accordance with 9.6.3.

14.3.4.3.1.2 The occupant notification required by 14.3.4.3.1.1 shall utilize an emergency voice/alarm communication system in accordance with 9.6.3 where the building has an occupant load of more than 100.

14.3.4.3.1.3 Positive alarm sequence shall be permitted in accordance with 9.6.3.4.

14.3.4.3.1.4 In accordance with 9.6.3.10.2 the emergency voice/alarm communication system shall be permitted to be used for other emergency signaling or for class changes.

14.3.4.3.1.5 To prevent students from being returned to a building that is burning, the recall signal shall be separate and distinct from any other signals, and such signal shall be permitted to be given by use of distinctively colored flags or banners.

14.3.4.3.1.6 If the recall signal required by 14.3.4.3.1.5 is electric, the push buttons or other controls shall be kept under lock, the key for which shall be in the possession of the principal or another designated person in order to prevent a recall at a time when there is an actual fire.

14.3.4.3.1.7 Regardless of the method of recall signal, the means of giving the recall signal shall be kept under lock.

14.3.4.3.2 Emergency Forces Notification. Emergency forces notification shall be accomplished in accordance with 9.6.4.

14.3.4.4 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

14.3.4.4.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with Section 9.12 shall be provided in new educational occupancies in the locations specified as follows:

(1) On the ceilings of rooms containing permanently installed fuel-burning appliances
(2) Centrally located within occupiable spaces served by the first supply air register from a permanently installed, fuel-burning HVAC system
(3) Centrally located within occupiable spaces adjacent to a communicating attached garage

14.3.4.4.2 Carbon monoxide alarms and carbon monoxide detectors as specified in 14.3.4.4.1 shall not be required in the following locations:

(1) Garages
(2) Occupiable spaces with communicating attached garages that are open parking structures as defined in 3.3.272.7.4
(3) Occupiable spaces with communicating attached garages that are mechanically ventilated in accordance with the applicable mechanical code

14.3.5 Extinguishment Requirements.

14.3.5.1* Educational occupancy buildings exceeding 12,000 ft^2 (1120 m^2) shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.3.5.2 Educational occupancy buildings four or more stories in height shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.3.5.3 Every portion of educational buildings below the level of exit discharge shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.3.5.4 Buildings with unprotected openings in accordance with 8.6.6 shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.3.5.5 Where another provision of this chapter requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with 9.7.1.1(1).

14.3.6 Corridors. Corridors shall be separated from other parts of the story by walls having a 1-hour fire resistance rating in accordance with Section 8.3, unless otherwise permitted by one of the following:

(1) Corridor protection shall not be required where all spaces normally subject to student occupancy have not less than one door opening directly to the outside or to an exterior exit access balcony or corridor in accordance with 7.5.3.
(2) The following shall apply to buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7:
    (a) Corridor walls shall not be required to be rated, provided that such walls form smoke partitions in accordance with Section 8.4.
    (b) The provisions of 8.4.3.5 shall not apply to normally occupied classrooms.
(3) Where the corridor ceiling is an assembly having a 1-hour fire resistance rating where tested as a wall, the corridor walls shall be permitted to terminate at the corridor ceiling.
(4) Lavatories shall not be required to be separated from corridors, provided that they are separated from all other spaces by walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3.
(5) Lavatories shall not be required to be separated from corridors, provided that both of the following criteria are met:
    (a) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
    (b) The walls separating the lavatory from other rooms form smoke partitions in accordance with Section 8.4.

14.3.7 Subdivision of Building Spaces.

14.3.7.1 Educational occupancies shall be subdivided into compartments by smoke partitions having not less than a 1-hour fire resistance rating and complying with Section 8.4 where one or both of the following conditions exist:

(1) The maximum floor area, including the aggregate area of all floors having a common atmosphere, exceeds 30,000 ft^2 (2800 m^2).
(2) The length or width of the building exceeds 300 ft (91 m).

14.3.7.2 The requirement of 14.3.7.1 shall not apply to either of the following:

(1) Where all spaces normally subject to student occupancy have not less than one door opening directly to the outside or to an exterior or exit access balcony or corridor in accordance with 7.5.3
(2) Buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7

14.3.7.3 The area of any smoke compartment required by 14.3.7.1 shall not exceed 30,000 ft^2 (2800 m^2), with no dimension exceeding 300 ft (91 m).

14.4 Special Provisions.

14.4.1 Limited Access Buildings and Underground Buildings. Limited access buildings and underground buildings shall comply with Section 11.7.

14.4.2 High-Rise Buildings. High-rise buildings shall comply with Section 11.8.

14.4.3 Flexible Plan and Open Plan Buildings.

14.4.3.1 Flexible plan and open plan buildings shall comply with the requirements of this chapter as modified by 14.4.3.2 through 14.4.3.5.

14.4.3.2 Each room occupied by more than 300 persons shall have two or more means of egress entering into separate atmospheres.

14.4.3.3 Where three or more means of egress are required, the number of means of egress permitted to enter into the same atmosphere shall not exceed two.

14.4.3.4 Flexible plan buildings shall be permitted to have walls and partitions rearranged periodically only if revised plans or diagrams have been approved by the authority having jurisdiction.

14.4.3.5 Flexible plan buildings shall be evaluated while all folding walls are extended and in use as well as when they are in the retracted position.

14.4.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following requirements are met:

(1) Dispensers shall be installed in rooms or spaces separated from corridors and exits.
(2) The maximum individual dispenser fluid capacity shall be as follows:
   (a) 0.32 gal (1.2 L) for dispensers in rooms
   (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) The dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Storage of quantities greater than 5 gal (18.9 L) in a single fire compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(5) The dispensers shall not be installed over or directly adjacent to an ignition source.
(6) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered rooms or spaces.

14.5 Building Services.

14.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

14.5.2 Heating, Ventilating, and Air-Conditioning Equipment.

14.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

14.5.2.2 Unvented fuel-fired heating equipment, other than gas space heaters in compliance with NFPA 54/ANSI Z223.1, *National Fuel Gas Code,* shall be prohibited.

14.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

14.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

14.6 Reserved.

14.7 Operating Features.

14.7.1 Emergency Action Plan. Emergency action plans shall be provided in accordance with Section 4.8.

14.7.2 Emergency Egress Drills.

14.7.2.1* Emergency egress drills shall be conducted in accordance with Section 4.7 and the applicable provisions of 14.7.2.3 as otherwise provided in 14.7.2.2.

14.7.2.2 Approved training programs designed for education and training and for the practice of emergency egress to familiarize occupants with the drill procedure, and to establish conduct of the emergency egress as a matter of routine, shall be permitted to receive credit on a one-for-one basis for not more than four of the emergency egress drills required by 14.7.2.3, provided that a minimum of four emergency egress drills are completed prior to the conduct of the first such training and practice program.

14.7.2.3 Emergency egress drills shall be conducted as follows:

(1) Not less than one emergency egress drill shall be conducted every month the facility is in session, unless both of the following criteria are met:
   (a) In climates where the weather is severe, the monthly emergency egress drills shall be permitted to be deferred.
   (b) The required number of emergency egress drills shall be conducted, and not less than four shall be conducted before the drills are deferred.
(2) All occupants of the building shall participate in the drill.
(3) One additional emergency egress drill, other than for educational occupancies that are open on a year-round basis, shall be required within the first 30 days of operation.

14.7.2.4 All emergency drill alarms shall be sounded on the fire alarm system.

14.7.3 Inspection.

14.7.3.1* It shall be the duty of principals, teachers, or staff to inspect all exit facilities daily to ensure that all stairways, doors, and other exits are in proper condition.

14.7.3.2 Open plan buildings shall require extra surveillance to ensure that exit paths are maintained clear of obstruction and are obvious.

14.7.3.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

14.7.4 Furnishings and Decorations.

14.7.4.1 Draperies, curtains, and other similar furnishings and decorations in educational occupancies shall be in accordance with the provisions of 10.3.1.

14.7.4.2 Clothing and personal effects shall not be stored in corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors protected by an automatic sprinkler system in accordance with Section 9.7.
(2) This requirement shall not apply to corridor areas protected by a smoke detection system in accordance with Section 9.6.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

14.7.4.3 Artwork and teaching materials shall be permitted to be attached directly to the walls in accordance with the following:

(1) The artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) The artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

14.7.5 Open Flames. Approved open flames shall be permitted in laboratories and vocational/technical areas.

Chapter 15 Existing Educational Occupancies

15.1 General Requirements.

15.1.1 Application.

15.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as educational occupancies.

15.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

15.1.1.3 General. The provisions of Chapter 4, General, shall apply.

15.1.1.4 Educational facilities that do not meet the definition of an educational occupancy shall not be required to comply with this chapter but shall comply with the following requirements:

(1) Instructional building — business occupancy
(2) Classrooms under 50 persons — business occupancy
(3) Classrooms, 50 persons and over — assembly occupancy
(4) Laboratories, instructional — business occupancy
(5) Laboratories, noninstructional — industrial occupancy

15.1.2 Classification of Occupancy. See 6.1.3.

15.1.2.1 Educational occupancies shall include all buildings used for educational purposes through the twelfth grade by six or more persons for 4 or more hours per day or more than 12 hours per week.

15.1.2.2 Educational occupancies shall include preschools, kindergartens, and other schools meeting both of the following criteria:

(1) The purpose is primarily educational, even though the children who attend such schools are of preschool age.
(2) The children are all 24 months of age or older.

15.1.2.3 In cases where instruction is incidental to some other occupancy, the section of this *Code* governing such other occupancy shall apply.

15.1.2.4 Other occupancies associated with educational institutions shall be in accordance with the appropriate parts of this *Code. (See Chapters 19, 21, 26, 29, 31, 40, and 42 and 6.1.14.)*

15.1.3 Multiple Occupancies.

15.1.3.1 General. Multiple occupancies shall be in accordance with 6.1.14.

15.1.3.2 Atrium Walls Used in an Occupancy Separation. Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

15.1.3.3 Assembly and Educational.

15.1.3.3.1 Spaces subject to assembly occupancy shall comply with Chapter 13, including 13.1.3.2, which provides that, where auditorium and gymnasium egress lead through corridors or stairways also serving as egress for other parts of the building, the egress capacity shall be sufficient to allow simultaneous egress from auditorium and classroom sections.

15.1.3.3.2 In the case of an assembly occupancy of a type suitable for use only by the school occupant load, and therefore not subject to simultaneous occupancy, the same egress capacity shall be permitted to serve both sections.

15.1.3.4 Dormitory and Classrooms.

15.1.3.4.1 Any building used for both classroom and dormitory purposes shall comply with the applicable provisions of Chapter 29 in addition to complying with Chapter 15.

15.1.3.4.2 Where classroom and dormitory sections are not subject to simultaneous occupancy, the same egress capacity shall be permitted to serve both sections.

15.1.4 Definitions.

15.1.4.1 General. For definitions, see Chapter 3, Definitions.

15.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Common Atmosphere.** See 3.3.26.1.
(2) **Flexible Plan and Open Plan Educational or Day-Care Building.** See 3.3.36.6.
(3) **Separate Atmosphere.** See 3.3.26.2.

15.1.5 Classification of Hazard of Contents. The contents of educational occupancies shall be classified in accordance with the provisions of Section 6.2.

15.1.6 Minimum Construction Requirements. (Reserved)

15.1.7 Occupant Load.

15.1.7.1 The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

15.1.7.2 The occupant load of an educational occupancy, or a portion thereof, shall be permitted to be modified from that specified in 15.1.7.1 if the necessary aisles and exits are provided.

15.1.7.3 An approved aisle or seating diagram shall be required by the authority having jurisdiction to substantiate the modification permitted in 15.1.7.2.

15.2 Means of Egress Requirements.

15.2.1 General.

15.2.1.1 Means of egress shall be in accordance with Chapter 7 and Section 15.2.

15.2.1.2 Rooms normally occupied by preschool, kindergarten, or first-grade students shall be located on a level of exit discharge, unless otherwise permitted by 15.2.1.4.

15.2.1.3 Rooms normally occupied by second-grade students shall not be located more than one story above a level of exit discharge, unless otherwise permitted by 15.2.1.4.

15.2.1.4 Rooms or areas located on floor levels other than as specified in 15.2.1.2 and 15.2.1.3 shall be permitted to be used where provided with independent means of egress dedicated for use by the preschool, kindergarten, first-grade, or second-grade students.

15.2.2 Means of Egress Components.

15.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 15.2.2.2 through 15.2.2.10.

15.2.2.2 Doors.

15.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

15.2.2.2.2 Any required exit door subject to use by 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7.

15.2.2.2.3 Special Locking.

15.2.2.2.3.1 Delayed-egress locking systems complying with 7.2.1.6.1 shall be permitted.

15.2.2.2.3.2 Access-controlled egress door assemblies complying with 7.2.1.6.2 shall be permitted.

15.2.2.2.3.3 Elevator lobby exit access door assemblies locking in accordance with 7.2.1.6.3 shall be permitted.

15.2.2.3* Stairs. Stairs complying with 7.2.2 shall be permitted.

15.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

15.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

15.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

15.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

15.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

15.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

15.2.2.10 Areas of Refuge. Areas of refuge complying with shall be permitted.

15.2.3 Capacity of Means of Egress.

15.2.3.1 General. Capacity of means of egress shall be in accordance with Section 7.3.

15.2.3.2 Minimum Corridor Width. Exit access corridors shall have not less than 6 ft (1830 mm) of clear width.

15.2.4 Number of Means of Egress.

15.2.4.1 The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3. through 7.4.1.6.

15.2.4.2 Not less than two separate exits shall be in accordance with the following criteria:

(1) They shall be provided on every story.
(2) They shall be accessible from every part of every story and mezzanine; however, exit access travel shall be permitted to be common for the distance permitted as common path of travel by 15.2.5.3.

15.2.5 Arrangement of Means of Egress.

15.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

15.2.5.2 No dead-end corridor shall exceed 20 ft (6100 mm), other than in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, in which case dead-end corridors shall not exceed 50 ft (15 m).

15.2.5.3 Limitations on common path of travel shall be in accordance with 15.2.5.3.1 and 15.2.5.3.2.

15.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

15.2.5.3.2 Common path of travel shall not exceed 75 ft (23 m) in a building not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

15.2.5.4 Every room or space larger than 1000 ft^2 (93 m^2) or with an occupant load of more than 50 persons shall comply with the following:

(1) The room or space shall have a minimum of two exit access doors.
(2) The doors required by 15.2.5.4(1) shall provide access to separate exits.
(3) The doors required by 15.2.5.4(1) shall be permitted to open onto a common corridor, provided that such corridor leads to separate exits located in opposite directions.

15.2.5.5 Every room that is normally subject to student occupancy shall have an exit access door leading directly to an exit access corridor or exit, unless otherwise permitted by one of the following:

(1) This requirement shall not apply where an exit door opens directly to the outside or to an exterior balcony or corridor as described in 15.2.5.9.
(2) One room shall be permitted to intervene between a normally occupied student room and an exit access corridor, provided that all of the following criteria are met:
    (a) The travel from a room served by an intervening room to the corridor door or exit shall not exceed 75 ft (23 m).
    (b) Clothing, personal effects, or other materials deemed hazardous by the authority having jurisdiction shall be stored in metal lockers, provided that they do not obstruct the exit access, or the intervening room shall be sprinklered in accordance with Section 9.7.
    (c) One of the following means of protection shall be provided:
        i. The intervening room shall have approved fire detection that activates the building alarm.
        ii. The building shall be protected by an approved automatic sprinkler system in accordance with Section 9.7.
(3) Approved existing arrangements shall be permitted to continue in use.

15.2.5.6 Doors that swing into an exit access corridor shall be arranged to prevent interference with corridor travel. *(See also 7.2.1.4.3.)*

15.2.5.7 Aisles shall be not less than 30 in. (760 mm) wide.

15.2.5.8 The space between parallel rows of seats shall not be subject to the minimum aisle width, provided that the number of seats that intervenes between any seat and an aisle does not exceed six.

15.2.5.9* Exterior exit access shall comply with 7.5.3.

15.2.6 Travel Distance to Exits. Travel distance shall comply with 15.2.6.1 through 15.2.6.4.

15.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

15.2.6.2 Travel distance to an exit shall not exceed 150 ft (46 m) from any point in a building, unless otherwise permitted by 15.2.6.3 or 15.2.6.4. *(See also Section 7.6.)*

15.2.6.3 Travel distance shall not exceed 200 ft (61 m) in educational occupancies protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

15.2.6.4 Approved existing travel distances shall be permitted to continue in use.

15.2.7 Discharge from Exits. Discharge from exits shall be arranged in accordance with Section 7.7.

15.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

15.2.9 Emergency Lighting.

15.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9, unless otherwise permitted by 15.2.9.2.

15.2.9.2 Approved existing emergency lighting installations shall be permitted to be continued in use.

15.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

15.2.11 Special Means of Egress Features.

15.2.11.1* Windows for Rescue.

15.2.11.1.1 Every room or space greater than 250 ft^2 (23.2 m^2) and used for classroom or other educational purposes or normally subject to student occupancy shall have not less than one outside window for emergency rescue that complies with all of the following, unless otherwise permitted by 15.2.11.1.2:

(1) Such windows shall be openable from the inside without the use of tools and shall provide a clear opening of not less than 20 in. (510 mm) in width, 24 in. (610 mm) in height, and 5.7 ft^2 (0.5 m^2) in area.
(2) The bottom of the opening shall be not more than 44 in. (1120 mm) above the floor, and any latching device shall be capable of being operated from not more than 54 in. (1370 mm) above the finished floor.
(3) The clear opening shall allow a rectangular solid, with a width and height that provides not less than the required 5.7 ft^2 (0.5 m^2) opening and a depth of not less than 20 in. (510 mm), to pass fully through the opening.

15.2.11.1.2 The requirements of 15.2.11.1.1 shall not apply to any of the following:

(1) Buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7
(2) Where the room or space has a door leading directly to an exit or directly to the outside of the building
(3) Where the room has a door, in addition to the door that leads to the exit access corridor as required by 15.2.5.5, and such door leads directly to another corridor located in a compartment separated from the compartment housing the corridor addressed in 15.2.5.5 by smoke partitions in accordance with Section 8.4
(4) Rooms located four or more stories above the finished ground level
(5) Where awning-type or hopper-type windows that are hinged or subdivided to provide a clear opening of not less than 4 ft^2 (0.38 m^2) or any dimension of not less than 22 in. (560 mm) meet the following criteria:
    (a) Such windows shall be permitted to continue in use.
    (b) Screen walls or devices located in front of required windows shall not interfere with rescue requirements.
(6) Where the room or space complies with all of the following:
    (a) One door providing direct access to an adjacent classroom and a second door providing direct access to another adjacent classroom shall be provided.
    (b) The two classrooms to which exit access travel is made in accordance with 15.2.11.1.2(6)(a) shall each provide exit access in accordance with 15.2.11.1.2(2) or 15.2.11.1.2(3).
    (c) The corridor required by 15.2.5.5, and the corridor addressed by 15.2.11.1.2(3), if provided, shall be separated from the classrooms by a wall that resists the passage of smoke, and all doors between the classrooms and the corridor shall be self-closing or automatic-closing in accordance with 7.2.1.8.
    (d) The length of travel to exits along such paths shall not exceed 150 ft (46 m).
    (e) Each communicating door shall be marked in accordance with Section 7.10.
    (f) No locking device shall be permitted on the communicating doors.

15.2.11.2 Lockups. Lockups in educational occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

15.3 Protection.

15.3.1 Protection of Vertical Openings.

15.3.1.1 Any vertical opening, other than unprotected vertical openings in accordance with 8.6.9.1, shall be enclosed or protected in accordance with Section 8.6.

15.3.1.2 Where the provisions of are used, the requirements of 15.3.5.4 shall be met.

15.3.1.3 Stairway enclosures shall not be required where all of the following conditions are met:

(1) The stairway serves only one adjacent floor, other than a basement.
(2) The stairway is not connected with stairways serving other floors.
(3) The stairway is not connected with corridors serving other than the two floors involved.

15.3.2 Protection from Hazards.

15.3.2.1 Rooms or spaces for the storage, processing, or use of materials shall be protected in accordance with the following:

(1) Such rooms or spaces shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating or protected by automatic extinguishing systems as specified in Section 8.7 in the following areas:
    (a) Boiler and furnace rooms, unless such rooms enclose only air-handling equipment
    (b) Rooms or spaces used for the storage of combustible supplies in quantities deemed hazardous by the authority having jurisdiction
    (c) Rooms or spaces used for the storage of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
    (d) Janitor closets *[see also 15.3.2.1(4)]*
(2) Such rooms or spaces shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating and protected by automatic extinguishing systems as specified in Section 8.7 in the following areas:

(a) Laundries
(b) Maintenance shops, including woodworking and painting areas
(c) Rooms or spaces used for processing or use of combustible supplies deemed hazardous by the authority having jurisdiction
(d) Rooms or spaces used for processing or use of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards

(3) Where automatic extinguishing is used to meet the requirements of 15.3.2.1(1) or (2), the protection shall be permitted in accordance with 9.7.1.2.
(4) Where janitor closets addressed in 15.3.2.1(1)(d) are protected in accordance with the sprinkler option of 15.3.2.1(1), the janitor closet doors shall be permitted to have ventilating louvers.

15.3.2.2 Cooking facilities shall be protected in accordance with 9.2.3. Openings shall not be required to be protected between food preparation areas and dining areas.

15.3.2.3 Stages and platforms shall be protected in accordance with Chapter 13.

15.3.2.4 Educational occupancy laboratories using chemicals shall be in accordance with 8.7.4.

15.3.3 Interior Finish.

15.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

15.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted as follows:

(1) Exits — Class A
(2) Corridors and lobbies — Class A or Class B
(3) Low-height partitions not exceeding 60 in. (1525 mm) and used in locations other than exits — Class A, Class B, or Class C

15.3.3.3 Interior Floor Finish. (Reserved)

15.3.4 Detection, Alarm, and Communications Systems.

15.3.4.1 General.

15.3.4.1.1 Educational occupancies shall be provided with a fire alarm system in accordance with Section 9.6.

15.3.4.1.2 The requirement of 15.3.4.1.1 shall not apply to buildings meeting all of the following criteria:

(1) Buildings having an area not exceeding 1000 ft^2 (93 m^2)
(2) Buildings containing a single classroom
(3) Buildings located not less than 30 ft (9.1 m) from another building

15.3.4.2 Initiation.

15.3.4.2.1 General. Initiation of the required fire alarm system shall be by manual means in accordance with 9.6.2.1(1), unless otherwise permitted by one of the following:

(1) Manual fire alarm boxes shall not be required where permitted by 15.3.4.2.3.
(2) In buildings where all normally occupied spaces are provided with a two-way communication system between such spaces and a constantly attended receiving station from where a general evacuation alarm can be sounded, the manual fire alarm boxes shall not be required, except in locations specifically designated by the authority having jurisdiction.

15.3.4.2.2 Automatic Initiation. In buildings provided with automatic sprinkler protection, the operation of the sprinkler system shall automatically activate the fire alarm system in addition to the initiation means required in 15.3.4.2.1.

15.3.4.2.3 Alternative Protection System. Manual fire alarm boxes shall be permitted to be eliminated in accordance with 15.3.4.2.3.1 or 15.3.4.2.3.2.

15.3.4.2.3.1* Manual fire alarm boxes shall be permitted to be eliminated where all of the following conditions apply:

(1) Interior corridors are protected by smoke detectors using an alarm verification system as described in *NFPA 72, National Fire Alarm and Signaling Code*.
(2) Auditoriums, cafeterias, and gymnasiums are protected by heat-detection devices or other approved detection devices.
(3) Shops and laboratories involving dusts or vapors are protected by heat-detection devices or other approved detection devices.
(4) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

15.3.4.2.3.2* Manual fire alarm boxes shall be permitted to be eliminated where both of the following conditions apply:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) Provision is made at a central point to manually activate the evacuation signal or to evacuate only affected areas.

15.3.4.3 Notification.

15.3.4.3.1 Occupant Notification.

15.3.4.3.1.1* Occupant notification shall be accomplished automatically in accordance with 9.6.3.

15.3.4.3.1.2 Reserved.

15.3.4.3.1.3 Positive alarm sequence shall be permitted in accordance with 9.6.3.4.

15.3.4.3.1.4 Where acceptable to the authority having jurisdiction, the fire alarm system shall be permitted to be used for other emergency signaling or for class changes, provided that the fire alarm is distinctive in signal and overrides all other use.

15.3.4.3.1.5 To prevent students from being returned to a building that is burning, the recall signal shall be separate and distinct from any other signals, and such signal shall be permitted to be given by use of distinctively colored flags or banners.

15.3.4.3.1.6 If the recall signal required by 15.3.4.3.1.5 is electric, the push buttons or other controls shall be kept under lock, the key for which shall be in the possession of the principal or another designated person in order to prevent a recall at a time when there is an actual fire.

15.3.4.3.1.7 Regardless of the method of recall signal, the means of giving the recall signal shall be kept under lock.

15.3.4.3.2 Emergency Forces Notification.

15.3.4.3.2.1 Wherever any of the school authorities determine that an actual fire exists, they shall immediately call the local fire department using the public fire alarm system or other available facilities.

15.3.4.3.2.2 Emergency forces notification shall be accomplished in accordance with 9.6.4 where the existing fire alarm system is replaced.

15.3.5 Extinguishment Requirements.

15.3.5.1 Where student occupancy exists below the level of exit discharge, every portion of such floor shall be protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

15.3.5.2 Where student occupancy does not exist on floors below the level of exit discharge, such floors shall be separated from the rest of the building by 1-hour fire resistance–rated construction or shall be protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

15.3.5.3 Automatic sprinkler protection shall not be required where student occupancy exists below the level of exit discharge, provided that both of the following criteria are met:

(1) The approval of the authority having jurisdiction shall be required.
(2) Windows for rescue and ventilation shall be provided in accordance with 15.2.11.1.

15.3.5.4 Buildings with unprotected openings in accordance with 8.6.6 shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

15.3.5.5 Where another provision of this chapter requires an automatic sprinkler system, the sprinkler system shall be installed in accordance with 9.7.1.1(1).

15.3.6 Corridors. Corridors shall be separated from other parts of the story by walls having a minimum ½-hour fire resistance rating in accordance with Section 8.3, unless otherwise permitted by one of the following:

(1) Corridor protection shall not be required where all spaces normally subject to student occupancy have not less than one door opening directly to the outside or to an exterior exit access balcony or corridor in accordance with 7.5.3.
(2)*The following shall apply to buildings protected throughout by an approved automatic sprinkler system with valve supervision in accordance with Section 9.7:
  (a) Corridor walls shall not be required to be rated, provided that such walls form smoke partitions in accordance with Section 8.4.
  (b) The provisions of 8.4.3.5 shall not apply to normally occupied classrooms.
(3) Where the corridor ceiling is an assembly having a minimum ½-hour fire resistance rating where tested as a wall, the corridor wall shall be permitted to terminate at the corridor ceiling.
(4) Lavatories shall not be required to be separated from corridors, provided that they are separated from all other spaces by walls having a minimum ½-hour fire resistance rating in accordance with Section 8.3.
(5) Lavatories shall not be required to be separated from corridors, provided that both of the following criteria are met:
  (a) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
  (b) The walls separating the lavatory from other rooms form smoke partitions in accordance with Section 8.4.

15.3.7 Subdivision of Building Spaces.

15.3.7.1 Educational occupancies shall be subdivided into compartments by smoke partitions having not less than a 1-hour fire resistance rating and complying with Section 8.4 where one or both of the following conditions exist:

(1) The maximum area of a compartment, including the aggregate area of all floors having a common atmosphere, exceeds 30,000 ft^2 (2800 m^2).
(2) The length or width of the building exceeds 300 ft (91 m).

15.3.7.2 The requirement of 15.3.7.1 shall not apply to either of the following:

(1) Where all classrooms have exterior exit access in accordance with 7.5.3
(2) Buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7

15.3.7.3 The area of any smoke compartment required by 15.3.7.1 shall not exceed 30,000 ft^2 (2800 m^2), with no dimension exceeding 300 ft (91 m).

15.4 Special Provisions.

15.4.1 Limited Access Buildings and Underground Buildings. Limited access buildings and underground buildings shall comply with Section 11.7.

15.4.2 High-Rise Buildings. High-rise buildings shall comply with 11.8.3.1.

15.4.3 Flexible Plan and Open Plan Buildings.

15.4.3.1 Flexible plan and open plan buildings shall comply with the requirements of this chapter as modified by 15.4.3.2 through 15.4.3.5.

15.4.3.2 Each room occupied by more than 300 persons shall have two or more means of egress entering into separate atmospheres.

15.4.3.3 Where three or more means of egress are required, the number of means of egress permitted to enter into the same atmosphere shall not exceed two.

15.4.3.4 Flexible plan buildings shall be permitted to have walls and partitions rearranged periodically only if revised plans or diagrams have been approved by the authority having jurisdiction.

15.4.3.5 Flexible plan buildings shall be evaluated while all folding walls are extended and in use as well as when they are in the retracted position.

15.4.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following requirements are met:

(1) Dispensers shall be installed in rooms or spaces separated from corridors and exits.
(2) The maximum individual dispenser fluid capacity shall be as follows:
  (a) 0.32 gal (1.2 L) for dispensers in rooms
  (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) The dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Storage of quantities greater than 5 gal (18.9 L) in a single fire compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.

(5) The dispensers shall not be installed over or directly adjacent to an ignition source.
(6) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered rooms or spaces.

15.5 Building Services.

15.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

15.5.2 Heating, Ventilating, and Air-Conditioning Equipment.

15.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

15.5.2.2 Unvented fuel-fired heating equipment, other than gas space heaters in compliance with NFPA 54/ANSI Z223.1, *National Fuel Gas Code*, shall be prohibited.

15.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

15.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

15.6 Reserved.

15.7 Operating Features.

15.7.1 Emergency Action Plans. Emergency action plans shall be provided in accordance with Section 4.8.

15.7.2 Emergency Egress Drills.

15.7.2.1* Emergency egress drills shall be conducted in accordance with Section 4.7 and the applicable provisions of 15.7.2.3 as otherwise provided by 15.7.2.2.

15.7.2.2 Approved training programs designed for education and training and for the practice of emergency egress to familiarize occupants with the drill procedure, and to establish conduct of the emergency egress as a matter of routine, shall be permitted to receive credit on a one-for-one basis for not more than four of the emergency egress drills required by 15.7.2.3, provided that a minimum of four emergency egress drills are completed prior to the conduct of the first such training and practice program.

15.7.2.3 Emergency egress drills shall be conducted as follows:

(1) Not less than one emergency egress drill shall be conducted every month the facility is in session, unless both of the following criteria are met:
    (a) In climates where the weather is severe, the monthly emergency egress drills shall be permitted to be deferred.
    (b) The required number of emergency egress drills shall be conducted, and not less than four shall be conducted before the drills are deferred.
(2) All occupants of the building shall participate in the drill.
(3) One additional emergency egress drill, other than for educational occupancies that are open on a year-round basis, shall be required within the first 30 days of operation.

15.7.2.4 All emergency drill alarms shall be sounded on the fire alarm system.

15.7.3 Inspection.

15.7.3.1* It shall be the duty of principals, teachers, or staff to inspect all exit facilities daily to ensure that all stairways, doors, and other exits are in proper condition.

15.7.3.2 Open plan buildings shall require extra surveillance to ensure that exit paths are maintained clear of obstruction and are obvious.

15.7.3.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

15.7.4 Furnishings and Decorations.

15.7.4.1 Draperies, curtains, and other similar furnishings and decorations in educational occupancies shall be in accordance with the provisions of 10.3.1.

15.7.4.2 Clothing and personal effects shall not be stored in corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors protected by an automatic sprinkler system in accordance with Section 9.7.
(2) This requirement shall not apply to corridor areas protected by a smoke detection system in accordance with Section 9.6.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

15.7.4.3 Artwork and teaching materials shall be permitted to be attached directly to the walls in accordance with the following:

(1) The artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.
(2) The artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

15.7.5 Open Flames. Approved open flames shall be permitted in laboratories and vocational/technical areas.

Chapter 16 New Day-Care Occupancies

16.1 General Requirements.

16.1.1* Application.

16.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as day-care occupancies. *(See 1.3.1.)*

16.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

16.1.1.3 General. The provisions of Chapter 4, General, shall apply.

16.1.1.4 The requirements of Sections 16.1 through 16.5 and Section 16.7 shall apply to day-care occupancies in which more than 12 clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day.

16.1.1.5 The requirements of Section 16.1 and Sections 16.4 through 16.7 shall apply to day-care homes as defined in 16.1.4.

16.1.1.6 Where a facility houses more than one age group or self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care occupancy or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area.

16.1.1.7 Places of religious worship shall not be required to meet the provisions of this chapter where providing day care while services are being held in the building.

16.1.1.8 Multiple-Level Buildings. For purposes of applying requirements of this chapter that utilize the term *level of exit discharge,* including determination of stories in height as addressed in 4.6.3, the level of exit discharge shall be permitted to be the combination of floor levels as addressed in 16.1.1.8.1, 16.1.1.8.2, or 16.1.1.8.3.

16.1.1.8.1 One floor level located not more than eight stair risers above the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

16.1.1.8.2 One floor level located not more than eight stair risers below the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

16.1.1.8.3 Where one floor level is located above the level of exit discharge, another floor level is located below the level of exit discharge, and not more than a total of eight stair risers separate the upper level from the lower level, the two floor levels shall be permitted to be considered part of the level of exit discharge.

16.1.1.8.4 The provisions of 16.1.1.8.1, 16.1.1.8.2, and 16.1.1.8.3 shall not be used in combination with each other.

16.1.2 Classification of Occupancy. See 6.1.4.

16.1.2.1 General. Occupancies that include preschools, kindergartens, and other schools whose purpose is primarily educational for children 24 months of age or older, even though the children who attend such schools are of preschool age, shall comply with the provisions of Chapter 14.

16.1.2.2 Adult Day-Care Occupancies.

16.1.2.2.1 Adult day-care occupancies shall include any building or portion thereof used for less than 24 hours per day to house more than three adults requiring care, maintenance, and supervision by other than their relative(s).

16.1.2.2.2 Clients in adult day-care occupancies shall be ambulatory or semiambulatory and shall not be bedridden.

16.1.2.2.3 Clients in adult day-care occupancies shall not exhibit behavior that is harmful to themselves or to others.

16.1.2.3* Conversions. A conversion from a day-care home to a day-care occupancy with more than 12 clients shall be permitted only if the day-care occupancy conforms to the requirements of this chapter for new day-care occupancies with more than 12 clients.

16.1.3 Multiple Occupancies.

16.1.3.1 General. Multiple occupancies shall be in accordance with 6.1.14.

16.1.3.2 Atrium Walls Used in an Occupancy Separation. Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis in other than high-hazard industrial and high-hazard storage occupancies.

16.1.3.3 Day-Care Occupancies in Apartment Buildings. If the two exit accesses from a day-care occupancy enter the same corridor as an apartment occupancy, the exit accesses shall be separated in the corridor by a smoke partition complying with both of the following:

(1) It shall have not less than a 1-hour fire resistance rating and shall be constructed in accordance with Section 8.4.
(2) It shall be located so that it has an exit on each side.

16.1.4 Definitions.

16.1.4.1 General. For definitions, see Chapter 3, Definitions.

16.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Day-Care Home.** See 3.3.142.2.
(2) **Flexible Plan and Open Plan Educational or Day-Care Building.** See 3.3.36.6.
(3) **Self-Preservation (Day-Care Occupancy).** See 3.3.242.
(4) **Separate Atmosphere.** See 3.3.26.2.

16.1.5 Classification of Hazard of Contents. The contents of day-care occupancies shall be classified as ordinary hazard in accordance with Section 6.2.

16.1.6 Location and Minimum Construction Requirements.

16.1.6.1 Day-care occupancies, other than day-care homes, shall be limited to the building construction types specified in Table 16.1.6.1 based on the number of stories in height as defined in 4.6.3. *(See 8.2.1.)*

16.1.6.2 Where day-care occupancies, other than day-care homes, with clients who are 24 months or less in age or who are incapable of self-preservation, are located one or more stories above the level of exit discharge, or where day-care occupancies are located two or more stories above the level of exit discharge, smoke partitions shall be provided to divide such stories into not less than two compartments. The smoke partitions shall be constructed in accordance with Section 8.4 but shall not be required to have a fire resistance rating.

16.1.7 Occupant Load.

16.1.7.1 The occupant load, in number of persons for whom means of egress and other provisions are required, either shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

16.1.7.2 Where the occupant load is determined as the maximum probable population of the space in accordance with 16.1.7.1, an approved aisle, seating, and exiting diagram shall be required by the authority having jurisdiction to substantiate such a modification.

16.2 Means of Egress Requirements.

16.2.1 General. Means of egress shall be in accordance with Chapter 7 and Section 16.2.

16.2.2 Means of Egress Components.

16.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 16.2.2.2 through 16.2.2.10.

16.2.2.2 Doors.

16.2.2.2.1 General. Doors complying with 7.2.1 shall be permitted.

16.2.2.2.2 Panic Hardware or Fire Exit Hardware. Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7.

Table 16.1.6.1 Construction Type Limitations

Construction Type	Sprinklered[b]	Stories in Height[a]					
		One Story Below[c]	1	2	3–4	>4 but Not High-Rise	High-Rise
I (442)	Yes	X	X	X	X	X	X
	No	NP	X	X	X	NP	NP
I (332)	Yes	X	X	X	X	X	X
	No	NP	X	X	X	NP	NP
II (222)	Yes	X	X	X	X	X	X
	No	NP	X	X	X	NP	NP
II (111)	Yes	X	X	X	X	X	NP
	No	NP	X	NP	NP	NP	NP
II (000)	Yes	X	X	X	X	NP	NP
	No	NP	X	NP	NP	NP	NP
III (211)	Yes	X	X	X	X	NP	NP
	No	NP	X	NP	NP	NP	NP
III (200)	Yes	NP	X	X	NP	NP	NP
	No	NP	X	NP	NP	NP	NP
IV (2HH)	Yes	X	X	X	NP	NP	NP
	No	NP	X	NP	NP	NP	NP
V (111)	Yes	X	X	X	X	NP	NP
	No	NP	X	NP	NP	NP	NP
V (000)	Yes	NP	X	X	NP	NP	NP
	No	NP	X	NP	NP	NP	NP

X: Permitted. NP: Not Permitted.
[a]See 4.6.3.
[b]Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
[c]One story below the level of exit discharge.

16.2.2.2.3 Special Locking Arrangements.

16.2.2.2.3.1 Delayed-egress locking systems complying with 7.2.1.6.1 shall be permitted.

16.2.2.2.3.2 Access-controlled egress door assemblies complying with 7.2.1.6.2 shall be permitted.

16.2.2.2.3.3 Elevator lobby exit access door assemblies locking in accordance with 7.2.1.6.3 shall be permitted.

16.2.2.2.4* Door Latches. Every door latch to closets, storage areas, kitchens, and other similar spaces or areas shall be such that clients can open the door from inside the space or area.

16.2.2.2.5 Bathroom Doors. Every bathroom door lock shall be designed to allow opening of the locked door from the outside by an opening device that shall be readily accessible to the staff.

16.2.2.3* Stairs. Stairs complying with 7.2.2 shall be permitted.

16.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

16.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

16.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

16.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

16.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

16.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

16.2.2.10 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

16.2.3 Capacity of Means of Egress. Capacity of means of egress shall be in accordance with Section 7.3.

16.2.4 Number of Means of Egress.

16.2.4.1 The number of means of egress shall be in accordance with Section 7.4.

16.2.4.2 Not less than two separate exits shall be in accordance with both of the following criteria:

(1) They shall be provided on every story.
(2) They shall be accessible from every part of every story and mezzanine; however, exit access travel shall be permitted to be common for the distance permitted as common path of travel by 16.2.5.3.

16.2.4.3 Reserved.

16.2.5 Arrangement of Means of Egress. See also 16.1.6.2.

16.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

16.2.5.2 No dead-end corridor shall exceed 20 ft (6100 mm), other than in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, in which case dead-end corridors shall not exceed 50 ft (15 m).

16.2.5.3 Limitations on common path of travel shall be in accordance with 16.2.5.3.1 and 16.2.5.3.2.

16.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

16.2.5.3.2 Common path of travel shall not exceed 75 ft (23 m) in a building not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

16.2.6 Travel Distance to Exits.

16.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

16.2.6.2 Travel distance shall meet all of the following criteria, unless otherwise permitted by 16.2.6.3:

(1) The travel distance between any room door intended as an exit access and an exit shall not exceed 100 ft (30 m).
(2) The travel distance between any point in a room and an exit shall not exceed 150 ft (46 m).
(3) The travel distance between any point in a sleeping room and an exit access door in that room shall not exceed 50 ft (15 m).

16.2.6.3 The travel distance required by 16.2.6.2(1) and (2) shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

16.2.7 Discharge from Exits. Discharge from exits shall be arranged in accordance with Section 7.7.

16.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

16.2.9 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9 in the following areas:

(1) Interior stairs and corridors
(2) Assembly use spaces
(3) Flexible and open plan buildings
(4) Interior or limited access portions of buildings
(5) Shops and laboratories

16.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

16.2.11 Special Means of Egress Features.

16.2.11.1 Windows for Rescue.

16.2.11.1.1 Every room or space normally subject to client occupancy, other than bathrooms, shall have not less than one outside window for emergency rescue that complies with all of the following, unless otherwise permitted by 16.2.11.1.2:

(1) Such windows shall be openable from the inside without the use of tools and shall provide a clear opening of not less than 20 in. (510 mm) in width, 24 in. (610 mm) in height, and 5.7 ft^2 (0.5 m^2) in area.
(2) The bottom of the opening shall be not more than 44 in. (1120 mm) above the floor.
(3) The clear opening shall allow a rectangular solid, with a width and height that provides not less than the required 5.7 ft^2 (0.5 m^2) opening and a depth of not less than 20 in. (510 mm), to pass fully through the opening.

16.2.11.1.2 The requirements of 16.2.11.1.1 shall not apply to either of the following:

(1) Buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(2) Where the room or space has a door leading directly to an exit or directly to the outside of the building

16.2.11.2 Lockups. Lockups in day-care occupancies shall comply with the requirements of 22.4.5.

16.3 Protection.

16.3.1 Protection of Vertical Openings. Any vertical opening, other than unprotected vertical openings in accordance with 8.6.9.1, shall be enclosed or protected in accordance with Section 8.6.

16.3.2 Protection from Hazards.

16.3.2.1 Rooms or spaces for the storage, processing, or use of materials specified in 16.3.2.1(1) through (3) shall be protected in accordance with the following:

(1) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating, or protection of such rooms by automatic extinguishing systems as specified in Section 8.7, in the following areas:
    (a) Boiler and furnace rooms, unless such rooms enclose only air-handling equipment
    (b) Rooms or spaces used for the storage of combustible supplies in quantities deemed hazardous by the authority having jurisdiction
    (c) Rooms or spaces used for the storage of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
    (d) Janitor closets
(2) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating and protection of such rooms by automatic extinguishing systems as specified in Section 8.7 in the following areas:
    (a)*Laundries
    (b) Maintenance shops, including woodworking and painting areas
    (c) Rooms or spaces used for processing or use of combustible supplies deemed hazardous by the authority having jurisdiction

(d) Rooms or spaces used for processing or use of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards

(3) Where automatic extinguishing is used to meet the requirements of 16.3.2.1(1) and (2), protection as permitted in accordance with 9.7.1.2

16.3.2.2 Janitor closets protected in accordance with 16.3.2.1(1)(d) shall be permitted to have doors fitted with ventilating louvers where the space is protected by automatic sprinklers.

16.3.2.3 Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 16.3.2.4 or 16.3.2.5.

16.3.2.4 Openings shall not be required to be protected between food preparation areas and dining areas.

16.3.2.5 Approved domestic cooking equipment used for food warming or limited cooking shall not be required to be protected.

16.3.3 Interior Finish.

16.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

16.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A in stairways, corridors, and lobbies; in all other occupied areas, interior wall and ceiling finish shall be Class A or Class B.

16.3.3.3 Interior Floor Finish.

16.3.3.3.1 Interior floor finish shall comply with Section 10.2.

16.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 14.3.6 shall be not less than Class II.

16.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

16.3.4 Detection, Alarm, and Communications Systems.

16.3.4.1 General. Day-care occupancies, other than day-care occupancies housed in one room having at least one door opening directly to the outside at grade plane or to an exterior exit access balcony in accordance with 7.5.3, shall be provided with a fire alarm system in accordance with Section 9.6.

16.3.4.2 Initiation. Initiation of the required fire alarm system shall be by manual means and by operation of any required smoke detectors and required sprinkler systems. *(See 16.3.4.5.)*

16.3.4.3 Occupant Notification.

16.3.4.3.1 Occupant notification shall be in accordance with 9.6.3.

16.3.4.3.2 Positive alarm sequence shall be permitted in accordance with 9.6.3.4.

16.3.4.3.3 Private operating mode in accordance with 9.6.3.6.3 shall be permitted.

16.3.4.4 Emergency Forces Notification. Emergency forces notification shall be accomplished in accordance with 9.6.4.

16.3.4.5 Detection. A smoke detection system in accordance with Section 9.6 shall be installed in day-care occupancies, other than those housed in one room having at least one door opening directly to the outside at grade plane or to an exterior exit access balcony in accordance with 7.5.3, and such system shall comply with both of the following:

(1) Detectors shall be installed on each story in front of the doors to the stairways and in the corridors of all floors occupied by the day-care occupancy.
(2) Detectors shall be installed in lounges, recreation areas, and sleeping rooms in the day-care occupancy.

16.3.5 Extinguishment Requirements.

16.3.5.1 Any required sprinkler systems shall be in accordance with Section 9.7.

16.3.5.2 Required sprinkler systems shall be installed in accordance with 9.7.1.1(1).

16.3.5.3 Buildings with unprotected openings in accordance with 8.6.6 shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

16.3.6 Corridors. Every interior corridor shall be constructed of walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3, unless otherwise permitted by any of the following:

(1) Corridor protection shall not be required where all spaces normally subject to client occupancy have not less than one door opening directly to the outside or to an exterior exit access balcony or corridor in accordance with 7.5.3.
(2) In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, corridor walls shall not be required to be rated, provided that such walls form smoke partitions in accordance with Section 8.4.
(3) Where the corridor ceiling is an assembly having a 1-hour fire resistance rating where tested as a wall, the corridor walls shall be permitted to terminate at the corridor ceiling.
(4) Lavatories shall not be required to be separated from corridors, provided that they are separated from all other spaces by walls having not less than a 1-hour fire resistance rating in accordance with Section 8.3.
(5) Lavatories shall not be required to be separated from corridors, provided that both of the following criteria are met:
    (a) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
    (b) The walls separating the lavatory from other rooms form smoke partitions in accordance with Section 8.4.

16.4 Special Provisions.

16.4.1 Limited Access Buildings and Underground Buildings. Limited access buildings and underground buildings shall comply with Section 11.7.

16.4.2 High-Rise Buildings. High-rise buildings that house day-care occupancies on floors more than 75 ft (23 m) above the lowest level of fire department vehicle access shall comply with Section 11.8.

16.4.3 Flexible Plan and Open Plan Buildings.

16.4.3.1 Flexible plan and open plan buildings shall comply with the requirements of this chapter as modified by 16.4.3.2 through 16.4.3.5.

16.4.3.2 Flexible plan buildings shall be permitted to have walls and partitions rearranged periodically only if revised plans or diagrams have been approved by the authority having jurisdiction.

16.4.3.3 Flexible plan buildings shall be evaluated while all folding walls are extended and in use as well as when they are in the retracted position.

16.4.3.4 Each room occupied by more than 300 persons shall have two or more means of egress entering into separate atmospheres.

16.4.3.5 Where three or more means of egress are required from a single room, the number of means of egress permitted to enter into a common atmosphere shall not exceed two.

16.4.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following requirements are met:

(1) Dispensers shall be installed in rooms or spaces separated from corridors and exits.
(2) The maximum individual dispenser fluid capacity shall be as follows:
  (a) 0.32 gal (1.2 L) for dispensers in rooms
  (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) The dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Storage of quantities greater than 5 gal (18.9 L) in a single fire compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(5) The dispensers shall not be installed over or directly adjacent to an ignition source.
(6) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered rooms or spaces.

16.5 Building Services.

16.5.1 Utilities.

16.5.1.1 Utilities shall comply with the provisions of Section 9.1.

16.5.1.2 Special protective covers for all electrical receptacles shall be installed in all areas occupied by clients.

16.5.2 Heating, Ventilating, and Air-Conditioning Equipment.

16.5.2.1 Heating, ventilating, and air-conditioning equipment shall be in accordance with Section 9.2.

16.5.2.2 Unvented fuel-fired heating equipment, other than gas space heaters in compliance with NFPA 54/ANSI Z223.1, *National Fuel Gas Code*, shall be prohibited.

16.5.2.3 Any heating equipment in spaces occupied by clients shall be provided with partitions, screens, or other means to protect clients from hot surfaces and open flames; if solid partitions are used to provide such protection, provisions shall be made to ensure adequate air for combustion and ventilation for the heating equipment.

16.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors, other than those in day-care homes, shall comply with the provisions of Section 9.4.

16.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes, other than those in day-care homes, shall comply with the provisions of Section 9.5.

16.6 Day-Care Homes.

16.6.1 General Requirements.

16.6.1.1 Application.

16.6.1.1.1 The requirements of Section 16.6 shall apply to new buildings or portions thereof used as day-care homes. *(See 1.3.1.)*

16.6.1.1.2 The requirements of Section 16.6 shall apply to day-care homes in which more than 3, but not more than 12, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit. *(See also 16.6.1.4.)*

16.6.1.1.3 Where a facility houses more than one age group or one self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care home or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area.

16.6.1.1.4 Facilities that supervise clients on a temporary basis with a parent or guardian in close proximity shall not be required to meet the provisions of Section 16.6.

16.6.1.1.5 Places of religious worship shall not be required to meet the provisions of Section 16.6 where operating a day-care home while services are being held in the building.

16.6.1.2 Multiple Occupancies. See 16.1.3.

16.6.1.3 Definitions. See 16.1.4.

16.6.1.4 Classification of Occupancy.

16.6.1.4.1 Subclassification of Day-Care Homes. Subclassification of day-care homes shall comply with 16.6.1.4.1.1 and 16.6.1.4.1.2.

16.6.1.4.1.1 Family Day-Care Home. A family day-care home shall be a day-care home in which more than three, but fewer than seven, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit.

16.6.1.4.1.2 Group Day-Care Home. A group day-care home shall be a day-care home in which not less than 7, but not more than 12, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit.

16.6.1.4.2* Conversions. A conversion from a day-care home to a day-care occupancy with more than 12 clients shall be permitted only if the day-care occupancy conforms to the requirements of Chapter 16 for new day-care occupancies with more than 12 clients.

16.6.1.5 Classification of Hazard of Contents. See 16.1.5.

16.6.1.6 Location and Construction. No day-care home shall be located more than one story below the level of exit discharge.

16.6.1.7 Occupant Load.

16.6.1.7.1 In family day-care homes, both of the following shall apply:

(1) The minimum staff-to-client ratio shall be not less than one staff for up to six clients, including the caretaker's own children under age six.
(2) There shall be not more than two clients incapable of self-preservation.

16.6.1.7.2 In group day-care homes, all of the following shall apply:

(1) The minimum staff-to-client ratio shall be not less than two staff for up to 12 clients.
(2) There shall be not more than 3 clients incapable of self-preservation.
(3) The staff-to-client ratio shall be permitted to be modified by the authority having jurisdiction where safeguards in addition to those specified by Section 16.6 are provided.

16.6.2 Means of Escape Requirements.

16.6.2.1 General. Means of escape shall comply with Section 24.2.

16.6.2.2 Reserved.

16.6.2.3 Reserved.

16.6.2.4 Number and Type of Means of Escape.

16.6.2.4.1 The number and type of means of escape shall comply with Section 24.2 and 16.6.2.4.2 through 16.6.2.4.4.

16.6.2.4.2 Every room used for sleeping, living, recreation, education, or dining purposes shall have the number and type of means of escape in accordance with Section 24.2.

16.6.2.4.3 No room or space that is accessible only by a ladder or folding stairs or through a trap door shall be occupied by clients.

16.6.2.4.4 In group day-care homes where spaces on the story above the level of exit discharge are used by clients, that story shall have not less than one means of escape complying with one of the following:

(1) Door leading directly to the outside with access to finished ground level
(2) Door leading directly to an outside stair to finished ground level
(3) Interior stair leading directly to the outside with access to finished ground level separated from other stories by a ½-hour fire barrier in accordance with Section 8.3

16.6.2.4.5 Where clients occupy a story below the level of exit discharge, that story shall have not less than one means of escape complying with one of the following:

(1) Door leading directly to the outside with access to finished ground level
(2) Door leading directly to an outside stair going to finished ground level
(3) Bulkhead enclosure complying with 24.2.7
(4) Interior stair leading directly to the outside with access to finished ground level, separated from other stories by a ½-hour fire barrier in accordance with Section 8.3

16.6.2.5 Arrangement of Means of Escape.

16.6.2.5.1 A story used above or below the level of exit discharge shall be in accordance with 16.6.2.4.3 and 16.6.2.4.4.

16.6.2.5.2 For group day-care homes, means of escape shall be arranged in accordance with Section 7.5.

16.6.2.5.3 No dead-end corridors shall exceed 20 ft (6100 mm).

16.6.2.5.4 Doors in means of escape shall be protected from obstructions, including snow and ice.

16.6.2.6 Travel Distance. Travel distance shall comply with 16.6.2.6.1 through 16.6.2.6.3.

16.6.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

16.6.2.6.2 Travel distance shall meet all of the following criteria, unless otherwise permitted by 16.6.2.6.3:

(1) The travel distance between any point in a room and a door leading directly to the outside with access to finished ground level shall not exceed 150 ft (46 m).
(2) The travel distance between any point in a sleeping room and access to a means of escape from that room shall not exceed 50 ft (15 m).

16.6.2.6.3 The travel distance required by 16.6.2.6.2(1) shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

16.6.2.7 Discharge from Exits. See 16.6.2.4.

16.6.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

16.6.2.9 Emergency Lighting. (Reserved)

16.6.2.10 Marking of Means of Egress. (Reserved)

16.6.3 Protection.

16.6.3.1 Protection of Vertical Openings.

16.6.3.1.1 For group day-care homes, the doorway between the level of exit discharge and any story below shall be equipped with a fire door assembly having a 20-minute fire protection rating.

16.6.3.1.2 For group day-care homes where the story above the level of exit discharge is used for sleeping purposes, there shall be a fire door assembly having a 20-minute fire protection rating at the top or bottom of each stairway.

16.6.3.2 Protection from Hazards.

16.6.3.2.1 Reserved.

16.6.3.3 Interior Finish.

16.6.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

16.6.3.3.2 Interior Wall and Ceiling Finish.

16.6.3.3.2.1 In group day-care homes, interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in corridors, hallways, stairways, foyers, and lobbies.

16.6.3.3.2.2 In family day-care homes, the interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in stairways.

16.6.3.3.2.3 Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C in occupied spaces.

16.6.3.3.3 Interior Floor Finish.

16.6.3.3.3.1 Interior floor finish shall comply with Section 10.2.

16.6.3.3.3.2 Interior floor finish in stairways shall be not less than Class II.

16.6.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

16.6.3.4 Detection, Alarm, and Communications Systems.

16.6.3.4.1 Smoke alarms shall be installed within day-care homes in accordance with 9.6.2.10.

16.6.3.4.2 Where a day-care home is located within a building of another occupancy, such as in an apartment building or office building, any corridors serving the day-care home shall be provided with a smoke detection system in accordance with Section 9.6.

16.6.3.4.3 Single-station or multiple-station smoke alarms or smoke detectors shall be provided in all rooms used for sleeping in accordance with 9.6.2.10.

16.6.3.4.4 Reserved.

16.6.3.4.5 Single-station or multiple-station carbon monoxide alarms or detectors shall be provided in accordance with Section 9.12 in day-care homes where client sleeping occurs and one or both of the following conditions exist:

(1) Fuel-fired equipment is present.
(2) An enclosed parking structure is attached to the day-care home.

16.6.3.5 Extinguishment Requirements. Any required sprinkler systems shall be in accordance with Section 9.7 and shall be installed in accordance with 9.7.1.1(1), (2), or (3), as appropriate with respect to the scope of the installation standard.

16.6.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following requirements are met:

(1) Dispensers shall be installed in rooms or spaces separated from corridors, stairways, and exterior doors.
(2) The maximum individual dispenser fluid capacity shall be as follows:
    (a) 0.32 gal (1.2 L) for dispensers in rooms
    (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) The dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Storage of quantities greater than 5 gal (18.9 L) in a single fire compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(5) The dispensers shall not be installed over or directly adjacent to an ignition source.
(6) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered rooms or spaces.

16.7 Operating Features.

16.7.1* Emergency Action Plans. Emergency action plans shall be provided in accordance with Section 4.8.

16.7.2 Emergency Egress and Relocation Drills.

16.7.2.1* Emergency egress and relocation drills shall be conducted in accordance with Section 4.7 and the applicable provisions of 16.7.2.2.

16.7.2.2 Emergency egress and relocation drills shall be conducted as follows:

(1) Not less than one emergency egress and relocation drill shall be conducted every month the facility is in session, unless both of the following criteria are met:
    (a) In climates where the weather is severe, the monthly emergency egress and relocation drills shall be permitted to be deferred.
    (b) The required number of emergency egress and relocation drills shall be conducted, and not less than four shall be conducted before the drills are deferred.
(2) All occupants of the building shall participate in the drill.
(3) One additional emergency egress and relocation drill, other than for day-care occupancies that are open on a year-round basis, shall be required within the first 30 days of operation.

16.7.3 Inspections.

16.7.3.1 Fire prevention inspections shall be conducted monthly by a trained senior member of the staff, after which a copy of the latest inspection report shall be posted in a conspicuous place in the day-care facility.

16.7.3.2* It shall be the duty of site administrators and staff members to inspect all exit facilities daily to ensure that all stairways, doors, and other exits are in proper condition.

16.7.3.3 Open plan buildings shall require extra surveillance to ensure that exit paths are maintained clear of obstruction and are obvious.

16.7.3.4 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

16.7.4 Furnishings and Decorations.

16.7.4.1 Draperies, curtains, and other similar furnishings and decorations in day-care occupancies, other than in day-care homes, shall be in accordance with the provisions of 10.3.1.

16.7.4.2 Clothing and personal effects shall not be stored in corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors protected by an automatic sprinkler system in accordance with Section 9.7.
(2) This requirement shall not apply to corridor areas protected by a smoke detection system in accordance with Section 9.6.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

16.7.4.3 Artwork and teaching materials shall be permitted to be attached directly to the walls in accordance with the following:

(1) The artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(2) The artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

16.7.4.4 The provision of 10.3.2 for cigarette ignition resistance of newly introduced upholstered furniture and mattresses shall not apply to day-care homes.

16.7.5* Day-Care Staff. Adequate adult staff shall be on duty in the facility and alert at all times where clients are present.

Chapter 17 Existing Day-Care Occupancies

17.1 General Requirements.

17.1.1* Application.

17.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as day-care occupancies.

17.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

17.1.1.3 General. The provisions of Chapter 4, General, shall apply.

17.1.1.4 The requirements of Sections 17.1 through 17.5 and Section 17.7 shall apply to existing day-care occupancies in which more than 12 clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day. An existing day-care occupancy shall be permitted the option of meeting the requirements of Chapter 16 in lieu of Chapter 17. An existing day-care occupancy that meets the requirements of Chapter 16 shall be judged as meeting the requirements of Chapter 17.

17.1.1.5 The requirements of Section 17.1 and Sections 17.4 through 17.7 shall apply to existing day-care homes as defined in 17.1.4. An existing day-care home shall be permitted the option of meeting the requirements of Chapter 16 in lieu of Chapter 17. An existing day-care home that meets the requirements of Chapter 16 shall be judged as meeting the requirements of Chapter 17.

17.1.1.6 Where a facility houses clients of more than one self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care occupancy or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area.

17.1.1.7 Places of religious worship shall not be required to meet the provisions of this chapter where providing day care while services are being held in the building.

17.1.1.8 Multiple-Level Buildings. For purposes of applying requirements of this chapter that utilize the term *level of exit discharge*, including determination of stories in height as addressed in 4.6.3, the level of exit discharge shall be permitted to be the combination of floor levels as addressed in 17.1.1.8.1, 17.1.1.8.2, or 17.1.1.8.3.

17.1.1.8.1 One floor level located not more than eight stair risers above the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

17.1.1.8.2 One floor level located not more than eight stair risers below the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

17.1.1.8.3 Where one floor level is located above the level of exit discharge, another floor level is located below the level of exit discharge, and not more than a total of eight stair risers separate the upper level from the lower level, the two floor levels shall be permitted to be considered part of the level of exit discharge.

17.1.1.8.4 The provisions of 17.1.1.8.1, 17.1.1.8.2, and 17.1.1.8.3 shall not be used in combination with each other.

17.1.2 Classification of Occupancy. See 6.1.4.

17.1.2.1 General. Occupancies that include preschools, kindergartens, and other schools whose purpose is primarily educational for children 24 months of age or older, even though the children who attend such schools are of preschool age, shall comply with the provisions of Chapter 15.

17.1.2.2 Adult Day-Care Occupancies.

17.1.2.2.1 Adult day-care occupancies shall include any building or portion thereof used for less than 24 hours per day to house more than three adults requiring care, maintenance, and supervision by other than their relative(s).

17.1.2.2.2 Clients in adult day-care occupancies shall be ambulatory or semiambulatory and shall not be bedridden.

17.1.2.2.3 Clients in adult day-care occupancies shall not exhibit behavior that is harmful to themselves or to others.

17.1.2.3* Conversions. A conversion from a day-care home to a day-care occupancy with more than 12 clients shall be permitted only if the day-care occupancy conforms to the requirements of Chapter 16 for new day-care occupancies with more than 12 clients.

17.1.3 Multiple Occupancies.

17.1.3.1 General. Multiple occupancies shall be in accordance with 6.1.14.

17.1.3.2 Atrium Walls Used in an Occupancy Separation. Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis in other than high-hazard industrial and high-hazard storage occupancies.

17.1.3.3 Day-Care Occupancies in Apartment Buildings. If the two exit accesses from a day-care occupancy enter the same corridor as an apartment occupancy, the exit accesses shall be separated in the corridor by a smoke partition complying with both of the following:

(1) It shall have not less than a 1-hour fire resistance rating and shall be constructed in accordance with Section 8.4.
(2) It shall be located so that it has an exit on each side.

17.1.4 Definitions.

17.1.4.1 General. For definitions, see Chapter 3, Definitions.

17.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Day-Care Home.** See 3.3.142.1.
(2) **Flexible Plan and Open Plan Educational or Day-Care Building.** See 3.3.36.6.
(3) **Self-Preservation (Day-Care Occupancy).** See 3.3.242.
(4) **Separate Atmosphere.** See 3.3.26.2.

17.1.5 Classification of Hazard of Contents. The contents of day-care occupancies shall be classified as ordinary hazard in accordance with Section 6.2.

17.1.6 Location and Minimum Construction Requirements.

17.1.6.1 Day-care occupancies, other than day-care homes, shall be limited to the building construction types specified in Table 17.1.6.1 based on the number of stories in height as defined in 4.6.3. *(See 8.2.1.)*

17.1.6.2 Reserved.

17.1.7 Occupant Load.

17.1.7.1 The occupant load, in number of persons for whom means of egress and other provisions are required, either shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

17.1.7.2 Where the occupant load is determined as the maximum probable population of the space in accordance with

Table 17.1.6.1 Construction Type Limitations

Construction Type	Sprinklered[b]	One Story Below[c]	Stories in Height[a] 1	2	3–4	>4 but Not High-Rise	High-Rise
I (442)	Yes	X	X	X	X	X	X
	No	X	X	X	X	X	NP
I (332)	Yes	X	X	X	X	X	X
	No	X	X	X	X	X	NP
II (222)	Yes	X	X	X	X	X	X
	No	X	X	X	X	X	NP
II (111)	Yes	X	X	X	X[d]	X[d]	NP
	No	X	X	X[d]	NP	NP	NP
II (000)	Yes	X	X	X	NP	NP	NP
	No	NP	X	NP	NP	NP	NP
III (211)	Yes	X	X	X	X[d]	NP	NP
	No	X	X	X[d]	NP	NP	NP
III (200)	Yes	NP	X	X	NP	NP	NP
	No	NP	X	NP	NP	NP	NP
IV (2HH)	Yes	X	X	X	NP	NP	NP
	No	X	X	X	NP	NP	NP
V (111)	Yes	X	X	X	X[d]	NP	NP
	No	X	X	X[d]	NP	NP	NP
V (000)	Yes	NP	X	X	NP	NP	NP
	No	NP	X	NP	NP	NP	NP

X: Permitted. NP: Not Permitted.
[a]See 4.6.3.
[b]Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7. *(See 17.3.5.)*
[c]One story below the level of exit discharge.
[d]Permitted only if clients capable of self-preservation.

17.1.7.1, an approved aisle, seating, and exiting diagram shall be required by the authority having jurisdiction to substantiate such a modification.

17.2 Means of Egress Requirements.

17.2.1 General. Means of egress shall be in accordance with Chapter 7 and Section 17.2.

17.2.2 Means of Egress Components.

17.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 17.2.2.2 through 17.2.2.10.

17.2.2.2 Doors.

17.2.2.2.1 General. Doors complying with 7.2.1 shall be permitted.

17.2.2.2.2 Panic Hardware or Fire Exit Hardware. Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if the latch or lock is panic hardware or fire exit hardware complying with 7.2.1.7.

17.2.2.2.3 Special Locking Arrangements.

17.2.2.2.3.1 Delayed-egress locking systems complying with 7.2.1.6.1 shall be permitted.

17.2.2.2.3.2 Access-controlled egress door assemblies complying with 7.2.1.6.2 shall be permitted.

17.2.2.2.3.3 Elevator lobby exit access door assemblies locking in accordance with 7.2.1.6.3 shall be permitted.

17.2.2.2.4* Door Latches. Every door latch to closets, storage areas, kitchens, and other similar spaces or areas shall be such that clients can open the door from inside the space or area.

17.2.2.2.5 Bathroom Doors. Every bathroom door lock shall be designed to allow opening of the locked door from the outside by an opening device that shall be readily accessible to the staff.

17.2.2.3* Stairs. Stairs complying with 7.2.2 shall be permitted.

17.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

17.2.2.5 Horizontal Exits.

17.2.2.5.1 Horizontal exits complying with 7.2.4 shall be permitted.

17.2.2.5.2 Day-care occupancies located six or more stories above the level of exit discharge shall have horizontal exits to provide areas of refuge, unless the building meets one of the following criteria:

(1) The building is provided with smokeproof enclosures.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

17.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

17.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

17.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

17.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

17.2.2.10 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

17.2.3 Capacity of Means of Egress. Capacity of means of egress shall be in accordance with Section 7.3.

17.2.4 Number of Means of Egress.

17.2.4.1 The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.

17.2.4.2 Not less than two separate exits shall be in accordance with both of the following criteria:

(1) They shall be provided on every story.
(2) They shall be accessible from every part of every story and mezzanine; however, exit access travel shall be permitted to be common for the distance permitted as common path of travel by 17.2.5.3.

17.2.4.3 Where the story below the level of exit discharge is occupied as a day-care occupancy, 17.2.4.3.1 and 17.2.4.3.2 shall apply.

17.2.4.3.1 One means of egress shall be an outside or interior stair in accordance with 7.2.2. An interior stair, if used, shall serve only the story below the level of exit discharge. The interior stair shall be permitted to communicate with the level of exit discharge; however, the exit route from the level of exit discharge shall not pass through the stair enclosure.

17.2.4.3.2 The second means of egress shall be permitted to be via an unenclosed stairway separated from the level of exit discharge in accordance with 8.6.5.

17.2.4.3.3 The path of egress travel on the level of exit discharge shall be protected in accordance with 7.1.3.1, unless one of the following criteria is met:

(1) The path of egress on the level of exit discharge shall be permitted to be unprotected if the level of exit discharge and the level below the level of exit discharge are protected throughout by a smoke detection system.
(2) The path of egress on the level of exit discharge shall be permitted to be unprotected if the level of exit discharge and the level below the level of exit discharge are protected throughout by an approved automatic sprinkler system.

17.2.5 Arrangement of Means of Egress.

17.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

17.2.5.2 No dead-end corridor shall exceed 20 ft (6100 mm), other than in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, in which case dead-end corridors shall not exceed 50 ft (15 m).

17.2.5.3 Limitations on common path of travel shall be in accordance with 17.2.5.3.1 and 17.2.5.3.2.

17.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

17.2.5.3.2 Common path of travel shall not exceed 75 ft (23 m) in a building not protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

17.2.5.4 The story used below the level of exit discharge shall be in accordance with 17.2.4.3.

17.2.6 Travel Distance to Exits.

17.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

17.2.6.2 Travel distance shall meet all of the following criteria, unless otherwise permitted by 17.2.6.3:

(1) The travel distance between any room door intended as an exit access and an exit shall not exceed 100 ft (30 m).
(2) The travel distance between any point in a room and an exit shall not exceed 150 ft (46 m).
(3) The travel distance between any point in a sleeping room and an exit access door in that room shall not exceed 50 ft (15 m).

17.2.6.3 The travel distance required by 17.2.6.2(1) and (2) shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

17.2.7 Discharge from Exits. Discharge from exits shall be arranged in accordance with Section 7.7, unless otherwise provided in 17.2.4.3.

17.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

17.2.9 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9 in the following areas:

(1) Interior stairs and corridors
(2) Assembly use spaces
(3) Flexible and open plan buildings
(4) Interior or limited access portions of buildings
(5) Shops and laboratories

17.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

17.2.11 Special Means of Egress Features.

17.2.11.1 Windows for Rescue.

17.2.11.1.1 Every room or space greater than 250 ft^2 (23.2 m^2) and normally subject to client occupancy shall have not less than one outside window for emergency rescue that complies with all of the following, unless otherwise permitted by 17.2.11.1.2:

(1) Such windows shall be openable from the inside without the use of tools and shall provide a clear opening of not less than 20 in. (510 mm) in width, 24 in. (610 mm) in height, and 5.7 ft^2 (0.5 m^2) in area.
(2) The bottom of the opening shall be not more than 44 in. (1120 mm) above the floor
(3) The clear opening shall allow a rectangular solid, with a width and height that provides not less than the required 5.7 ft^2 (0.5 m^2) opening and a depth of not less than 20 in. (510 mm), to pass fully through the opening.

17.2.11.1.2 The requirements of 17.2.11.1.1 shall not apply to any of the following:

(1) Buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(2) Where the room or space has a door leading directly to an exit or directly to the outside of the building
(3) Where the room has a door, in addition to the door that leads to the exit access corridor and such door leads directly to an exit or directly to another corridor located in a compartment separated from the compartment housing the initial corridor by smoke partitions in accordance with Section 8.4
(4) Rooms located four or more stories above the finished ground level
(5) Where awning-type or hopper-type windows that are hinged or subdivided to provide a clear opening of not less than 4 ft^2 (0.38 m^2) or any dimension of not less than 22 in. (560 mm) meet the following criteria:
   (a) Such windows shall be permitted to continue in use.
   (b) Screen walls or devices in front of required windows shall not interfere with normal rescue requirements.
(6) Where the room or space complies with all of the following:
   (a) One door providing direct access to an adjacent room and a second door providing direct access to another adjacent room shall be provided.
   (b) The two rooms to which exit access travel is made in accordance with 17.2.11.1.2(6)(a) shall each provide exit access in accordance with 17.2.11.1.2(2) or (3).
   (c) The corridor addressed by 17.2.11.1.2(3), if provided, shall be separated from the rooms by a wall that resists the passage of smoke, and all doors between the rooms and the corridor shall be self-closing in accordance with 7.2.1.8.
   (d) The length of travel to exits along such paths shall not exceed 150 ft (46 m).
   (e) Each communicating door shall be marked in accordance with Section 7.10.
   (f) No locking device shall be permitted on the communicating doors.

17.2.11.2 Lockups. Lockups in day-care occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

17.3 Protection.

17.3.1 Protection of Vertical Openings. Any vertical opening, other than unprotected vertical openings in accordance with 8.6.9.1, shall be enclosed or protected in accordance with Section 8.6.

17.3.2 Protection from Hazards.

17.3.2.1 Rooms or spaces for the storage, processing, or use of materials specified in 17.3.2.1(1) through (3) shall be protected in accordance with the following:

(1) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating, or protection of such rooms by automatic extinguishing systems as specified in Section 8.7, in the following areas:
   (a) Boiler and furnace rooms, unless such rooms enclose only air-handling equipment
   (b) Rooms or spaces used for the storage of combustible supplies in quantities deemed hazardous by the authority having jurisdiction
   (c) Rooms or spaces used for the storage of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
   (d) Janitor closets
(2) Separation from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating and protection of such rooms by automatic extinguishing systems as specified in Section 8.7 in the following areas:
   (a)*Laundries
   (b) Maintenance shops, including woodworking and painting areas
   (c) Rooms or spaces used for processing or use of combustible supplies deemed hazardous by the authority having jurisdiction
   (d) Rooms or spaces used for processing or use of hazardous materials or flammable or combustible liquids in quantities deemed hazardous by recognized standards
(3) Where automatic extinguishing is used to meet the requirements of 17.3.2.1(1) and (2), protection as permitted in accordance with 9.7.1.2

17.3.2.2 Janitor closets protected in accordance with 17.3.2.1(1)(d) shall be permitted to have doors fitted with ventilating louvers where the space is protected by automatic sprinklers.

17.3.2.3 Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 17.3.2.4 or 17.3.2.5.

17.3.2.4 Openings shall not be required to be protected between food preparation areas and dining areas.

17.3.2.5 Approved domestic cooking equipment used for food warming or limited cooking shall not be required to be protected.

17.3.3 Interior Finish.

17.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

17.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B throughout.

17.3.3.3 Interior Floor Finish. (Reserved)

17.3.4 Detection, Alarm, and Communications Systems.

17.3.4.1 General. Day-care occupancies, other than day-care occupancies housed in one room, shall be provided with a fire alarm system in accordance with Section 9.6.

17.3.4.2 Initiation. Initiation of the required fire alarm system shall be by manual means and by operation of any required smoke detectors and required sprinkler systems. *(See 17.3.4.5.)*

17.3.4.3 Occupant Notification.

17.3.4.3.1 Occupant notification shall be in accordance with 9.6.3.

17.3.4.3.2 Positive alarm sequence shall be permitted in accordance with 9.6.3.4.

17.3.4.3.3 Private operating mode in accordance with 9.6.3.6.3 shall be permitted.

17.3.4.4 Emergency Forces Notification.

17.3.4.4.1 Emergency forces notification, other than for day-care occupancies with not more than 100 clients, shall be accomplished in accordance with 9.6.4.

17.3.4.4.2 Emergency forces notification shall be accomplished in accordance with 9.6.4 where the existing fire alarm system is replaced.

17.3.4.5 Detection. A smoke detection system in accordance with Section 9.6 shall be installed in day-care occupancies, other than those housed in one room or those housing clients capable of self-preservation where no sleeping facilities are provided, and such system shall comply with both of the following:

(1) Detectors shall be installed on each story in front of the doors to the stairways and in the corridors of all floors occupied by the day-care occupancy.
(2) Detectors shall be installed in lounges, recreation areas, and sleeping rooms in the day-care occupancy.

17.3.5 Extinguishment Requirements.

17.3.5.1 Any required sprinkler system shall be in accordance with Section 9.7.

17.3.5.2 Required sprinkler systems, other than approved existing systems, shall be installed in accordance with 9.7.1.1(1).

17.3.5.3 Buildings with unprotected openings in accordance with 8.6.6 shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

17.3.6 Corridors. Every interior corridor shall be constructed of walls having a minimum ½-hour fire resistance rating in accordance with Section 8.3, unless otherwise permitted by any of the following:

(1) Corridor protection shall not be required where all spaces normally subject to student occupancy have not less than one door opening directly to the outside or to an exterior exit access balcony or corridor in accordance with 7.5.3.
(2) In buildings protected throughout by an approved automatic sprinkler system with valve supervision in accordance with Section 9.7, corridor walls shall not be required to be rated, provided that such walls form smoke partitions in accordance with Section 8.4.
(3) Where the corridor ceiling is an assembly having a minimum ½-hour fire resistance rating where tested as a wall, the corridor walls shall be permitted to terminate at the corridor ceiling.
(4) Lavatories shall not be required to be separated from corridors, provided that they are separated from all other spaces by walls having a minimum ½-hour fire resistance rating in accordance with Section 8.3.
(5) Lavatories shall not be required to be separated from corridors, provided that both of the following criteria are met:
    (a) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
    (b) The walls separating the lavatory from other rooms form smoke partitions in accordance with Section 8.4.

17.4 Special Provisions.

17.4.1 Limited Access Buildings and Underground Buildings. Limited access buildings and underground buildings shall comply with Section 11.7.

17.4.2 High-Rise Buildings. High-rise buildings that house day-care occupancies on floors more than 75 ft (23 m) above the lowest level of fire department vehicle access shall comply with Section 11.8.

17.4.3 Flexible Plan and Open Plan Buildings.

17.4.3.1 Flexible plan and open plan buildings shall comply with the requirements of this chapter as modified by 17.4.3.2 and 17.4.3.3.

17.4.3.2 Flexible plan buildings shall be permitted to have walls and partitions rearranged periodically only if revised plans or diagrams have been approved by the authority having jurisdiction.

17.4.3.3 Flexible plan buildings shall be evaluated while all folding walls are extended and in use as well as when they are in the retracted position.

17.4.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following requirements are met:

(1) Dispensers shall be installed in rooms or spaces separated from corridors and exits.
(2) The maximum individual dispenser fluid capacity shall be as follows:
    (a) 0.32 gal (1.2 L) for dispensers in rooms
    (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) The dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Storage of quantities greater than 5 gal (18.9 L) in a single fire compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code.*
(5) The dispensers shall not be installed over or directly adjacent to an ignition source.
(6) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered rooms or spaces.

17.5 Building Services.

17.5.1 Utilities.

17.5.1.1 Utilities shall comply with the provisions of Section 9.1.

17.5.1.2 Special protective covers for all electrical receptacles shall be installed in all areas occupied by clients.

17.5.2 Heating, Ventilating, and Air-Conditioning Equipment.

17.5.2.1 Heating, ventilating, and air-conditioning equipment shall be in accordance with Section 9.2.

17.5.2.2 Unvented fuel-fired heating equipment, other than gas space heaters in compliance with NFPA 54/ANSI Z 223.1, *National Fuel Gas Code,* shall be prohibited.

17.5.2.3 Any heating equipment in spaces occupied by clients shall be provided with partitions, screens, or other means to protect clients from hot surfaces and open flames; if solid partitions are used to provide such protection, provisions shall be made to ensure adequate air for combustion and ventilation for the heating equipment.

17.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors, other than those in day-care homes, shall comply with the provisions of Section 9.4.

17.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes, other than those in day-care homes, shall comply with the provisions of Section 9.5.

17.6 Day-Care Homes.

17.6.1 General Requirements.

17.6.1.1 Application.

17.6.1.1.1 Reserved.

17.6.1.1.2* The requirements of Section 17.6 shall apply to existing day-care homes in which more than 3, but not more than 12, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit. An existing day-care home shall be permitted the option of meeting the requirements of Section 16.6 in lieu of Section 17.6. Any existing day-care home that meets the requirements of Chapter 16 shall be judged as meeting the requirements of this chapter. *(See also 17.6.1.4.)*

17.6.1.1.3 Where a facility houses clients of more than one self-preservation capability, the strictest requirements applicable to any group present shall apply throughout the day-care home or building, as appropriate to a given area, unless the area housing such a group is maintained as a separate fire area.

17.6.1.1.4 Facilities that supervise clients on a temporary basis with a parent or guardian in close proximity shall not be required to meet the provisions of Section 17.6.

17.6.1.1.5 Places of religious worship shall not be required to meet the provisions of Section 17.6 where operating a day-care home while services are being held in the building.

17.6.1.2 Multiple Occupancies. See 17.1.3.

17.6.1.3 Definitions. See 17.1.4.

17.6.1.4 Classification of Occupancy.

17.6.1.4.1 Subclassification of Day-Care Homes. Subclassification of day-care homes shall comply with 17.6.1.4.1.1 and 17.6.1.4.1.2.

17.6.1.4.1.1 Family Day-Care Home. A family day-care home shall be a day-care home in which more than three, but fewer than seven, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit.

17.6.1.4.1.2 Group Day-Care Home. A group day-care home shall be a day-care home in which not less than 7, but not more than 12, clients receive care, maintenance, and supervision by other than their relative(s) or legal guardian(s) for less than 24 hours per day, generally within a dwelling unit.

17.6.1.4.2* Conversions. A conversion from a day-care home to a day-care occupancy with more than 12 clients shall be permitted only if the day-care occupancy conforms to the requirements of Chapter 16 for new day-care occupancies with more than 12 clients.

17.6.1.5 Classification of Hazard of Contents. See 17.1.5.

17.6.1.6 Location and Construction. No day-care home shall be located more than one story below the level of exit discharge.

17.6.1.7 Occupant Load.

17.6.1.7.1 In family day-care homes, both of the following shall apply:

(1) The minimum staff-to-client ratio shall be not less than one staff for up to six clients, including the caretaker's own children under age six.
(2) There shall be not more than two clients incapable of self-preservation.

17.6.1.7.2 In group day-care homes, all of the following shall apply:

(1) The minimum staff-to-client ratio shall be not less than two staff for up to 12 clients.
(2) There shall be not more than 3 clients incapable of self-preservation.
(3) The staff-to-client ratio shall be permitted to be modified by the authority having jurisdiction where safeguards in addition to those specified by Section 17.6 are provided.

17.6.2 Means of Escape Requirements.

17.6.2.1 General. Means of escape shall comply with Section 24.2.

17.6.2.2 Reserved.

17.6.2.3 Reserved.

17.6.2.4 Number and Type of Means of Escape.

17.6.2.4.1 The number and type of means of escape shall comply with Section 24.2 and 17.6.2.4.1 through 17.6.2.4.4.

17.6.2.4.2 Every room used for sleeping, living, recreation, education, or dining purposes shall have the number and type of means of escape in accordance with Section 24.2.

17.6.2.4.3 No room or space that is accessible only by a ladder or folding stairs or through a trap door shall be occupied by clients.

17.6.2.4.4 In group day-care homes where spaces on the story above the level of exit discharge are used by clients, that story shall have not less than one means of escape complying with one of the following:

(1) Door leading directly to the outside with access to finished ground level
(2) Door leading directly to an outside stair to finished ground level

(3) Interior stair leading directly to the outside with access to finished ground level separated from other stories by a ½-hour fire barrier in accordance with Section 8.3
(4) Interior stair leading directly to the outside with access to finished ground level separated from other stories by a barrier that has been previously approved for use in a group day-care home

17.6.2.4.5 Where clients occupy a story below the level of exit discharge, that story shall have not less than one means of escape complying with one of the following:

(1) Door leading directly to the outside with access to finished ground level
(2) Door leading directly to an outside stair to finished ground level
(3) Bulkhead enclosure complying with 24.2.7
(4) Interior stair leading directly to the outside with access to finished ground level separated from other stories by a ½-hour fire barrier in accordance with Section 8.3
(5) Interior stair leading directly to the outside with access to finished ground level separated from other stories by a barrier that has been previously approved for use in a group day-care home

17.6.2.5 Arrangement of Means of Escape.

17.6.2.5.1 A story used above or below the level of exit discharge shall be in accordance with 17.6.2.4.3 or 17.6.2.4.4.

17.6.2.5.2 For group day-care homes, means of escape shall be arranged in accordance with Section 7.5.

17.6.2.5.3 No dead-end corridor shall exceed 20 ft (6100 mm), other than in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, in which case dead-end corridors shall not exceed 50 ft (15 m).

17.6.2.5.4 Doors in means of escape shall be protected from obstructions, including snow and ice.

17.6.2.6 Travel Distance. Travel distance shall comply with 17.6.2.6.1 through 17.6.2.6.3.

17.6.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

17.6.2.6.2 Travel distance shall meet all of the following criteria, unless otherwise permitted by 17.6.2.6.3:

(1) The travel distance between any point in a room and a door leading directly to the outside with access to finished ground level shall not exceed 150 ft (46 m).
(2) The travel distance between any point in a sleeping room and access to a means of escape from that room shall not exceed 50 ft (15 m).

17.6.2.6.3 The travel distance required by 17.6.2.6.2(1) shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

17.6.2.7 Discharge from Exits. See 17.6.2.4.

17.6.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

17.6.2.9 Emergency Lighting. (Reserved)

17.6.2.10 Marking of Means of Egress. (Reserved)

17.6.3 Protection.

17.6.3.1 Protection of Vertical Openings.

17.6.3.1.1 For group day-care homes, the doorway between the level of exit discharge and any story below shall be equipped with a fire door assembly having a 20-minute fire protection rating.

17.6.3.1.2 For group day-care homes where the story above the level of exit discharge is used for sleeping purposes, there shall be a fire door assembly having a 20-minute fire protection rating at the top or bottom of each stairway, unless otherwise permitted by 17.6.3.1.3.

17.6.3.1.3 Approved, existing, self-closing, 1¾ in. (44 mm) thick, solid-bonded wood doors without rated frames shall be permitted to continue in use.

17.6.3.2 Protection from Hazards.

17.6.3.2.1 Reserved.

17.6.3.3 Interior Finish.

17.6.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

17.6.3.3.2 Interior Wall and Ceiling Finish.

17.6.3.3.2.1 Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in stairways.

17.6.3.3.2.2 Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C in occupied spaces.

17.6.3.3.3 Interior Floor Finish. (Reserved)

17.6.3.4 Detection, Alarm, and Communications Systems.

17.6.3.4.1 Smoke alarms shall be installed within day-care homes in accordance with 9.6.2.10.

17.6.3.4.2 Where a day-care home is located within a building of another occupancy, such as in an apartment building or office building, any corridors serving the day-care home shall be provided with a smoke detection system in accordance with Section 9.6.

17.6.3.4.3 Single-station or multiple-station smoke alarms or smoke detectors shall be provided in all rooms used for sleeping in accordance with 9.6.2.10, other than as permitted by 17.6.3.4.4.

17.6.3.4.4 Approved existing battery-powered smoke alarms, rather than house electrical service–powered smoke alarms required by 17.6.3.4.3, shall be permitted where the facility has testing, maintenance, and battery replacement programs that ensure reliability of power to the smoke alarms.

17.6.3.5 Extinguishment Requirements. Any required sprinkler systems shall be in accordance with Section 9.7 and, other than approved existing systems, shall be installed in accordance with 9.7.1.1(1), (2), or (3), as appropriate with respect to the scope of the installation standard.

17.6.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following requirements are met:

(1) Dispensers shall be installed in rooms or spaces separated from corridors, stairways, and exterior doors.

(2) The maximum individual dispenser fluid capacity shall be as follows:
  (a) 0.32 gal (1.2 L) for dispensers in rooms
  (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) The dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(4) Storage of quantities greater than 5 gal (18.9 L) in a single fire compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(5) The dispensers shall not be installed over or directly adjacent to an ignition source.
(6) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered rooms or spaces.

17.7 Operating Features.

17.7.1* Emergency Action Plans. Emergency action plans shall be provided in accordance with Section 4.8.

17.7.2 Emergency Egress and Relocation Drills.

17.7.2.1* Emergency egress and relocation drills shall be conducted in accordance with Section 4.7 and the applicable provisions of 17.7.2.2.

17.7.2.2 Emergency egress and relocation drills shall be conducted as follows:

(1) Not less than one emergency egress and relocation drill shall be conducted every month the facility is in session, unless both of the following criteria are met:
  (a) In climates where the weather is severe, the monthly emergency egress and relocation drills shall be permitted to be deferred.
  (b) The required number of emergency egress and relocation drills shall be conducted, and not less than four shall be conducted before the drills are deferred.
(2) All occupants of the building shall participate in the drill.
(3) One additional emergency egress and relocation drill, other than for day-care occupancies that are open on a year-round basis, shall be required within the first 30 days of operation.

17.7.3 Inspections.

17.7.3.1 Fire prevention inspections shall be conducted monthly by a trained senior member of the staff, after which a copy of the latest inspection report shall be posted in a conspicuous place in the day-care facility.

17.7.3.2* It shall be the duty of site administrators and staff members to inspect all exit facilities daily to ensure that all stairways, doors, and other exits are in proper condition.

17.7.3.3 Open plan buildings shall require extra surveillance to ensure that exit paths are maintained clear of obstruction and are obvious.

17.7.3.4 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

17.7.4 Furnishings and Decorations.

17.7.4.1 Draperies, curtains, and other similar furnishings and decorations in day-care occupancies, other than in day-care homes, shall be in accordance with the provisions of 10.3.1.

17.7.4.2 Clothing and personal effects shall not be stored in corridors, unless otherwise permitted by one of the following:

(1) This requirement shall not apply to corridors protected by an automatic sprinkler system in accordance with Section 9.7.
(2) This requirement shall not apply to corridor areas protected by a smoke detection system in accordance with Section 9.6.
(3) This requirement shall not apply to storage in metal lockers, provided that the required egress width is maintained.

17.7.4.3 Artwork and teaching materials shall be permitted to be attached directly to the walls in accordance with the following:

(1) The artwork and teaching materials shall not exceed 20 percent of the wall area in a building that is not protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.
(2) The artwork and teaching materials shall not exceed 50 percent of the wall area in a building that is protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

17.7.4.4 The provision of 10.3.2 for cigarette ignition resistance of newly introduced upholstered furniture and mattresses shall not apply to day-care homes.

17.7.5* Day-Care Staff. Adequate adult staff shall be on duty in the facility and alert at all times where clients are present.

Chapter 18 New Health Care Occupancies

18.1 General Requirements.

18.1.1 Application.

18.1.1.1 General.

18.1.1.1.1* The requirements of this chapter shall apply to new buildings or portions thereof used as health care occupancies. *(See 1.3.1.)*

18.1.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

18.1.1.1.3 General. The provisions of Chapter 4, General, shall apply.

18.1.1.1.4 The requirements established by this chapter shall apply to the design of all new hospitals, nursing homes, and limited care facilities. The term *hospital*, wherever used in this *Code*, shall include general hospitals, psychiatric hospitals, and specialty hospitals. The term *nursing home*, wherever used in this *Code*, shall include nursing and convalescent homes, skilled nursing facilities, intermediate care facilities, and infirmaries in homes for the aged. Where requirements vary, the specific subclass of health care occupancy that shall apply is named in the paragraph pertaining thereto. The requirements established by Chapter 20 shall apply to all new ambulatory health care facilities. The operating feature requirements established by Section 18.7 shall apply to all health care occupancies.

18.1.1.1.5 The health care facilities regulated by this chapter shall be those that provide sleeping accommodations for their occupants and are occupied by persons who are mostly incapable of self-preservation because of age, because of physical or mental disability, or because of security measures not under the occupants' control.

18.1.1.1.6 Buildings, or sections of buildings, that primarily house patients who, in the opinion of the governing body of the facility and the governmental agency having jurisdiction, are capable of exercising judgment and appropriate physical action for self-preservation under emergency conditions shall be permitted to comply with chapters of this *Code* other than Chapter 18.

18.1.1.1.7* It shall be recognized that, in buildings housing certain patients, it might be necessary to lock doors and bar windows to confine and protect building inhabitants.

18.1.1.1.8 Buildings, or sections of buildings, that house older persons and that provide activities that foster continued independence but that do not include services distinctive to health care occupancies *(see 18.1.4.2)*, as defined in 3.3.190.7, shall be permitted to comply with the requirements of other chapters of this *Code*, such as Chapters 30 or 32.

18.1.1.1.9 Facilities that do not provide housing on a 24-hour basis for their occupants shall be classified as other occupancies and shall be covered by other chapters of this *Code*.

18.1.1.1.10* The requirements of this chapter shall apply based on the assumption that staff is available in all patient-occupied areas to perform certain fire safety functions as required in other paragraphs of this chapter.

18.1.1.2* Goals and Objectives. The goals and objectives of Sections 4.1 and 4.2 shall be met with due consideration for functional requirements, which are accomplished by limiting the development and spread of a fire emergency to the room of fire origin and reducing the need for occupant evacuation, except from the room of fire origin.

18.1.1.3 Total Concept.

18.1.1.3.1 All health care facilities shall be designed, constructed, maintained, and operated to minimize the possibility of a fire emergency requiring the evacuation of occupants.

18.1.1.3.2 Because the safety of health care occupants cannot be ensured adequately by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities; adequate, trained staff; and development of operating and maintenance procedures composed of the following:

(1) Design, construction, and compartmentation
(2) Provision for detection, alarm, and extinguishment
(3) Fire prevention procedures and planning, training, and drilling programs for the isolation of fire, transfer of occupants to areas of refuge, or evacuation of the building

18.1.1.4 Additions, Conversions, Modernization, Renovation, and Construction Operations.

18.1.1.4.1 Additions. Additions shall be separated from any existing structure not conforming to the provisions within Chapter 19 by a fire barrier having not less than a 2-hour fire resistance rating and constructed of materials as required for the addition. *(See 4.6.7 and 4.6.11.)*

18.1.1.4.1.1 Communicating openings in dividing fire barriers required by 18.1.1.4.1 shall be permitted only in corridors and shall be protected by approved self-closing fire door assemblies. *(See also Section 8.3.)*

18.1.1.4.1.2 Doors in barriers required by 18.1.1.4.1 shall normally be kept closed, unless otherwise permitted by 18.1.1.4.1.3.

18.1.1.4.1.3 Doors shall be permitted to be held open if they meet the requirements of 18.2.2.2.7.

18.1.1.4.2 Changes of Use or Occupancy Classification. Changes of use or occupancy classification shall comply with 4.6.11, unless otherwise permitted by one of the following:

(1) A change from a hospital to a nursing home or from a nursing home to a hospital shall not be considered a change in occupancy classification or a change in use.
(2) A change from a hospital or nursing home to a limited care facility shall not be considered a change in occupancy classification or a change in use.
(3) A change from a hospital or nursing home to an ambulatory health care facility shall not be considered a change in occupancy classification or a change in use.

18.1.1.4.3 Rehabilitation.

18.1.1.4.3.1 For purposes of the provisions of this chapter, the following shall apply:

(1) A major rehabilitation shall involve the modification of more than 50 percent, or more than 4500 ft^2 (420 m^2), of the area of the smoke compartment.
(2) A minor rehabilitation shall involve the modification of not more than 50 percent, and not more than 4500 ft^2 (420 m^2), of the area of the smoke compartment.

18.1.1.4.3.2 Work that is exclusively plumbing, mechanical, fire protection system, electrical, medical gas, or medical equipment work shall not be included in the computation of the modification area within the smoke compartment.

18.1.1.4.3.3* Where major rehabilitation is done in a nonsprinklered smoke compartment, the automatic sprinkler requirements of 18.3.5 shall apply to the smoke compartment undergoing the rehabilitation, and, in cases where the building is not protected throughout by an approved automatic sprinkler system, the requirements of 18.4.4.2, 18.4.4.3, and 18.4.4.8 shall also apply.

18.1.1.4.3.4* Where minor rehabilitation is done in a nonsprinklered smoke compartment, the requirements of 18.3.5.1 shall not apply, but, in such cases, the rehabilitation shall not reduce life safety below the level required for new buildings or below the level of the requirements of 18.4.3 for nonsprinklered smoke compartment rehabilitation. *(See 4.6.7.)*

18.1.1.4.4 Construction, Repair, and Improvement Operations. See 4.6.10.

18.1.2 Classification of Occupancy. See 6.1.5 and 18.1.4.2.

18.1.3 Multiple Occupancies.

18.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

18.1.3.2 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis, provided both of the following are met:

(1) The provision is not used for occupancy separations involving industrial and storage occupancies.
(2) Smoke partitions serving as atrium walls are not permitted to serve as enclosures for hazardous areas.

18.1.3.3 Sections of health care facilities shall be permitted to be classified as other occupancies in accordance with the separated occupancies provisions of 6.1.14.4 and either 18.1.3.4 or 18.1.3.5.

18.1.3.4* Sections of health care facilities shall be permitted to be classified as other occupancies, provided that they meet both of the following conditions:

(1) They are not intended to provide services simultaneously for four or more inpatients for purposes of housing, treatment, or customary access by inpatients incapable of self-preservation.
(2) They are separated from areas of health care occupancies by construction having a minimum 2-hour fire resistance rating in accordance with Chapter 8.

18.1.3.5 Contiguous Non-Health Care Occupancies.

18.1.3.5.1* Ambulatory care facilities, medical clinics, and similar facilities that are contiguous to health care occupancies, but are primarily intended to provide outpatient services, shall be permitted to be classified as business occupancies or ambulatory health care facilities, provided that the facilities are separated from the health care occupancy by construction having a minimum 2-hour fire resistance rating, and the facility is not intended to provide services simultaneously for four or more inpatients who are incapable of self preservation.

18.1.3.5.2 Ambulatory care facilities, medical clinics, and similar facilities that are contiguous to health care occupancies shall be permitted to be used for diagnostic and treatment services of inpatients who are capable of self-preservation.

18.1.3.6 Where separated occupancies provisions are used in accordance with either 18.1.3.4 or 18.1.3.5, the most stringent construction type shall be provided throughout the building, unless a 2-hour separation is provided in accordance with 8.2.1.3, in which case the construction type shall be determined as follows:

(1) The construction type and supporting construction of the health care occupancy shall be based on the story on which it is located in the building in accordance with the provisions of 18.1.6 and Table 18.1.6.1.
(2) The construction type of the areas of the building enclosing the other occupancies shall be based on the applicable occupancy chapters of this *Code*.

18.1.3.7 All means of egress from health care occupancies that traverse non-health care spaces shall conform to the requirements of this *Code* for health care occupancies, unless otherwise permitted by 18.1.3.7.

18.1.3.8 Exit through a horizontal exit into other contiguous occupancies that do not conform to health care egress provisions, but that do comply with requirements set forth in the appropriate occupancy chapter of this *Code*, shall be permitted, provided that both of the following criteria apply:

(1) The occupancy does not contain high hazard contents.
(2) The horizontal exit complies with the requirements of 18.2.2.5.

18.1.3.9 Egress provisions for areas of health care facilities that correspond to other occupancies shall meet the corresponding requirements of this *Code* for such occupancies, and, where the clinical needs of the occupant necessitate the locking of means of egress, staff shall be present for the supervised release of occupants during all times of use.

18.1.3.10 Auditoriums, chapels, staff residential areas, or other occupancies provided in connection with health care facilities shall have means of egress provided in accordance with other applicable sections of this *Code*.

18.1.3.11 Any area with a hazard of contents classified higher than that of the health care occupancy and located in the same building shall be protected as required by 18.3.2.

18.1.3.12 Non-health care–related occupancies classified as containing high hazard contents shall not be permitted in buildings housing health care occupancies.

18.1.4 Definitions.

18.1.4.1 General. For definitions, see Chapter 3, Definitions.

18.1.4.2 Special Definitions. The following is a list of special terms used in this chapter:

(1) **Ambulatory Health Care Occupancy.** *(See 3.3.190.1.)*
(2) **Deep-fat Frying.** *(See 3.3.55.)*
(3) **Hospital.** *(See 3.3.144.)*
(4) **Limited Care Facility.** *(See 3.3.90.2.)*
(5) **Nursing Home.** *(See 3.3.142.2.)*

18.1.5 Classification of Hazard of Contents. The classification of hazard of contents shall be as defined in Section 6.2.

18.1.6 Minimum Construction Requirements.

18.1.6.1 Health care occupancies shall be limited to the building construction types specified in Table 18.1.6.1, unless otherwise permitted by 18.1.6.2 through 18.1.6.7. *(See 8.2.1.)*

18.1.6.2 Any building of Type I(442), Type I(332), Type II(222), or Type II(111) construction shall be permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:

(1) The roof covering shall meet Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.
(2) The roof shall be separated from all occupied portions of the building by a noncombustible floor assembly having not less than a 2-hour fire resistance rating that includes not less than 2½ in. (63 mm) of concrete or gypsum fill.
(3) The structural elements supporting the 2-hour fire resistance–rated floor assembly specified in 18.1.6.2(2) shall be required to have only the fire resistance rating required of the building.

18.1.6.3 Any building of Type I(442), Type I(332), Type II(222), or Type II(111) construction shall be permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:

(1) The roof covering shall meet Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.
(2) The roof/ceiling assembly shall be constructed with fire-retardant-treated wood meeting the requirements of NFPA 220, *Standard on Types of Building Construction*.
(3) The roof/ceiling assembly shall have the required fire resistance rating for the type of construction.

18.1.6.4 Interior nonbearing walls in buildings of Type I or Type II construction shall be constructed of noncombustible or limited-combustible materials, unless otherwise permitted by 18.1.6.5.

Table 18.1.6.1 Construction Type Limitations

Construction Type	Sprinklered†	Total Number of Stories of Building‡			
		1	2	3	≥4
I (442)	Yes	X	X	X	X
	No	NP	NP	NP	NP
I (332)	Yes	X	X	X	X
	No	NP	NP	NP	NP
II (222)	Yes	X	X	X	X
	No	NP	NP	NP	NP
II (111)	Yes	X	X	X	NP
	No	NP	NP	NP	NP
II (000)	Yes	X	NP	NP	NP
	No	NP	NP	NP	NP
III (211)	Yes	X	NP	NP	NP
	No	NP	NP	NP	NP
III (200)	Yes	NP	NP	NP	NP
	No	NP	NP	NP	NP
IV (2HH)	Yes	X	NP	NP	NP
	No	NP	NP	NP	NP
V (111)	Yes	X	NP	NP	NP
	No	NP	NP	NP	NP
V (000)	Yes	NP	NP	NP	NP
	No	NP	NP	NP	NP

X: Permitted. NP: Not permitted.
The total number of stories of the building is required to be determined as follows:
(1) The total number of stories is to be counted starting with the level of exit discharge and ending with the highest occupiable story of the building.
(2) Stories below the level of exit discharge are not counted as stories.
(3) Interstitial spaces used solely for building or process systems directly related to the level above or below are not considered a separate story.
(4) A mezzanine in accordance with 8.6.9 is not counted as a story.
†Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7. *(See 18.3.5.)*
‡Basements are not counted as stories.

18.1.6.5 Interior nonbearing walls required to have a fire resistance rating of 2 hours or less shall be permitted to be of fire-retardant-treated wood enclosed within noncombustible or limited-combustible materials, provided that such walls are not used as shaft enclosures.

18.1.6.6 Fire-retardant-treated wood that serves as supports for the installation of fixtures and equipment shall be permitted to be installed behind noncombustible or limited-combustible sheathing.

18.1.6.7 All buildings with more than one level below the level of exit discharge shall have all such lower levels separated from the level of exit discharge by not less than Type II(111) construction.

18.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, either shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

18.2 Means of Egress Requirements.

18.2.1 General. Every aisle, passageway, corridor, exit discharge, exit location, and access shall be in accordance with Chapter 7, unless otherwise modified by 18.2.2 through 18.2.11.

18.2.2* Means of Egress Components.

18.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 18.2.2.2 through 18.2.2.10.

18.2.2.2 Doors.

18.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

18.2.2.2.2 Locks shall not be permitted on patient sleeping room doors, unless otherwise permitted by one of the following:

(1) Key-locking devices that restrict access to the room from the corridor and that are operable only by staff from the corridor side shall be permitted, provided that such devices do not restrict egress from the room.
(2) Locks complying with 18.2.2.2.5 shall be permitted.

18.2.2.2.3 Doors not located in a required means of egress shall be permitted to be subject to locking.

18.2.2.2.4 Doors within a required means of egress shall not be equipped with a latch or lock that requires the use of a tool or key from the egress side, unless otherwise permitted by one of the following:

(1) Locks complying with 18.2.2.2.5 shall be permitted.
(2)*Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.
(3)*Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.
(4) Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

18.2.2.2.5 Door-locking arrangements shall be permitted in accordance with either 18.2.2.2.5.1 or 18.2.2.2.5.2.

18.2.2.2.5.1* Door-locking arrangements shall be permitted where the clinical needs of patients require specialized security measures or where patients pose a security threat, provided that staff can readily unlock doors at all times in accordance with 18.2.2.2.6.

18.2.2.2.5.2* Door-locking arrangements shall be permitted where patient special needs require specialized protective measures for their safety, provided that all of the following criteria are met:

(1) Staff can readily unlock doors at all times in accordance with 18.2.2.2.6.
(2) A total (complete) smoke detection system is provided throughout the locked space in accordance with 9.6.2.9, or locked doors can be remotely unlocked at an approved, constantly attended location within the locked space.
(3)*The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 18.3.5.1.
(4) The locks are electrical locks that fail safely so as to release upon loss of power to the device.
(5) The locks release by independent activation of each of the following:
   (a) Activation of the smoke detection system required by 18.2.2.2.5.2(2)
   (b) Waterflow in the automatic sprinkler system required by 18.2.2.2.5.2(3)

18.2.2.2.6 Doors that are located in the means of egress and are permitted to be locked under other provisions of 18.2.2.2.5 shall comply with both of the following:

(1) Provisions shall be made for the rapid removal of occupants by means of one of the following:
   (a) Remote control of locks from within the locked smoke compartment
   (b) Keying of all locks to keys carried by staff at all times
   (c) Other such reliable means available to the staff at all times
(2) Only one locking device shall be permitted on each door.

18.2.2.2.7* Doors permitted to be locked in accordance with 18.2.2.2.5.1 shall be permitted to have murals on the egress doors to disguise the doors, provided all of the following are met:

(1) Staff can readily unlock the doors at all times in accordance with 18.2.2.2.6.
(2)*The door-releasing hardware, where provided, is readily accessible for staff use.
(3)*Door leaves, windows, and door hardware, other than door-releasing hardware, are permitted to be covered by the murals.
(4) The murals do not impair the operation of the doors.
(5) The location and operation of doors disguised with murals are identified in the fire safety plan and are included in staff training.

18.2.2.2.8* Any door in an exit passageway, stairway enclosure, horizontal exit, smoke barrier, or hazardous area enclosure (except boiler rooms, heater rooms, and mechanical equipment rooms) shall be permitted to be held open only by an automatic release device that complies with 7.2.1.8.2. The automatic sprinkler system and the fire alarm system, and the systems required by 7.2.1.8.2, shall be arranged to initiate the closing action of all such doors throughout the smoke compartment or throughout the entire facility.

18.2.2.2.9 Where doors in a stair enclosure are held open by an automatic release device as permitted in 18.2.2.2.8, initiation of a door-closing action on any level shall cause all doors at all levels in the stair enclosure to close.

18.2.2.2.10 High-rise health care occupancies shall comply with the re-entry provisions of 7.2.1.5.8.

18.2.2.2.11 Horizontal-sliding doors shall be permitted in accordance with 18.2.2.2.11.1 or 18.2.2.2.11.2.

18.2.2.2.11.1 Horizontal sliding doors that are not automatic-closing shall be limited to a single leaf and shall have a latch or other mechanism that ensures that the doors will not rebound into a partially open position if forcefully closed.

18.2.2.2.11.2 Horizontal-sliding doors serving an occupant load of fewer than 10 shall be permitted, provided that all of the following criteria are met:

(1) The area served by the door has no high hazard contents.
(2) The door is readily operable from either side without special knowledge or effort.
(3) The force required to operate the door in the direction of door travel is not more than 30 lbf (133 N) to set the door in motion and is not more than 15 lbf (67 N) to close the door or open it to the minimum required width.
(4) The door assembly complies with any required fire protection rating and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 7.2.1.8 and is installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.
(5) Where corridor doors are required to latch, the doors are equipped with a latch or other mechanism that ensures that the doors will not rebound into a partially open position if forcefully closed.

18.2.2.3 Stairs. Stairs complying with 7.2.2 shall be permitted.

18.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

18.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 and the modifications of 18.2.2.5.1 through 18.2.2.5.7 shall be permitted.

18.2.2.5.1 Accumulation space shall be provided in accordance with 18.2.2.5.1.1 and 18.2.2.5.1.2.

18.2.2.5.1.1 Not less than 30 net ft^2 (2.8 net m^2) per patient in a hospital or nursing home, or not less than 15 net ft^2 (1.4 net m^2) per resident in a limited care facility, shall be provided within the aggregated area of corridors, patient rooms, treatment rooms, lounge or dining areas, and other similar areas on each side of the horizontal exit.

18.2.2.5.1.2 On stories not housing bedridden or litterborne patients, not less than 6 net ft^2 (0.56 net m^2) per occupant shall be provided on each side of the horizontal exit for the total number of occupants in adjoining compartments.

18.2.2.5.2 The total egress capacity of the other exits (stairs, ramps, doors leading outside the building) shall not be reduced below one-third of that required for the entire area of the building.

18.2.2.5.3 A single door shall be permitted in a horizontal exit if all of the following conditions apply:

(1) The exit serves one direction only.
(2) Such door is a swinging door or a special-purpose horizontally sliding accordion or folding door assembly complying with 7.2.1.14.
(3) The door is not less than 41½ in. (1055 mm) in clear width.

18.2.2.5.4 A horizontal exit involving a corridor 8 ft (2440 mm) or more in width and serving as a means of egress from both sides of the doorway shall have the opening protected by a pair of swinging doors arranged to swing in opposite directions from each other, with each door having a clear width of not less than 41½ in. (1055 mm), or by a special-purpose horizontally sliding accordion or folding door assembly that complies with 7.2.1.14 and provides a clear width of not less than 6 ft 11 in. (2110 mm).

18.2.2.5.5 A horizontal exit involving a corridor 6 ft (1830 mm) or more in width and serving as a means of egress from both sides of the doorway shall have the opening protected by a pair of swinging doors, arranged to swing in opposite directions from each other, with each door having a clear width of not less than 32 in. (810 mm), or by a special-purpose horizontally sliding accordion or folding door assembly that complies with 7.2.1.14 and provides a clear width of not less than 64 in. (1625 mm).

18.2.2.5.6 An approved vision panel shall be required in each horizontal exit door.

18.2.2.5.7 Center mullions shall be prohibited in horizontal exit door openings.

18.2.2.6 Ramps.

18.2.2.6.1 Ramps complying with 7.2.5 shall be permitted.

18.2.2.6.2 Ramps enclosed as exits shall be of sufficient width to provide egress capacity in accordance with 18.2.3.

18.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

18.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

18.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

18.2.2.10 Areas of Refuge. Areas of refuge used as part of a required accessible means of egress shall comply with 7.2.12.

18.2.3 Capacity of Means of Egress.

18.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

18.2.3.2 Reserved.

18.2.3.3 Reserved.

18.2.3.4* Aisles, corridors, and ramps required for exit access in a hospital or nursing home shall be not less than 8 ft (2440 mm) in clear and unobstructed width, unless otherwise permitted by one of the following:

(1)*Aisles, corridors, and ramps in adjunct areas not intended for the housing, treatment, or use of inpatients shall be not less than 44 in. (1120 mm) in clear and unobstructed width.
(2)*Noncontinuous projections not more than 6 in. (150 mm) from the corridor wall, positioned not less than 38 in. (965 mm) above the floor, shall be permitted.
(3)*Exit access within a room or suite of rooms complying with the requirements of 18.2.5 shall be permitted.
(4) Projections into the required width shall be permitted for wheeled equipment, provided that all of the following conditions are met:
   (a) The wheeled equipment does not reduce the clear unobstructed corridor width to less than 60 in. (1525 mm).
   (b) The health care occupancy fire safety plan and training program address the relocation of the wheeled equipment during a fire or similar emergency.
   (c)*The wheeled equipment is limited to the following:
      i. Equipment in use and carts in use
      ii. Medical emergency equipment not in use
      iii. Patient lift and transport equipment
(5)*Where the corridor width is at least 8 ft (2440 mm), projections into the required width shall be permitted for fixed furniture, provided that all of the following conditions are met:
   (a) The fixed furniture is securely attached to the floor or to the wall.
   (b) The fixed furniture does not reduce the clear unobstructed corridor width to less than 6 ft (1830 mm), except as permitted by 18.2.3.4(2).
   (c) The fixed furniture is located only on one side of the corridor.
   (d) The fixed furniture is grouped such that each grouping does not exceed an area of 50 ft^2 (4.6 m^2).
   (e) The fixed furniture groupings addressed in 18.2.3.4(5)(d) are separated from each other by a distance of at least 10 ft (3050 mm).
   (f)*The fixed furniture is located so as to not obstruct access to building service and fire protection equipment.
   (g) Corridors throughout the smoke compartment are protected by an electrically supervised automatic smoke detection system in accordance with 18.3.4, or the fixed furniture spaces are arranged and located to allow direct supervision by the facility staff from a nurses' station or similar space.
(6)*Cross-corridor door openings in corridors with a required minimum width of 8 ft (2440 mm) shall have a clear width of not less than 6 ft 11 in. (2110 mm) for pairs of doors or a clear width of not less than 41½ in. (1055 mm) for a single door.
(7) Nursing home corridors shall be permitted to be not less than 6 ft (1830 mm) wide in smoke compartments housing not more than 30 patients.

(8) Cross-corridor door openings in corridors with a required minimum width of 6 ft (1830 mm) shall have a clear width of not less than 64 in. (1625 mm) for pairs of doors or a clear width of not less than 41½ in. (1055 mm) for a single door.

18.2.3.5 Aisles, corridors, and ramps required for exit access in a limited care facility or hospital for psychiatric care shall be not less than 6 ft (1830 mm) in clear and unobstructed width, unless otherwise permitted by one of the following:

(1)*Aisles, corridors, and ramps in adjunct areas not intended for the housing, treatment, or use of inpatients shall be not less than 44 in. (1120 mm) in clear and unobstructed width.
(2)*Noncontinuous projections not more than 6 in. (150 mm) from the corridor wall, positioned not less than 38 in. (965 mm) above the floor, shall be permitted.
(3)*Exit access within a room or suite of rooms complying with the requirements of 18.2.5 shall be permitted.
(4) Projections into the required width shall be permitted for wheeled equipment, provided that all of the following conditions are met:
   (a) The wheeled equipment does not reduce the clear unobstructed corridor width to less than 60 in.(1525 mm).
   (b) The health care occupancy fire safety plan and training program address the relocation of the wheeled equipment during a fire or similar emergency.
   (c)*The wheeled equipment is limited to the following:
      i. Equipment in use and carts in use
      ii. Medical emergency equipment not in use
      iii. Patient lift and transport equipment
(5)*Cross-corridor door openings in corridors with a required minimum width of 6 ft (1830 mm) shall have a clear width of not less than 64 in. (1625 mm) for pairs of doors or a clear width of not less than 32 in. (810 mm) for a single door.

18.2.3.6 The minimum clear width for doors in the means of egress from sleeping rooms; diagnostic and treatment areas, such as x-ray, surgery, or physical therapy; and nursery rooms shall be as follows:

(1) Hospitals and nursing homes — 41½ in. (1055 mm)
(2) Psychiatric hospitals and limited care facilities — 32 in. (810 mm)

18.2.3.7 The requirements of 18.2.3.6 shall not apply where otherwise permitted by one of the following:

(1) Doors that are located so as not to be subject to use by any health care occupant shall be not less than 32 in. (810 mm) in clear width.
(2) Doors in exit stair enclosures shall be not less than 32 in. (810 mm) in clear width.
(3) Doors serving newborn nurseries shall be not less than 32 in. (810 mm) in clear width.
(4) Where a pair of doors is provided, all of the following criteria shall be met:
   (a) Not less than one of the doors shall provide not less than a 32 in. (810 mm) clear width opening.
   (b) A rabbet, bevel, or astragal shall be provided at the meeting edge.
   (c) The inactive door leaf shall have an automatic flush bolt to provide positive latching.

18.2.4 Number of Means of Egress.

18.2.4.1 The number of means of egress shall be in accordance with Section 7.4.

18.2.4.2 Not less than two exits shall be provided on every story.

18.2.4.3 Not less than two separate exits shall be accessible from every part of every story.

18.2.4.4* Not less than two exits shall be accessible from each smoke compartment, and egress shall be permitted through an adjacent compartment(s), provided that the two required egress paths are arranged so that both do not pass through the same adjacent smoke compartment.

18.2.5 Arrangement of Means of Egress.

18.2.5.1 General. Arrangement of means of egress shall comply with Section 7.5.

18.2.5.2 Dead-End Corridors. Dead-end corridors shall not exceed 30 ft (9.1 m).

18.2.5.3 Common Path of Travel. Common path of travel shall not exceed 100 ft (30 m).

18.2.5.4* Intervening Rooms or Spaces. Every corridor shall provide access to not less than two approved exits in accordance with Sections 7.4 and 7.5 without passing through any intervening rooms or spaces other than corridors or lobbies.

18.2.5.5 Two Means of Egress.

18.2.5.5.1 Sleeping rooms of more than 1000 ft^2 (93 m^2) shall have not less than two exit access doors remotely located from each other.

18.2.5.5.2 Non-sleeping rooms of more than 2500 ft^2 (230 m^2) shall have not less than two exit access doors remotely located from each other.

18.2.5.6 Corridor Access.

18.2.5.6.1* Every habitable room shall have an exit access door leading directly to an exit access corridor, unless otherwise provided in 18.2.5.6.2, 18.2.5.6.3, and 18.2.5.6.4.

18.2.5.6.2 Exit access from a patient sleeping room with not more than eight patient beds shall be permitted to pass through one intervening room to reach an exit access corridor, provided that the intervening room is equipped with an approved automatic smoke detection system in accordance with Section 9.6.

18.2.5.6.3 Rooms having an exit door opening directly to the outside from the room at the finished ground level shall not be required to have an exit access door leading directly to an exit access corridor.

18.2.5.6.4 Rooms within suites complying with 18.2.5.7 shall not be required to have an exit access door leading directly to an exit access corridor.

18.2.5.7 Suites.

18.2.5.7.1 General.

18.2.5.7.1.1 Suite Permission. Suites complying with 18.2.5.7 shall be permitted to be used to meet the corridor access requirements of 18.2.5.6.

18.2.5.7.1.2* Suite Separation. Suites shall be separated from the remainder of the building, and from other suites, by walls and doors meeting the requirements of 18.3.6.2 through 18.3.6.5.

18.2.5.7.1.3 Suite Hazardous Contents Areas.

(A)* Intervening rooms shall not be hazardous areas as defined by 18.3.2.

(B) Hazardous areas within a suite shall be separated from the remainder of the suite in accordance with 18.3.2.1, unless otherwise provided in 18.2.5.7.1.3(C).

(C)* Hazardous areas within a suite shall not be required to be separated from the remainder of the suite where complying with all of the following:

(1) The suite is primarily a hazardous area.
(2) The suite is protected by an approved automatic smoke detection system in accordance with Section 9.6.
(3) The suite is separated from the rest of the health care facility as required for a hazardous area by 18.3.2.1.

18.2.5.7.1.4 Suite Subdivision. The subdivision of suites shall be by means of noncombustible or limited-combustible partitions or partitions constructed with fire-retardant-treated wood enclosed with noncombustible or limited-combustible materials, and such partitions shall not be required to be fire rated.

18.2.5.7.2 Sleeping Suites. Sleeping suites shall be in accordance with the following:

(1) Sleeping suites for patient care shall comply with the provisions of 18.2.5.7.2.1 through 18.2.5.7.2.4.
(2) Sleeping suites not for patient care shall comply with the provisions of 18.2.5.7.4.

18.2.5.7.2.1 Sleeping Suite Supervision.

(A) Sleeping suites shall be provided with constant staff supervision within the suite.

(B)* Sleeping suites shall be arranged in accordance with one of the following:

(1)*Patient sleeping rooms within sleeping suites shall provide one of the following:
   (a) The patient sleeping rooms shall be arranged to allow for direct supervision from a normally attended location within the suite, such as is provided by glass walls, and cubicle curtains shall be permitted.
   (b) Any patient sleeping rooms without the direct supervision required by 18.2.5.7.2.1(B)(1)(a) shall be provided with smoke detection in accordance with Section 9.6 and 18.3.4.
(2) Sleeping suites shall be provided with a total (complete) coverage automatic smoke detection system in accordance with 9.6.2.9 and 18.3.4.

18.2.5.7.2.2 Sleeping Suite Means of Egress.

(A)* Sleeping suites shall have exit access to a corridor complying with 18.3.6 or to a horizontal exit, directly from the suite.

(B) Sleeping suites of more than 1000 ft^2 (93 m^2) shall have not less than two exit access doors remotely located from each other.

(C)* For suites requiring two exit access doors, one of the exit access doors from the suite shall be permitted to be to one of the following:

(1) An exit stair
(2) An exit passageway
(3) An exit door to the exterior
(4) Another suite, provided that the separation between the suites complies with the corridor requirements of 18.3.6.2 through 18.3.6.5

18.2.5.7.2.3 Sleeping Suite Maximum Size.

(A) Reserved.

(B) Sleeping suites shall not exceed 7500 ft^2 (700 m^2), unless otherwise provided in 18.2.5.7.2.3(C).

(C) Sleeping suites greater than 7500 ft^2 (700 m^2) and not exceeding 10,000 ft^2 (930 m^2) shall be permitted where both of the following are provided in the suite:

(1)*Direct visual supervision in accordance with 18.2.5.7.2.1(B)(1)(a)
(2) Total (complete) coverage automatic smoke detection in accordance with 9.6.2.9 and 18.3.4

18.2.5.7.2.4 Sleeping Suite Travel Distance.

(A) Travel distance between any point in a sleeping suite and an exit access door to another suite, an exit access corridor door, or a horizontal exit door from that suite shall not exceed 100 ft (30 m).

(B) Travel distance between any point in a sleeping suite and an exit shall not exceed 200 ft (61 m).

18.2.5.7.3 Patient Care Non-Sleeping Suites. Non-sleeping suites shall be in accordance with the following:

(1) Non-sleeping suites for patient care shall comply with the provisions of 18.2.5.7.3.1 through 18.2.5.7.3.3.
(2) Non-sleeping suites not for patient care shall comply with the provisions of 18.2.5.7.4.

18.2.5.7.3.1 Patient Care Non-Sleeping Suite Means of Egress.

(A) Patient care non-sleeping suites shall have exit access to a corridor complying with 18.3.6 or to a horizontal exit, directly from the suite.

(B) Patient care non-sleeping suites of more than 2500 ft^2 (230 m^2) shall have not less than two exit access doors remotely located from each other.

(C)* For suites requiring two exit access doors, one of the exit access doors shall be permitted to be to one of the following:

(1) An exit stair
(2) An exit passageway
(3) An exit door to the exterior
(4) Another suite, provided that the separation between the suites complies with the corridor requirements of 18.3.6.2 through 18.3.6.5.

18.2.5.7.3.2 Patient Care Non-Sleeping Suite Maximum Size.

(A) Non-sleeping suites shall not exceed 12,500 ft^2 (1160 m^2), unless otherwise provided in 18.2.5.7.3.2(B).

(B) Non-sleeping suites greater than 12,500 ft^2 (1160 m^2) and not exceeding 15,000 ft^2 (1390 m^2) shall be permitted where provided with total (complete) coverage automatic smoke detection in accordance with 9.6.2.9 and 18.3.4.

18.2.5.7.3.3 Patient Care Non-Sleeping Suite Travel Distance.

(A) Travel distance within a non-sleeping suite to an exit access door to another suite, an exit access corridor door, or a horizontal exit door from the suite shall not exceed 100 ft (30 m).

(B) Travel distance between any point in a non-sleeping suite and an exit shall not exceed 200 ft (61 m).

18.2.5.7.4 Non-Patient-Care Suites. The egress provisions for non-patient-care suites shall be in accordance with the primary use and occupancy of the space.

18.2.6 Travel Distance to Exits.

18.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

18.2.6.2 Travel distance shall comply with 18.2.6.2.1 through 18.2.6.2.4.

18.2.6.2.1 The travel distance between any point in a room and an exit shall not exceed 200 ft (61 m).

18.2.6.2.2 Reserved.

18.2.6.2.3 The travel distance between any point in a health care sleeping room and an exit access door in that room shall not exceed 50 ft (15 m).

18.2.6.2.4 The travel distance within suites shall be in accordance with 18.2.5.7.

18.2.7 Discharge from Exits. Discharge from exits shall be arranged in accordance with Section 7.7.

18.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

18.2.9 Emergency Lighting.

18.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9.

18.2.9.2 Buildings equipped with, or in which patients require the use of, life-support systems *(see 18.5.1.3)* shall have emergency lighting equipment supplied by the life safety branch of the electrical system as described in NFPA 99, *Health Care Facilities Code*.

18.2.10 Marking of Means of Egress.

18.2.10.1 Means of egress shall have signs in accordance with Section 7.10, unless otherwise permitted by 18.2.10.3 or 18.2.10.4.

18.2.10.2 Reserved.

18.2.10.3 Where the path of egress travel is obvious, signs shall not be required at gates in outside secured areas.

18.2.10.4 Access to exits within rooms or sleeping suites shall not be required to be marked where staff is responsible for relocating or evacuating occupants.

18.2.10.5 Illumination of required exit and directional signs in buildings equipped with, or in which patients use, life-support systems *(see 18.5.1.3)* shall be provided as follows:

(1) Illumination shall be supplied by the life safety branch of the electrical system as described in NFPA 99, *Health Care Facilities Code*.
(2) Self-luminous exit signs complying with 7.10.4 shall be permitted.

18.2.11 Special Means of Egress Features. (Reserved)

18.3 Protection.

18.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed or protected in accordance with Section 8.6, unless otherwise modified by 18.3.1.1 through 18.3.1.8.

18.3.1.1 Reserved.

18.3.1.2 Unprotected vertical openings in accordance with 8.6.9.1 shall be permitted.

18.3.1.3 Subparagraph 8.6.7(1)(b) shall not apply to patient sleeping and treatment rooms.

18.3.1.4 Multilevel patient sleeping areas in psychiatric facilities shall be permitted without enclosure protection between levels, provided that all of the following conditions are met:

(1) The entire normally occupied area, including all communicating floor levels, is sufficiently open and unobstructed so that a fire or other dangerous condition in any part is obvious to the occupants or supervisory personnel in the area.
(2) The egress capacity provides simultaneously for all the occupants of all communicating levels and areas, with all communicating levels in the same fire area being considered as a single floor area for purposes of determination of required egress capacity.
(3) The height between the highest and lowest finished floor levels does not exceed 13 ft (3960 mm), and the number of levels is permitted to be unrestricted.

18.3.1.5 Unprotected openings in accordance with 8.6.6 shall not be permitted.

18.3.1.6 Reserved.

18.3.1.7 A door in a stair enclosure shall be self-closing and shall normally be kept in the closed position, unless otherwise permitted by 18.3.1.8.

18.3.1.8 Doors in stair enclosures shall be permitted to be held open under the conditions specified by 18.2.2.2.7 and 18.2.2.2.8.

18.3.2 Protection from Hazards.

18.3.2.1 Hazardous Areas.

18.3.2.1.1 Any hazardous areas shall be protected in accordance with Section 8.7, and the areas addressed in 18.3.2.1.2 and 18.3.2.1.3 shall be protected as indicated.

18.3.2.1.2 The following areas shall be considered hazardous areas and shall be protected by fire barriers having a minimum 1-hour fire resistance rating in accordance with Section 8.3:

(1) Boiler and fuel-fired heater rooms
(2) Central/bulk laundries larger than 100 ft^2 (9.3 m^2)
(3) Paint shops employing hazardous substances and materials in quantities less than those that would be classified as a severe hazard
(4) Physical plant maintenance shops
(5) Rooms with soiled linen in volume exceeding 64 gal (242 L)
(6) Rooms with collected trash in volume exceeding 64 gal (242 L)
(7) Storage rooms larger than 100 ft^2 (9.3 m^2) and storing combustible material

18.3.2.1.3 The following areas shall be considered hazardous areas and shall be protected by smoke partitions in accordance with Section 8.4:

(1) Laboratories employing flammable or combustible materials in quantities less than those that would be considered a severe hazard
(2) Storage rooms larger than 50 ft^2 (4.6 m^2) but not exceeding 100 ft^2 (9.3 m^2) and storing combustible material

18.3.2.2 Laboratories. Laboratories in which chemicals are handled or stored shall comply with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

18.3.2.3 Hyperbaric Chambers. Health care occupancies housing hyperbaric chambers shall comply with 8.7.5.

18.3.2.4 Medical Gas. Areas where medical gas is stored or administered, and the operation, testing, and maintenance of medical gases shall be in accordance with NFPA 99, *Health Care Facilities Code*.

18.3.2.5 Cooking Facilities.

18.3.2.5.1 Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 18.3.2.5.2, 18.3.2.5.3, or 18.3.2.5.4.

18.3.2.5.2* Where residential cooking equipment is used for food warming or limited cooking, the equipment shall not be required to be protected in accordance with 9.2.3, and the presence of the equipment shall not require the area to be protected as a hazardous area.

18.3.2.5.3* Within a smoke compartment, where residential or commercial cooking equipment is used to prepare meals for 30 or fewer persons, one cooking facility shall be permitted to be open to the corridor, provided that all of the following conditions are met:

(1) The portion of the health care facility served by the cooking facility is limited to 30 beds and is separated from other portions of the health care facility by a smoke barrier constructed in accordance with 18.3.7.3, 18.3.7.6, and 18.3.7.8.
(2) The cooktop or range is equipped with a range hood of a width at least equal to the width of the cooking surface, with grease baffles or other grease-collecting and cleanout capability.
(3)*The hood systems have a minimum airflow of 500 cfm (14,000 L/min).
(4) The hood systems that are not ducted to the exterior additionally have a charcoal filter to remove smoke and odor.
(5) The cooktop or range complies with all of the following:
    (a) The cooktop or range is protected with a fire suppression system listed in accordance with ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment*, or is tested and meets all requirements of UL 300A, *Extinguishing System Units for Residential Range Top Cooking Surfaces*, in accordance with the applicable testing document's scope.
    (b) A manual release of the extinguishing system is provided in accordance with Section 10.5 of NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.
    (c) An interlock is provided to turn off all sources of fuel and electrical power to the cooktop or range when the suppression system is activated.
(6)*The use of solid fuel for cooking is prohibited.
(7) Deep-fat frying is prohibited
(8) Portable fire extinguishers in accordance with NFPA 96 are located in all kitchen areas.
(9)*A switch meeting all of the following is provided:
    (a) A locked switch, or a switch located in a restricted location, is provided within the cooking facility that deactivates the cooktop or range.
    (b) The switch is used to deactivate the cooktop or range whenever the kitchen is not under staff supervision.
    (c) The switch is on a timer, not exceeding a 120-minute capacity, that automatically deactivates the cooktop or range, independent of staff action.
(10) Procedures for the use, inspection, testing, and maintenance of the cooking equipment are in accordance with Chapter 11 of NFPA 96 and the manufacturer's instructions are followed.
(11)*Not less than two AC-powered photoelectric smoke alarms with battery backup, interconnected in accordance with 9.6.2.10.3, and equipped with a silence feature are located not closer than 20 ft (6.1 m) and not further than 25 ft (7.6 m) from the cooktop or range.
(12)*The smoke alarms required by 18.3.2.5.3(11) are permitted to be located outside the kitchen area where such placement is necessary for compliance with the 20 ft (7.6 m) minimum distance criterion.
(13)*A single system smoke detector is permitted to be installed in lieu of the smoke alarms required in 18.3.2.5.3(11) provided the following criteria are met:
    (a) The detector is located not closer than 20 ft (6.1 m) and not further than 25 ft (7.6 m) from the cooktop or range.
    (b) The detector is permitted to initiate a local audible alarm signal only.
    (c) The detector is not required to initiate a building-wide occupant notification signal.
    (d) The detector is not required to notify emergency forces.
    (e) The local audible signal initiated by the detector is permitted to be silenced and reset by a button on the detector or by a switch installed within 10 ft (3.0 m) of the system smoke detector.
(14) System smoke detectors that are required to be installed in corridors or spaces open to the corridor by other sections of this chapter are not used to meet the requirements of 18.3.2.5.3(11) and are located not closer than 25 ft (7.6 m) to the cooktop or range.

18.3.2.5.4* Within a smoke compartment, residential or commercial cooking equipment that is used to prepare meals for 30 or fewer persons shall be permitted, provided that the cooking facility complies with all of the following conditions:

(1) The space containing the cooking equipment is not a sleeping room.
(2) The space containing the cooking equipment is separated from the corridor by partitions complying with 18.3.6.2 through 18.3.6.5.
(3) The requirements of 18.3.2.5.3(1) through (10) are met.

18.3.2.5.5* Where cooking facilities are protected in accordance with 9.2.3, the presence of the cooking equipment shall not cause the room or space housing the equipment to be classified as a hazardous area with respect to the requirements of 18.3.2.1, and the room or space shall not be permitted to be open to the corridor.

18.3.2.6 Heliports. Buildings that house health care occupancies, as indicated in 18.1.1.1.4, and have rooftop heliports shall be protected in accordance with NFPA 418, *Standard for Heliports*.

18.3.3 Interior Finish.

18.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

18.3.3.2* Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted throughout if Class A, except as indicated in 18.3.3.2.1 or 18.3.3.2.2.

18.3.3.2.1 Walls and ceilings shall be permitted to have Class A or Class B interior finish in individual rooms having a capacity not exceeding four persons.

18.3.3.2.2 Corridor wall finish not exceeding 48 in. (1220 mm) in height that is restricted to the lower half of the wall shall be permitted to be Class A or Class B.

18.3.3.3 Interior Floor Finish.

18.3.3.3.1 Interior floor finish shall comply with Section 10.2.

18.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 18.3.6 shall be Class I or Class II.

18.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

18.3.4 Detection, Alarm, and Communications Systems.

18.3.4.1 General. Health care occupancies shall be provided with a fire alarm system in accordance with Section 9.6.

18.3.4.2* Initiation.

18.3.4.2.1 Initiation of the required fire alarm systems shall be by manual means in accordance with 9.6.2 and by means of any required sprinkler system waterflow alarms, detection devices, or detection systems, unless otherwise permitted by 18.3.4.2.2 and 18.3.4.2.3.

18.3.4.2.2 Manual fire alarm boxes in patient sleeping areas shall not be required at exits if located at all nurses' control stations or other continuously attended staff location, provided that both of the following criteria are met:

(1) Such manual fire alarm boxes are visible and continuously accessible.
(2) Travel distances required by 9.6.2.5 are not exceeded.

18.3.4.2.3 The system smoke detector installed in accordance with 18.3.2.5.3(13) shall not be required to initiate the fire alarm system.

18.3.4.3 Notification. Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

18.3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 9.6.3, unless otherwise modified by the following:

(1) Paragraph 9.6.3.2.3 shall not be permitted to be used.
(2)*In lieu of audible alarm signals, visible alarm-indicating appliances shall be permitted to be used in critical care areas.
(3) The provision of 18.3.2.5.3(13)(c) shall be permitted to be used.

18.3.4.3.2 Emergency Forces Notification.

18.3.4.3.2.1 Emergency forces notification shall be accomplished in accordance with 9.6.4, except that the provision of 18.3.2.5.3(13)(d) shall be permitted to be used.

18.3.4.3.2.2 Reserved.

18.3.4.3.3 Annunciation and Annunciation Zoning.

18.3.4.3.3.1 Annunciation and annunciation zoning shall be provided in accordance with 9.6.7, unless otherwise permitted by 18.3.4.3.3.2 or 18.3.4.3.3.3.

18.3.4.3.3.2 The alarm zone shall be permitted to coincide with the permitted area for smoke compartments.

18.3.4.3.3.3 The provision of 9.6.7.4.5, which permits sprinkler system waterflow to be annunciated as a single building zone, shall be prohibited.

18.3.4.4 Fire Safety Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically any control functions to be performed by that device. *(See 9.6.5.)*

18.3.4.5 Detection.

18.3.4.5.1 General. Detection systems, where required, shall be in accordance with Section 9.6.

18.3.4.5.2 Detection in Spaces Open to Corridors. See 18.3.6.1.

18.3.4.5.3* Nursing Homes. An approved automatic smoke detection system shall be installed in corridors throughout smoke compartments containing patient sleeping rooms and in spaces open to corridors as permitted in nursing homes by 18.3.6.1, unless otherwise permitted by one of the following:

(1) Corridor systems shall not be required where each patient sleeping room is protected by an approved smoke detection system.
(2) Corridor systems shall not be required where patient room doors are equipped with automatic door-closing devices with integral smoke detectors on the room side installed in accordance with their listing, provided that the integral detectors provide occupant notification.

18.3.5 Extinguishment Requirements.

18.3.5.1* Buildings containing health care occupancies shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, unless otherwise permitted by 18.3.5.5.

18.3.5.2 Reserved.

18.3.5.3 Reserved.

18.3.5.4 The sprinkler system required by 18.3.5.1 shall be installed in accordance with 9.7.1.1(1).

18.3.5.5 In Type I and Type II construction, alternative protection measures shall be permitted to be substituted for sprinkler protection without causing a building to be classified as nonsprinklered in specified areas where the authority having jurisdiction has prohibited sprinklers.

18.3.5.6* Listed quick-response or listed residential sprinklers shall be used throughout smoke compartments containing patient sleeping rooms.

18.3.5.7 Reserved.

18.3.5.8 Reserved.

18.3.5.9 Reserved.

18.3.5.10* Sprinklers shall not be required in clothes closets of patient sleeping rooms in hospitals where the area of the closet does not exceed 6 ft^2 (0.55 m^2), provided that the distance from the sprinkler in the patient sleeping room to the back wall of the closet does not exceed the maximum distance permitted by NFPA 13, *Standard for the Installation of Sprinkler Systems.*

18.3.5.11* Sprinklers in areas where cubicle curtains are installed shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

18.3.5.12 Portable fire extinguishers shall be provided in all health care occupancies in accordance with Section 9.9.

18.3.6 Corridors.

18.3.6.1 Corridor Separation. Corridors shall be separated from all other areas by partitions complying with 18.3.6.2 through 18.3.6.5 *(see also 18.2.5.4)*, unless otherwise permitted by one of the following:

(1) Spaces shall be permitted to be unlimited in area and open to the corridor, provided that all of the following criteria are met:
   (a)*The spaces are not used for patient sleeping rooms, treatment rooms, or hazardous areas.
   (b) The corridors onto which the spaces open in the same smoke compartment are protected by an electrically supervised automatic smoke detection system in accordance with 18.3.4, or the smoke compartment in which the space is located is protected throughout by quick-response sprinklers.
   (c) The open space is protected by an electrically supervised automatic smoke detection system in accordance with 18.3.4, or the entire space is arranged and located to allow direct supervision by the facility staff from a nurses' station or similar space.
   (d) The space does not obstruct access to required exits.
(2) Waiting areas shall be permitted to be open to the corridor, provided that all of the following criteria are met:
   (a) The aggregate waiting area in each smoke compartment does not exceed 600 ft^2 (55.7 m^2).
   (b) Each area is protected by an electrically supervised automatic smoke detection system in accordance with 18.3.4, or each area is arranged and located to allow direct supervision by the facility staff from a nursing station or similar space.
   (c) The area does not obstruct access to required exits.
(3)*This requirement shall not apply to spaces for nurses' stations.
(4) Gift shops not exceeding 500 ft^2 (46.4 m^2) shall be permitted to be open to the corridor or lobby.
(5) In a limited care facility, group meeting or multipurpose therapeutic spaces shall be permitted to open to the corridor, provided that all of the following criteria are met:
   (a) The space is not a hazardous area.
   (b) The space is protected by an electrically supervised automatic smoke detection system in accordance with 18.3.4, or the space is arranged and located to allow direct supervision by the facility staff from the nurses' station or similar location.
   (c) The space does not obstruct access to required exits.
(6) Cooking facilities in accordance with 18.3.2.5.3 shall be permitted to be open to the corridor.

18.3.6.2* Construction of Corridor Walls.

18.3.6.2.1 Corridor walls shall be permitted to terminate at the ceiling where the ceiling is constructed to limit the transfer of smoke.

18.3.6.2.2 No fire resistance rating shall be required for corridor walls.

18.3.6.2.3* Corridor walls shall form a barrier to limit the transfer of smoke.

18.3.6.3* Corridor Doors.

18.3.6.3.1* Doors, including doors or panels to nurse servers and pass-through openings, protecting corridor openings shall be constructed to resist the passage of smoke, and the following also shall apply:

(1) Compliance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, shall not be required.
(2) For other than doors protecting pass-through openings, a clearance between the bottom of the door and the floor covering not exceeding 1 in. (25 mm) shall be permitted.
(3) For doors protecting pass-through openings, a clearance between the bottom of the door and the sill not exceeding ⅛ in. (3 mm) shall be permitted.
(4) Doors to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible material shall not be required to be constructed to resist the passage of smoke.

18.3.6.3.2 Reserved.

18.3.6.3.3 Reserved.

18.3.6.3.4 Reserved.

18.3.6.3.5 Doors shall be self-latching and provided with positive latching hardware.

18.3.6.3.6 Doors to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials shall not be required to meet the latching requirements of 18.3.6.3.5.

18.3.6.3.7 Powered doors that comply with the requirements of 7.2.1.9 shall not be required to meet the latching requirements of 18.3.6.3.5, provided that both of the following criteria are met:

(1) The door is equipped with a means for keeping the door closed that is acceptable to the authority having jurisdiction.
(2) The device used is capable of keeping the door fully closed if a force of 5 lbf (22 N) is applied at the latch edge of a swinging door and applied in any direction to a sliding or folding door, whether or not power is applied.

18.3.6.3.8 Corridor doors utilizing an inactive leaf shall have automatic flush bolts on the inactive leaf to provide positive latching.

18.3.6.3.9 Roller Latches.

18.3.6.3.9.1 Roller latches shall be prohibited, except as permitted by 18.3.6.3.9.2.

18.3.6.3.9.2 Roller latches shall be permitted for acute psychiatric settings where patient special clinical needs require specialized protective measures for their safety, provided that the roller latches are capable of keeping the door fully closed if a force of 5 lbf (22 N) is applied at the latch edge of the door.

18.3.6.3.10* Doors shall not be held open by devices other than those that release when the door is pushed or pulled.

18.3.6.3.11 Door-closing devices shall not be required on doors in corridor wall openings other than those serving required exits, smoke barriers, or enclosures of vertical openings and hazardous areas.

18.3.6.3.12* Nonrated, factory- or field-applied protective plates, unlimited in height, shall be permitted.

18.3.6.3.13 Dutch doors shall be permitted where they conform to 18.3.6.3 and meet all of the following criteria:

(1) Both the upper leaf and lower leaf are equipped with a latching device.

(2) The meeting edges of the upper and lower leaves are quipped with an astragal, a rabbet, or a bevel.
(3) Where protecting openings in enclosures around hazardous areas, the doors comply with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

18.3.6.4 Transfer Grilles.

18.3.6.4.1 Transfer grilles shall not be used in corridor walls or doors, unless otherwise permitted by 18.3.6.4.2.

18.3.6.4.2 Doors to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials shall be permitted to have ventilating louvers or to be undercut.

18.3.6.5 Openings.

18.3.6.5.1* In other than smoke compartments containing patient bedrooms, miscellaneous openings, such as mail slots, pharmacy pass-through windows, laboratory pass-through windows, and cashier pass-through windows, shall be permitted to be installed in vision panels or doors without special protection, provided that both of the following criteria are met:

(1) The aggregate area of openings per room does not exceed 80 in.^{2} (0.05 m^2).
(2) The openings are installed at or below half the distance from the floor to the room ceiling.

18.3.6.5.2 Reserved.

18.3.7* Subdivision of Building Spaces.

18.3.7.1 Buildings containing health care facilities shall be subdivided by smoke barriers *(see 18.2.4.3)*, unless otherwise permitted by 18.3.7.2, as follows:

(1) To divide every story used by inpatients for sleeping or treatment into not less than two smoke compartments
(2) To divide every story having an occupant load of 50 or more persons, regardless of use, into not less than two smoke compartments
(3) To limit the size of each smoke compartment required by 18.3.7.1(1) and (2) to an area not exceeding 22,500 ft^2 (2100 m^2), unless the area is an atrium separated in accordance with 8.6.7, in which case no limitation in size is required
(4) To limit the travel distance from any point to reach a door in the required smoke barrier to a distance not exceeding 200 ft (61 m)

18.3.7.2 The smoke barrier subdivision requirement of 18.3.7.1 shall not apply to any of the following occupancies:

(1) Stories that do not contain a health care occupancy located directly above the health care occupancy
(2) Areas on health care floors that do not contain a health care occupancy and that are separated from the health care occupancy by a fire barrier complying with 7.2.4.3
(3) Stories that do not contain a health care occupancy and that are below the health care occupancy
(4) Open-air parking structures protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7

18.3.7.3 Any required smoke barrier shall be constructed in accordance with Section 8.5 and shall have a minimum 1-hour fire resistance rating, unless otherwise permitted by one of the following:

(1) This requirement shall not apply where an atrium is used, and both of the following criteria also shall apply:
   (a) Smoke barriers shall be permitted to terminate at an atrium wall constructed in accordance with 8.6.7(1)(c).
   (b) Not less than two separate smoke compartments shall be provided on each floor.
(2)*Smoke dampers shall not be required in duct penetrations of smoke barriers in fully ducted heating, ventilating, and air-conditioning systems.

18.3.7.4 Materials and methods of construction used for required smoke barriers shall not reduce the required fire resistance rating.

18.3.7.5 Accumulation space shall be provided in accordance with 18.3.7.5.1 and 18.3.7.5.2.

18.3.7.5.1 Not less than 30 net ft^2 (2.8 net m^2) per patient in a hospital or nursing home, or not less than 15 net ft^2 (1.4 net m^2) per resident in a limited care facility, shall be provided within the aggregate area of corridors, patient rooms, treatment rooms, lounge or dining areas, and other low hazard areas on each side of the smoke barrier.

18.3.7.5.2 On stories not housing bedridden or litterborne patients, not less than 6 net ft^2 (0.56 net m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments.

18.3.7.6* Doors in smoke barriers shall be substantial doors, such as nonrated 1¾ in. (44 mm) thick, solid-bonded wood-core doors, or shall be of construction that resists fire for a minimum of 20 minutes, and shall meet the following requirements:

(1) Nonrated factory- or field-applied protective plates, unlimited in height, shall be permitted.
(2) Cross-corridor openings in smoke barriers shall be protected by a pair of swinging doors or a special-purpose horizontally sliding accordion or folding door assembly complying with 7.2.1.14, unless otherwise permitted by 18.3.7.7.
(3) The swinging doors addressed by 18.3.7.6(2) shall be arranged so that each door swings in a direction opposite from the other.
(4) The minimum clear width of swinging doors shall be as follows:
   (a) Where the corridor is required to be a minimum of 8 ft (2440 mm) wide — 41½ in. (1055 mm)
   (b) Where the corridor is required to be a minimum of 6 ft (1830 mm) wide — 32 in. (810 mm)
(5) The minimum clear width opening for horizontal sliding doors shall be as follows:
   (a) Where the corridor is required to be a minimum of 8 ft (2440 mm) wide — 6 ft 11 in. (2110 mm)
   (b) Where the corridor is required to be a minimum of 6 ft (1830 mm) wide — 64 in. (1625 mm)
(6) The clearance under the bottom of smoke barrier doors shall not exceed ¾ in. (19 mm).

18.3.7.7 Cross-corridor openings in smoke barriers that are not in required means of egress from a health care space shall be permitted to be protected by a single-leaf door.

18.3.7.8* Doors in smoke barriers shall comply with 8.5.4 and all of the following:

(1) The doors shall be self-closing or automatic-closing in accordance with 18.2.2.2.7.

(2) Latching hardware shall not be required.
(3) Stops shall be required at the head and sides of door frames.
(4) Rabbets, bevels, or astragals shall be required at the meeting edges of pairs of doors.
(5) Center mullions shall be prohibited.

18.3.7.9* Vision panels consisting of fire-rated glazing in approved frames shall be provided in each cross-corridor swinging door and at each cross-corridor horizontal-sliding door in a smoke barrier.

18.3.7.9.1 The bottom of at least one vision panel in each leaf shall be not more than 43 in. (1090 mm) above the finished floor.

18.3.7.10 Vision panels in doors in smoke barriers, if provided, shall be of fire-rated glazing in approved frames.

18.3.8 Special Protection Features. (Reserved)

18.4 Special Provisions.

18.4.1 Limited Access Buildings. Limited access buildings or limited access portions of buildings shall not be used for patient sleeping rooms and shall comply with Section 11.7.

18.4.2 High-Rise Buildings. High-rise buildings shall comply with Section 11.8.

18.4.3* Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following conditions are met:

(1) Where dispensers are installed in a corridor, the corridor shall have a minimum width of 6 ft (1830 mm).
(2) The maximum individual dispenser fluid capacity shall be as follows:
    (a) 0.32 gal (1.2 L) for dispensers in rooms, corridors, and areas open to corridors
    (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) Where aerosol containers are used, the maximum capacity of the aerosol dispenser shall be 18 oz (0.51 kg) and shall be limited to Level 1 aerosols as defined in NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.
(4) Dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(5) Not more than an aggregate 10 gal (37.8 L) of alcohol-based hand-rub solution or 1135 oz (32.2 kg) of Level 1 aerosols, or a combination of liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gal (37.8 L) or 1135 oz (32.2 kg), shall be in use outside of a storage cabinet in a single smoke compartment, except as otherwise provided in 18.4.3(6).
(6) One dispenser complying with 18.4.3(2) or (3) per room and located in that room shall not be included in the aggregated quantity addressed in 18.4.3(5).
(7) Storage of quantities greater than 5 gal (18.9 L) in a single smoke compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(8) Dispensers shall not be installed in the following locations:
    (a) Above an ignition source within a 1 in. (25 mm) horizontal distance from each side of the ignition source
    (b) To the side of an ignition source within a 1 in. (25 mm) horizontal distance from the ignition source
    (c) Beneath an ignition source within a 1 in. (25 mm) vertical distance from the ignition source
(9) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered smoke compartments.
(10) The alcohol-based hand-rub solution shall not exceed 95 percent alcohol content by volume.
(11) Operation of the dispenser shall comply with the following criteria:
    (a) The dispenser shall not release its contents except when the dispenser is activated, either manually or automatically by touch-free activation.
    (b) Any activation of the dispenser shall occur only when an object is placed within 4 in. (100 mm) of the sensing device.
    (c) An object placed within the activation zone and left in place shall not cause more than one activation.
    (d) The dispenser shall not dispense more solution than the amount required for hand hygiene consistent with label instructions.
    (e) The dispenser shall be designed, constructed, and operated in a manner that ensures that accidental or malicious activation of the dispensing device is minimized.
    (f) The dispenser shall be tested in accordance with the manufacturer's care and use instructions each time a new refill is installed.

18.4.4 Nonsprinklered Existing Smoke Compartment Rehabilitation.

18.4.4.1* General. Where a modification in a nonsprinklered smoke compartment is exempted by the provisions of 18.1.1.4.3.4 from the sprinkler requirement of 18.3.5.1, the requirements of 18.4.4.2 through 18.4.4.8 shall apply.

18.4.4.2 Minimum Construction Requirements (Nonsprinklered Smoke Compartment Rehabilitation). Health care occupancies in buildings not protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7 shall be limited to the building construction types specified in Table 18.4.4.2.

18.4.4.3 Capacity of Means of Egress (Nonsprinklered Smoke Compartment Rehabilitation). The capacity of the means of egress serving the modification area shall be as follows:

(1) ½ in. (13 mm) per person for horizontal travel, without stairs, by means such as doors, ramps, or level floor surfaces
(2) 0.6 in. (15 mm) per person for travel by means of stairs

18.4.4.4 Travel Distance (Nonsprinklered Smoke Compartment Rehabilitation).

18.4.4.4.1 The travel distance between any room door required as an exit access and an exit shall not exceed the following:

(1) 150 ft (46 m) where the travel is wholly within smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7
(2) 100 ft (30 m) where the travel is not wholly within smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7

18.4.4.4.2 The travel distance between any point in a room and an exit shall not exceed the following:

(1) 200 ft (61 m) where the travel is wholly within smoke compartments protected throughout by an approved supervised sprinkler system in accordance with 19.3.5.7
(2) 150 ft (46 m) where the travel is not wholly within smoke compartments protected throughout by an approved supervised sprinkler system in accordance with 19.3.5.7

Table 18.4.4.2 Construction Type Limitations (Nonsprinklered Buildings)

Construction Type	Sprinklered	Total Number of Stories of Building†			
		1	2	3	≥4
I (442)	Yes	NA	NA	NA	NA
	No	X	X	X	X
I (332)	Yes	NA	NA	NA	NA
	No	X	X	X	X
II (222)	Yes	NA	NA	NA	NA
	No	X	X	X	X
II (111)	Yes	NA	NA	NA	NA
	No	X	NP	NP	NP
II (000)	Yes	NA	NA	NA	NA
	No	NP	NP	NP	NP
III (211)	Yes	NA	NA	NA	NA
	No	NP	NP	NP	NP
III (200)	Yes	NA	NA	NA	NA
	No	NP	NP	NP	NP
IV (2HH)	Yes	NA	NA	NA	NA
	No	NP	NP	NP	NP
V (111)	Yes	NA	NA	NA	NA
	No	NP	NP	NP	NP
V (000)	Yes	NA	NA	NA	NA
	No	NP	NP	NP	NP

NA: Not applicable. X: Permitted. NP: Not permitted.
The total number of stories of the building is required to be determined as follows:
(1) The total number of stories is to be counted starting with the level of exit discharge and ending with the highest occupiable story of the building.
(2) Stories below the level of exit discharge are not counted as stories.
(3) Interstitial spaces used solely for building or process systems directly related to the level above or below are not considered a separate story.
(4) A mezzanine in accordance with 8.6.9 is not counted as a story.
†Basements are not counted as stories.

18.4.4.5 Hazardous Area Protection (Nonsprinklered Smoke Compartment Rehabilitation).

18.4.4.5.1 Where a new hazardous area is formed in an existing nonsprinklered smoke compartment, the hazardous area itself shall be protected as indicated in Table 18.4.4.5.1.

18.4.4.5.2 Laboratories in which chemicals are handled or stored shall comply with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

18.4.4.6 Interior Finish (Nonsprinklered Smoke Compartment Rehabilitation).

18.4.4.6.1 General. Interior finish within the modification area shall be in accordance with Section 10.2.

18.4.4.6.2 Interior Wall and Ceiling Finish. Newly installed interior wall and ceiling finish materials complying with Section 10.2 shall be permitted throughout nonsprinklered smoke compartments if the materials are Class A, except as otherwise permitted in 18.4.4.6.2.1 or 18.4.4.6.2.2.

18.4.4.6.2.1 Walls and ceilings shall be permitted to have Class A or Class B interior finish in individual rooms having a capacity not exceeding four persons.

18.4.4.6.2.2 Corridor wall finish not exceeding 48 in. (1220 mm) in height and restricted to the lower half of the wall shall be permitted to be Class A or Class B.

18.4.4.6.3 Interior Floor Finish.

18.4.4.6.3.1 Newly installed interior floor finish shall comply with Section 10.2.

18.4.4.6.3.2 The requirements for newly installed interior floor finish in exit enclosures and corridors not separated from them by walls complying with 19.3.5.7 shall be as follows:

(1) Unrestricted in smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7
(2) Not less than Class I in smoke compartments not protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7

Table 18.4.4.5.1 Hazardous Area Protection (Nonsprinklered Buildings)

Hazardous Area Description	Protection*/Separation
Boiler and fuel-fired heater rooms	1 hour and sprinklers
Central/bulk laundries larger than 100 ft^2 (9.3 m^2)	1 hour and sprinklers
Paint shops employing hazardous substances and materials in quantities less than those that would be classified as a severe hazard	1 hour and sprinklers
Physical plant maintenance shops	1 hour and sprinklers
Soiled linen rooms	1 hour and sprinklers
Storage rooms larger than 50 ft^2 (4.6 m^2) but not exceeding 100 ft^2 (9.3 m^2) and storing combustible material	1 hour or sprinklers *(Also see 18.4.4.7.2.2.)*
Storage rooms larger than 100 ft^2 (9.3 m^2) and storing combustible material	1 hour and sprinklers
Trash collection rooms	1 hour and sprinklers

*Minimum fire resistance rating.

18.4.4.7 Corridors (Nonsprinklered Smoke Compartment Rehabilitation).

18.4.4.7.1 Construction of Corridor Walls.

18.4.4.7.1.1 Where the smoke compartment being modified is not protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7, corridor walls shall comply with all of the following, as modified by 18.4.4.7.1.2:

(1) They shall have a minimum ½-hour fire resistance rating.
(2) They shall be continuous from the floor to the underside of the floor or roof deck above.
(3) They shall resist the passage of smoke.

18.4.4.7.1.2 The requirements of 18.4.4.7.1.1 shall be permitted to be modified for conditions permitted by 19.3.6.1(3) and (4) and 19.3.6.1(6) through (8).

18.4.4.7.2 Corridor Doors.

18.4.4.7.2.1 Where the smoke compartment being modified is not protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7, all of the following shall apply:

(1) Doors protecting corridor openings shall be constructed of 1¾ in. (44 mm) thick, solid-bonded core wood or of construction that resists the passage of fire for a minimum of 20 minutes.
(2) Door frames shall be labeled or of steel construction.
(3) Existing roller latches demonstrated to keep the door closed against a force of 5 lbf (22 N) shall be permitted.

18.4.4.7.2.2 Door-closing devices shall be required on doors in corridor wall openings serving smoke barriers or enclosures of exits, hazardous contents areas, or vertical openings.

18.4.4.8 Subdivision of Building Space (Nonsprinklered Smoke Compartment Rehabilitation). Subparagraph 18.3.7.3(2) shall be permitted only where adjacent smoke compartments are protected throughout by an approved, supervised automatic sprinkler system in accordance with 18.3.5.4 and 18.3.5.6.

18.5 Building Services.

18.5.1 Utilities.

18.5.1.1 Utilities shall comply with the provisions of Section 9.1.

18.5.1.2 Power for alarms, emergency communications systems, and illumination of generator set locations shall be in accordance with the essential electrical system requirements of NFPA 99, *Health Care Facilities Code*.

18.5.1.3 Any health care occupancy, as indicated in 18.1.1.1.4, that normally uses life-support devices shall have electrical systems designed and installed in accordance with NFPA 99, *Health Care Facilities Code*, unless the facility uses life-support equipment for emergency purposes only.

18.5.2 Heating, Ventilating, and Air-Conditioning.

18.5.2.1 Heating, ventilating, and air-conditioning shall comply with the provisions of Section 9.2 and shall be installed in accordance with the manufacturer's specifications, unless otherwise modified by 18.5.2.2.

18.5.2.2* Any heating device, other than a central heating plant, shall be designed and installed so that combustible material cannot be ignited by the device or its appurtenances, and the following requirements shall also apply:

(1) If fuel-fired, such heating devices shall comply with the following:
  (a) They shall be chimney connected or vent connected.
  (b) They shall take air for combustion directly from outside.
  (c) They shall be designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area.
(2) Any heating device shall have safety features to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperatures or ignition failure.

18.5.2.3 The requirements of 18.5.2.2 shall not apply where otherwise permitted by the following:

(1) Approved, suspended unit heaters shall be permitted in locations other than means of egress and patient sleeping areas, provided that both of the following criteria are met:
  (a) Such heaters are located high enough to be out of the reach of persons using the area.
  (b) Such heaters are equipped with the safety features required by 18.5.2.2(2).
(2) Direct-vent gas fireplaces, as defined in NFPA 54, *National Fuel Gas Code*, shall be permitted inside of smoke compartments containing patient sleeping areas, provided that all of the following criteria are met:
  (a) All such devices shall be installed, maintained, and used in accordance with 9.2.2.
  (b) No such device shall be located inside of a patient sleeping room.
  (c) The smoke compartment in which the direct-vent gas fireplace is located shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1) with listed quick-response or listed residential sprinklers.

(d)*The direct-vent fireplace shall include a sealed glass front with a wire mesh panel or screen.
(e)*The controls for the direct-vent gas fireplace shall be locked or located in a restricted location.
(f) Electrically supervised carbon monoxide detection in accordance with Section 9.12 shall be provided in the room where the fireplace is located.

(3) Solid fuel–burning fireplaces shall be permitted and used only in areas other than patient sleeping areas, provided that all of the following criteria are met:
   (a) Such areas are separated from patient sleeping spaces by construction having not less than a 1-hour fire resistance rating.
   (b) The fireplace complies with the provisions of 9.2.2.
   (c) The fireplace is equipped with both of the following:
      i. Hearth raised not less than 4 in. (100 mm)
      ii. Fireplace enclosure guaranteed against breakage up to a temperature of 650°F (343°C) and constructed of heat-tempered glass or other approved material
   (d) Electrically supervised carbon monoxide detection in accordance with Section 9.12 is provided in the room where the fireplace is located
(4) If, in the opinion of the authority having jurisdiction, special hazards are present, a lock on the enclosure specified in 18.5.2.3(3)(c)(ii) and other safety precautions shall be permitted to be required.

18.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

18.5.4 Waste Chutes, Incinerators, and Laundry Chutes.

18.5.4.1 Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5, unless otherwise specified in 18.5.4.2.

18.5.4.2 The fire resistance rating of chute service opening rooms shall not be required to exceed 1 hour.

18.5.4.3 Any waste chute or linen chute, including pneumatic waste and linen systems, shall be provided with automatic extinguishing protection in accordance with Section 9.7. *(See Section 9.5.)*

18.5.4.4 Any chute shall discharge into a chute discharge room used for no other purpose and shall be protected in accordance with Section 8.7 and Section 9.5.

18.5.4.5 Reserved.

18.5.4.6 Incinerators shall not be directly flue-fed, nor shall any floor-charging chute directly connect with the combustion chamber.

18.6 Reserved.

18.7* Operating Features.

18.7.1 Evacuation and Relocation Plan and Fire Drills.

18.7.1.1 The administration of every health care occupancy shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for their evacuation from the building when necessary.

18.7.1.2 All employees shall be periodically instructed and kept informed with respect to their duties under the plan required by 18.7.1.1.

18.7.1.3 A copy of the plan required by 18.7.1.1 shall be readily available at all times in the telephone operator's location or at the security center.

18.7.1.4* Fire drills in health care occupancies shall include the transmission of a fire alarm signal and simulation of emergency fire conditions.

18.7.1.5 Infirm or bedridden patients shall not be required to be moved during drills to safe areas or to the exterior of the building.

18.7.1.6 Drills shall be conducted quarterly on each shift to familiarize facility personnel (nurses, interns, maintenance engineers, and administrative staff) with the signals and emergency action required under varied conditions.

18.7.1.7 When drills are conducted between 9:00 p.m. and 6:00 a.m. (2100 hours and 0600 hours), a coded announcement shall be permitted to be used instead of audible alarms.

18.7.1.8 Employees of health care occupancies shall be instructed in life safety procedures and devices.

18.7.2 Procedure in Case of Fire.

18.7.2.1* Protection of Patients.

18.7.2.1.1 For health care occupancies, the proper protection of patients shall require the prompt and effective response of health care personnel.

18.7.2.1.2 The basic response required of staff shall include the following:

(1) Removal of all occupants directly involved with the fire emergency
(2) Transmission of an appropriate fire alarm signal to warn other building occupants and summon staff
(3) Confinement of the effects of the fire by closing doors to isolate the fire area
(4) Relocation of patients as detailed in the health care occupancy's fire safety plan

18.7.2.2 Fire Safety Plan. A written health care occupancy fire safety plan shall provide for all of the following:

(1) Use of alarms
(2) Transmission of alarms to fire department
(3) Emergency phone call to fire department
(4) Response to alarms
(5) Isolation of fire
(6) Evacuation of immediate area
(7) Evacuation of smoke compartment
(8) Preparation of floors and building for evacuation
(9) Extinguishment of fire
(10) Location and operation of doors disguised with murals as permitted by 18.2.2.2.7

18.7.2.3 Staff Response.

18.7.2.3.1 All health care occupancy personnel shall be instructed in the use of and response to fire alarms.

18.7.2.3.2 All health care occupancy personnel shall be instructed in the use of the code phrase to ensure transmission of an alarm under any of the following conditions:

(1) When the individual who discovers a fire must immediately go to the aid of an endangered person
(2) During a malfunction of the building fire alarm system

18.7.2.3.3 Personnel hearing the code announced shall first activate the building fire alarm using the nearest manual fire alarm box and then shall execute immediately their duties as outlined in the fire safety plan.

18.7.3 Maintenance of Means of Egress.

18.7.3.1 Proper maintenance shall be provided to ensure the dependability of the method of evacuation selected.

18.7.3.2 Health care occupancies that find it necessary to lock means of egress doors shall, at all times, maintain an adequate staff qualified to release locks and direct occupants from the immediate danger area to a place of safety in case of fire or other emergency.

18.7.3.3* Where required by the authority having jurisdiction, a floor plan shall be provided to indicate the location of all required means of egress corridors in smoke compartments having spaces not separated from the corridor by partitions.

18.7.4* Smoking. Smoking regulations shall be adopted and shall include not less than the following provisions:

(1) Smoking shall be prohibited in any room, ward, or individual enclosed space where flammable liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and such areas shall be posted with signs that read NO SMOKING or shall be posted with the international symbol for no smoking.
(2) In health care occupancies where smoking is prohibited and signs are prominently placed at all major entrances, secondary signs with language that prohibits smoking shall not be required.
(3) Smoking by patients classified as not responsible shall be prohibited.
(4) The requirement of 18.7.4(3) shall not apply where the patient is under direct supervision.
(5) Ashtrays of noncombustible material and safe design shall be provided in all areas where smoking is permitted.
(6) Metal containers with self-closing cover devices into which ashtrays can be emptied shall be readily available to all areas where smoking is permitted.

18.7.5 Furnishings, Mattresses, and Decorations.

18.7.5.1* Draperies, curtains, and other loosely hanging fabrics and films serving as furnishings or decorations in health care occupancies shall be in accordance with the provisions of 10.3.1 *(see 18.3.5.11)*, and the following also shall apply:

(1) Such curtains shall include cubicle curtains.
(2) Such curtains shall not include curtains at showers and baths.
(3) Such draperies and curtains shall not include draperies and curtains at windows in patient sleeping rooms.
(4) Such draperies and curtains shall not include draperies and curtains in other rooms or areas where the draperies and curtains comply with both of the following:
    (a) Individual drapery or curtain panel area does not exceed 48 ft^2 (4.5 m^2)
    (b) Total area of drapery and curtain panels per room or area does not exceed 20 percent of the aggregate area of the wall on which they are located

18.7.5.2 Newly introduced upholstered furniture within health care occupancies shall comply with one of the following provisions:

(1) The furniture shall meet the criteria specified in 10.3.2.1 and 10.3.3.
(2) The furniture shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

18.7.5.3 Reserved.

18.7.5.4 Newly introduced mattresses within health care occupancies shall comply with one of the following provisions:

(1) The mattresses shall meet the criteria specified in 10.3.2.2 and 10.3.4.
(2) The mattresses shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

18.7.5.5 Reserved.

18.7.5.6 Combustible decorations shall be prohibited in any health care occupancy, unless one of the following criteria is met:

(1) They are flame-retardant or are treated with approved fire-retardant coating that is listed and labeled for application to the material to which it is applied.
(2)*The decorations meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(3) The decorations exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(4)*The decorations, such as photographs, paintings, and other art, are attached directly to the walls, ceiling, and non-fire-rated doors in accordance with the following:
    (a) Decorations on non-fire-rated doors do not interfere with the operation or any required latching of the door and do not exceed the area limitations of 18.7.5.6(4)(b), (c), or (d).
    (b) Decorations do not exceed 20 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is not protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.
    (c) Decorations do not exceed 30 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is protected throughout by an approved supervised automatic sprinkler system in accordance with Section 9.7.
    (d) Decorations do not exceed 50 percent of the wall, ceiling, and door areas inside patient sleeping rooms having a capacity not exceeding four persons, in a smoke compartment that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

18.7.5.7 Soiled Linen and Trash Receptacles.

18.7.5.7.1 Soiled linen or trash collection receptacles shall not exceed 32 gal (121 L) in capacity and shall meet all of the following requirements:

(1) The average density of container capacity in a room or space shall not exceed 0.5 gal/ft^2 (20.4 L/m^2).
(2) A capacity of 32 gal (121 L) shall not be exceeded within any 64 ft^2 (6 m^2) area.

(3)*Mobile soiled linen or trash collection receptacles with capacities greater than 32 gal (121 L) shall be located in a room protected as a hazardous area when not attended.
(4) Container size and density shall not be limited in hazardous areas.

18.7.5.7.2* Containers used solely for recycling clean waste or for patient records awaiting destruction shall be permitted to be excluded from the requirements of 18.7.5.7.1 where all the following conditions are met:

(1) Each container shall be limited to a maximum capacity of 96 gal (363 L), except as permitted by 18.7.5.7.2(2) or (3).
(2)*Containers with capacities greater than 96 gal (363 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size shall not be limited in hazardous areas.
(4) Containers for combustibles shall be labeled and listed as meeting the requirements of FM Approval Standard 6921, *Containers for Combustible Waste*; however, such testing, listing, and labeling shall not be limited to FM Approvals.

18.7.5.7.3 The provisions of 10.3.9, applicable to containers for waste, or linen, shall not apply.

18.7.6 Maintenance and Testing. See 4.6.12.

18.7.7 Engineered Smoke Control Systems.

18.7.7.1 New engineered smoke control systems shall be designed, installed, tested, and maintained in accordance with NFPA 92, *Standard for Smoke Control Systems*.

18.7.7.2 Test documentation shall be maintained on the premises at all times.

18.7.8* Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all health care occupancies, unless both of the following criteria are met:

(1) Such devices are permitted to be used only in nonsleeping staff and employee areas.
(2) The heating elements of such devices do not exceed 212°F (100°C).

18.7.9 Construction, Repair, and Improvement Operations.

18.7.9.1 Construction, repair, and improvement operations shall comply with 4.6.10.

18.7.9.2 The means of egress in any area undergoing construction, repair, or improvements shall be inspected daily for compliance with 7.1.10.1 and shall also comply with NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

Chapter 19 Existing Health Care Occupancies

19.1 General Requirements.

19.1.1 Application.

19.1.1.1 General.

19.1.1.1.1* The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as health care occupancies, unless the authority having jurisdiction has determined equivalent safety has been provided in accordance with Section 1.4.

19.1.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

19.1.1.1.3 General. The provisions of Chapter 4, General, shall apply.

19.1.1.1.4 The requirements established by this chapter shall apply to all existing hospitals, nursing homes, and limited care facilities. The term *hospital*, wherever used in this *Code*, shall include general hospitals, psychiatric hospitals, and specialty hospitals. The term *nursing home*, wherever used in this *Code*, shall include nursing and convalescent homes, skilled nursing facilities, intermediate care facilities, and infirmaries in homes for the aged. Where requirements vary, the specific subclass of health care occupancy that shall apply is named in the paragraph pertaining thereto. The requirements established by Chapter 21 shall apply to all existing ambulatory health care facilities. The operating features requirements established by Section 19.7 shall apply to all health care occupancies.

19.1.1.1.5 The health care facilities regulated by this chapter shall be those that provide sleeping accommodations for their occupants and are occupied by persons who are mostly incapable of self-preservation because of age, because of physical or mental disability, or because of security measures not under the occupants' control.

19.1.1.1.6 Buildings, or sections of buildings, that primarily house patients who, in the opinion of the governing body of the facility and the governmental agency having jurisdiction, are capable of exercising judgment and appropriate physical action for self-preservation under emergency conditions shall be permitted to comply with chapters of the *Code* other than Chapter 19.

19.1.1.1.7* It shall be recognized that, in buildings housing certain patients, it might be necessary to lock doors and bar windows to confine and protect building inhabitants.

19.1.1.1.8 Buildings, or sections of buildings, that house older persons and that provide activities that foster continued independence but do not include services distinctive to health care occupancies *(see 19.1.4.2)*, as defined in 3.3.190.7, shall be permitted to comply with the requirements of other chapters of this *Code*, such as Chapters 31 or 33.

19.1.1.1.9 Facilities that do not provide housing on a 24-hour basis for their occupants shall be classified as other occupancies and shall be covered by other chapters of this *Code*.

19.1.1.1.10* The requirements of this chapter shall apply based on the assumption that staff is available in all patient-occupied areas to perform certain fire safety functions as required in other paragraphs of this chapter.

19.1.1.2* Goals and Objectives. The goals and objectives of Sections 4.1 and 4.2 shall be met with due consideration for functional requirements, which are accomplished by limiting the development and spread of a fire emergency to the room of fire origin and reducing the need for occupant evacuation, except from the room of fire origin.

19.1.1.3 Total Concept.

19.1.1.3.1 All health care facilities shall be designed, constructed, maintained, and operated to minimize the possibility of a fire emergency requiring the evacuation of occupants.

19.1.1.3.2 Because the safety of health care occupants cannot be ensured adequately by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities; adequate, trained staff; and development of operating and maintenance procedures composed of the following:

(1) Design, construction, and compartmentation
(2) Provision for detection, alarm, and extinguishment
(3) Fire prevention procedures and planning, training, and drilling programs for the isolation of fire, transfer of occupants to areas of refuge, or evacuation of the building

19.1.1.4 Additions, Conversions, Modernization, Renovation, and Construction Operations.

19.1.1.4.1 Additions. Additions shall be separated from any existing structure not conforming to the provisions within Chapter 19 by a fire barrier having not less than a 2-hour fire resistance rating and constructed of materials as required for the addition. *(See 4.6.7 and 4.6.11.)*

19.1.1.4.1.1 Communicating openings in dividing fire barriers required by 19.1.1.4.1 shall be permitted only in corridors and shall be protected by approved self-closing fire door assemblies. *(See also Section 8.3.)*

19.1.1.4.1.2 Doors in barriers required by 19.1.1.4.1 shall normally be kept closed, unless otherwise permitted by 19.1.1.4.1.3.

19.1.1.4.1.3 Doors shall be permitted to be held open if they meet the requirements of 19.2.2.2.7.

19.1.1.4.2 Changes of Use or Occupancy Classification. Changes of use or occupancy classification shall comply with 4.6.11, unless otherwise permitted by one of the following:

(1) A change from a hospital to a nursing home or from a nursing home to a hospital shall not be considered a change in occupancy classification or a change in use.
(2) A change from a hospital or nursing home to a limited care facility shall not be considered a change in occupancy classification or a change in use.
(3) A change from a hospital or nursing home to an ambulatory health care facility shall not be considered a change in occupancy classification or a change in use.

19.1.1.4.3 Rehabilitation.

19.1.1.4.3.1 For purposes of the provisions of this chapter, the following shall apply:

(1) A major rehabilitation shall involve the modification of more than 50 percent, or more than 4500 ft^2 (420 m^2), of the area of the smoke compartment.
(2) A minor rehabilitation shall involve the modification of not more than 50 percent, and not more than 4500 ft^2 (420 m^2), of the area of the smoke compartment.

19.1.1.4.3.2 Work that is exclusively plumbing, mechanical, fire protection system, electrical, medical gas, or medical equipment work shall not be included in the computation of the modification area within the smoke compartment.

19.1.1.4.3.3* Where major rehabilitation is done in a nonsprinklered smoke compartment, the automatic sprinkler requirements of 18.3.5 shall apply to the smoke compartment undergoing the rehabilitation, and, in cases where the building is not protected throughout by an approved automatic sprinkler system, the requirements of 18.4.4.2, 18.4.4.3, and 18.4.4.8 shall also apply.

19.1.1.4.3.4* Where minor rehabilitation is done in a nonsprinklered smoke compartment, the requirements of 18.3.5.1 shall not apply, but, in such cases, the rehabilitation shall not reduce life safety below the level required for new buildings or below the level of the requirements of 18.4.3 for nonsprinklered smoke compartment rehabilitation. *(See 4.6.7.)*

19.1.1.4.4 Construction, Repair, and Improvement Operations. See 4.6.10.

19.1.2 Classification of Occupancy. See 6.1.5 and 19.1.4.2.

19.1.3 Multiple Occupancies.

19.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

19.1.3.2 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis, provided both of the following are met:

(1) The provision is not used for occupancy separations involving industrial and storage occupancies.
(2) Smoke partitions serving as atrium walls are not permitted to serve as enclosures for hazardous areas.

19.1.3.3 Sections of health care facilities shall be permitted to be classified as other occupancies in accordance with the separated occupancies provisions of 6.1.14.4 and either 19.1.3.4 or 19.1.3.5.

19.1.3.4* Sections of health care facilities shall be permitted to be classified as other occupancies, provided that they meet all of the following conditions:

(1) They are not intended to provide services simultaneously for four or more inpatients for purposes of housing, treatment, or customary access by inpatients incapable of self-preservation.
(2) They are separated from areas of health care occupancies by construction having a minimum 2-hour fire resistance rating in accordance with Chapter 8.
(3) For other than previously approved occupancy separation arrangements, the entire building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

19.1.3.5 Contiguous Non-Health Care Occupancies.

19.1.3.5.1* Ambulatory care facilities, medical clinics, and similar facilities that are contiguous to health care occupancies, but are primarily intended to provide outpatient services, shall be permitted to be classified as business occupancies or ambulatory health care facilities, provided that the facilities are separated from the health care occupancy by not less than 2-hour fire resistance–rated construction, and the facility is not intended to provide services simultaneously for four or more inpatients who are litterborne.

19.1.3.5.2 Ambulatory care facilities, medical clinics, and similar facilities that are contiguous to health care occupancies shall be permitted to be used for diagnostic and treatment services of inpatients who are capable of self-preservation.

19.1.3.6 Where separated occupancies provisions are used in accordance with either 19.1.3.4 or 19.1.3.5, the most stringent construction type shall be provided throughout the building, unless a 2-hour separation is provided in accordance with 8.2.1.3, in which case the construction type shall be determined as follows:

(1) The construction type and supporting construction of the health care occupancy shall be based on the story on which it is located in the building in accordance with the provisions of 19.1.6 and Table 19.1.6.1.
(2) The construction type of the areas of the building enclosing the other occupancies shall be based on the applicable occupancy chapters of this *Code*.

19.1.3.7 All means of egress from health care occupancies that traverse non-health care spaces shall conform to the requirements of this *Code* for health care occupancies, unless otherwise permitted by 19.1.3.8.

19.1.3.8 Exit through a horizontal exit into other contiguous occupancies that do not conform to health care egress provisions, but that do comply with requirements set forth in the appropriate occupancy chapter of this *Code*, shall be permitted, provided that both of the following criteria apply:

(1) The occupancy does not contain high hazard contents.
(2) The horizontal exit complies with the requirements of 19.2.2.5.

19.1.3.9 Egress provisions for areas of health care facilities that correspond to other occupancies shall meet the corresponding requirements of this *Code* for such occupancies, and, where the clinical needs of the occupant necessitate the locking of means of egress, staff shall be present for the supervised release of occupants during all times of use.

19.1.3.10 Auditoriums, chapels, staff residential areas, or other occupancies provided in connection with health care facilities shall have means of egress provided in accordance with other applicable sections of this *Code*.

19.1.3.11 Any area with a hazard of contents classified higher than that of the health care occupancy and located in the same building shall be protected as required by 19.3.2.

19.1.3.12 Non-health care–related occupancies classified as containing high hazard contents shall not be permitted in buildings housing health care occupancies.

19.1.4 Definitions.

19.1.4.1 General. For definitions, see Chapter 3, Definitions.

19.1.4.2 Special Definitions. The following is a list of special terms used in this chapter:

(1) **Ambulatory Health Care Occupancy.** *(See 3.3.190.1.)*
(2) **Deep-fat Frying.** *(See 3.3.55.)*
(3) **Hospital.** *(See 3.3.144.)*
(4) **Limited Care Facility.** *(See 3.3.90.2.)*
(5) **Nursing Home.** *(See 3.3.142.2.)*

19.1.5 Classification of Hazard of Contents. The classification of hazard of contents shall be as defined in Section 6.2.

19.1.6 Minimum Construction Requirements.

19.1.6.1 Health care occupancies shall be limited to the building construction types specified in Table 19.1.6.1, unless otherwise permitted by 19.1.6.2 through 19.1.6.7. *(See 8.2.1.)*

19.1.6.2* Any building of Type I(442), Type I(332), Type II(222), or Type II(111) construction shall be permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:

(1) The roof covering shall meet Class C requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.
(2) The roof shall be separated from all occupied portions of the building by a noncombustible floor assembly that includes not less than 2½ in. (63 mm) of concrete or gypsum fill.
(3) The attic or other space shall be either unoccupied or protected throughout by an approved automatic sprinkler system.

19.1.6.3 Any building of Type I(442), Type I(332), Type II(222), or Type II(111) construction shall be permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:

(1) The roof covering shall meet Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.
(2) The roof/ceiling assembly shall be constructed with fire-retardant-treated wood meeting the requirements of NFPA 220, *Standard on Types of Building Construction*.
(3) The roof/ceiling assembly shall have the required fire resistance rating for the type of construction.

19.1.6.4 Interior nonbearing walls in buildings of Type I or Type II construction shall be constructed of noncombustible or limited-combustible materials, unless otherwise permitted by 19.1.6.5.

19.1.6.5 Interior nonbearing walls required to have a fire resistance rating of 2 hours or less shall be permitted to be fire-retardant-treated wood enclosed within noncombustible or limited-combustible materials, provided that such walls are not used as shaft enclosures.

19.1.6.6 Fire-retardant-treated wood that serves as supports for the installation of fixtures and equipment shall be permitted to be installed behind noncombustible or limited-combustible sheathing.

19.1.6.7 Each exterior wall of frame construction and all interior stud partitions shall be firestopped to cut off all concealed draft openings, both horizontal and vertical, between any cellar or basement and the first floor, and such firestopping shall consist of wood not less than 2 in. (51 mm) (nominal) thick or shall be of noncombustible material.

19.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, either shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

19.2 Means of Egress Requirements.

19.2.1 General. Every aisle, passageway, corridor, exit discharge, exit location, and access shall be in accordance with Chapter 7, unless otherwise modified by 19.2.2 through 19.2.11.

Table 19.1.6.1 Construction Type Limitations

Construction Type	Sprinklered†	Total Number of Stories of Building‡			
		1	2	3	≥4
I (442)	Yes	X	X	X	X
	No	X	X	X	X
I (332)	Yes	X	X	X	X
	No	X	X	X	X
II (222)	Yes	X	X	X	X
	No	X	X	X	X
II (111)	Yes	X	X	X	NP
	No	X	NP	NP	NP
II (000)	Yes	X	X	NP	NP
	No	NP	NP	NP	NP
III (211)	Yes	X	X	NP	NP
	No	NP	NP	NP	NP
III (200)	Yes	X	NP	NP	NP
	No	NP	NP	NP	NP
IV (2HH)	Yes	X	X	NP	NP
	No	NP	NP	NP	NP
V (111)	Yes	X	X	NP	NP
	No	NP	NP	NP	NP
V (000)	Yes	X	NP	NP	NP
	No	NP	NP	NP	NP

X: Permitted. NP: Not permitted.
The total number of stories of the building is to be determined as follows:
(1) The total number of stories is to be counted starting with the level of exit discharge and ending with the highest occupiable story of the building.
(2) Stories below the level of exit discharge are not counted as stories.
(3) Interstitial spaces used solely for building or process systems directly related to the level above or below are not considered a separate story.
(4) A mezzanine in accordance with 8.6.9 is not counted as a story.
†Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7. *(See 19.3.5.)*
‡Basements are not counted as stories.

19.2.2 Means of Egress Components.

19.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 19.2.2.2 through 19.2.2.10.

19.2.2.2 Doors.

19.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

19.2.2.2.2 Locks shall not be permitted on patient sleeping room doors, unless otherwise permitted by one of the following:

(1) Key-locking devices that restrict access to the room from the corridor and that are operable only by staff from the corridor side shall be permitted, provided that such devices do not restrict egress from the room.
(2) Locks complying with 19.2.2.2.5 shall be permitted.

19.2.2.2.3 Doors not located in a required means of egress shall be permitted to be subject to locking.

19.2.2.2.4 Doors within a required means of egress shall not be equipped with a latch or lock that requires the use of a tool or key from the egress side, unless otherwise permitted by one of the following:

(1) Locks complying with 19.2.2.2.5 shall be permitted.
(2)*Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.
(3)*Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.
(4) Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.
(5) Approved existing door-locking installations shall be permitted.

19.2.2.2.5 Door-locking arrangements shall be permitted in accordance with either 19.2.2.2.5.1 or 19.2.2.2.5.2.

19.2.2.2.5.1* Door-locking arrangements shall be permitted where the clinical needs of patients require specialized security measures or where patients pose a security threat, provided that staff can readily unlock doors at all times in accordance with 19.2.2.2.6.

19.2.2.2.5.2* Door-locking arrangements shall be permitted where patient special needs require specialized protective measures for their safety, provided that all of the following are met:

(1) Staff can readily unlock doors at all times in accordance with 19.2.2.2.6.
(2) A total (complete) smoke detection system is provided throughout the locked space in accordance with 9.6.2.9, or locked doors can be remotely unlocked at an approved, constantly attended location within the locked space.
(3)*The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7.
(4) The locks are electrical locks that fail safely so as to release upon loss of power to the device.
(5) The locks release by independent activation of each of the following:
  (a) Activation of the smoke detection system required by 19.2.2.2.5.2(2)
  (b) Waterflow in the automatic sprinkler system required by 19.2.2.2.5.2(3)

19.2.2.2.6 Doors that are located in the means of egress and are permitted to be locked under other provisions of 19.2.2.2.5 shall comply with all of the following:

(1) Provisions shall be made for the rapid removal of occupants by means of one of the following:
  (a) Remote control of locks
  (b) Keying of all locks to keys carried by staff at all times
  (c) Other such reliable means available to the staff at all times
(2) Only one locking device shall be permitted on each door.
(3) More than one lock shall be permitted on each door, subject to approval of the authority having jurisdiction.

19.2.2.2.7* Doors permitted to be locked in accordance with 19.2.2.2.5.1 shall be permitted to have murals on the egress doors to disguise the doors, provided all of the following are met:

(1) Staff can readily unlock the doors at all times in accordance with 19.2.2.2.6.
(2)*The door-releasing hardware, where provided, is readily accessible for staff use.
(3)*Door leaves, windows, and door hardware, other than door-releasing hardware, are permitted to be covered by the murals.
(4) The murals do not impair the operation of the doors.
(5) The affected smoke compartments are protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7.
(6) The location and operation of doors disguised with murals are identified in the fire safety plan and are included in staff training.

19.2.2.2.8* Any door in an exit passageway, stairway enclosure, horizontal exit, smoke barrier, or hazardous area enclosure shall be permitted to be held open only by an automatic release device that complies with 7.2.1.8.2. The automatic sprinkler system, if provided, and the fire alarm system, and the systems required by 7.2.1.8.2, shall be arranged to initiate the closing action of all such doors throughout the smoke compartment or throughout the entire facility.

19.2.2.2.9 Where doors in a stair enclosure are held open by an automatic release device as permitted in 19.2.2.2.8, initiation of a door-closing action on any level shall cause all doors at all levels in the stair enclosure to close.

19.2.2.2.10* Existing health care occupancies shall be exempt from the re-entry provisions of 7.2.1.5.8.

19.2.2.2.11 Horizontal-sliding doors shall be permitted in accordance with 19.2.2.2.11.1 or 19.2.2.2.11.2.

19.2.2.2.11.1 Horizontal-sliding doors that are not automatic-closing shall be limited to a single leaf and shall have a latch or other mechanism that ensures that the doors will not rebound into a partially open position if forcefully closed.

19.2.2.2.11.2 Horizontal-sliding doors serving an occupant load of fewer than 10 shall be permitted, provided that all of the following criteria are met:

(1) The area served by the door has no high hazard contents.
(2) The door is readily operable from either side without special knowledge or effort.
(3) The force required to operate the door in the direction of door travel is not more than 30 lbf (133 N) to set the door in motion and is not more than 15 lbf (67 N) to close the door or open it to the minimum required width.
(4) The door assembly complies with any required fire protection rating and, where rated, is self-closing or automatic-closing by means of smoke detection in accordance with 7.2.1.8 and is installed in accordance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.
(5) Where corridor doors are required to latch, the doors are equipped with a latch or other mechanism that ensures that the doors will not rebound into a partially open position if forcefully closed.

19.2.2.3 Stairs. Stairs complying with 7.2.2 shall be permitted.

19.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

19.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 and the modifications of 19.2.2.5.1 through 19.2.2.5.4 shall be permitted.

19.2.2.5.1 Accumulation space shall be provided in accordance with 19.2.2.5.1.1 and 19.2.2.5.1.2.

19.2.2.5.1.1 Not less than 30 net ft^2 (2.8 net m^2) per patient in a hospital or nursing home, or not less than 15 net ft^2 (1.4 net m^2) per resident in a limited care facility, shall be provided within the aggregated area of corridors, patient rooms, treatment rooms, lounge or dining areas, and other similar areas on each side of the horizontal exit.

19.2.2.5.1.2 On stories not housing bedridden or litterborne patients, not less than 6 net ft^2 (0.56 net m^2) per occupant shall be provided on each side of the horizontal exit for the total number of occupants in adjoining compartments.

19.2.2.5.2 The total egress capacity of the other exits (stairs, ramps, doors leading outside the building) shall not be reduced below one-third of that required for the entire area of the building.

19.2.2.5.3* A door in a horizontal exit shall not be required to swing with egress travel as specified in 7.2.4.3.8(1).

19.2.2.5.4 Door openings in horizontal exits shall be protected by one of the following methods:

(1) Such door openings shall be protected by a swinging door providing a clear width of not less than 32 in. (810 mm).
(2) Such door openings shall be protected by a special-purpose horizontally sliding accordion or folding door assemblies that complies with 7.2.1.14 and provides a clear width of not less than 32 in. (810 mm).
(3) Such door openings shall be protected by an existing 34 in. (865 mm) swinging door.

19.2.2.6 Ramps.

19.2.2.6.1 Ramps complying with 7.2.5 shall be permitted.

19.2.2.6.2 Ramps enclosed as exits shall be of sufficient width to provide egress capacity in accordance with 19.2.3.

19.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

19.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

19.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

19.2.2.10 Areas of Refuge. Areas of refuge used as part of a required accessible means of egress shall comply with 7.2.12.

19.2.3 Capacity of Means of Egress.

19.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

19.2.3.2 The capacity of means of egress providing travel by means of stairs shall be 0.6 in. (15 mm) per person, and the capacity of means of egress providing horizontal travel (without stairs) by means such as doors, ramps, or horizontal exits shall be ½ in. (13 mm) per person, unless otherwise permitted by 19.2.3.3.

19.2.3.3 The capacity of means of egress in health care occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7 shall be 0.3 in. (7.6 mm) per person for travel by means of stairs and 0.2 in. (5 mm) per person for horizontal travel without stairs.

19.2.3.4* Any required aisle, corridor, or ramp shall be not less than 48 in. (1220 mm) in clear width where serving as means of egress from patient sleeping rooms, unless otherwise permitted by one of the following:

(1) Aisles, corridors, and ramps in adjunct areas not intended for the housing, treatment, or use of inpatients shall be not less than 44 in. (1120 mm) in clear and unobstructed width.
(2)*Where corridor width is at least 6 ft (1830 mm), noncontinuous projections not more than 6 in. (150 mm) from the corridor wall, above the handrail height, shall be permitted.
(3) Exit access within a room or suite of rooms complying with the requirements of 19.2.5 shall be permitted.
(4) Projections into the required width shall be permitted for wheeled equipment, provided that all of the following conditions are met:
  (a) The wheeled equipment does not reduce the clear unobstructed corridor width to less than 60 in. (1525 mm).
  (b) The health care occupancy fire safety plan and training program address the relocation of the wheeled equipment during a fire or similar emergency.
  (c)*The wheeled equipment is limited to the following:
    i. Equipment in use and carts in use
    ii. Medical emergency equipment not in use
    iii. Patient lift and transport equipment
(5)*Where the corridor width is at least 8 ft (2440 mm), projections into the required width shall be permitted for fixed furniture, provided that all of the following conditions are met:
  (a) The fixed furniture is securely attached to the floor or to the wall.
  (b) The fixed furniture does not reduce the clear unobstructed corridor width to less than 6 ft (1830 mm), except as permitted by 19.2.3.4(2).
  (c) The fixed furniture is located only on one side of the corridor.
  (d) The fixed furniture is grouped such that each grouping does not exceed an area of 50 ft^2 (4.6 m^2).
  (e) The fixed furniture groupings addressed in 19.2.3.4(5)(d) are separated from each other by a distance of at least 10 ft (3050 mm).
  (f)*The fixed furniture is located so as to not obstruct access to building service and fire protection equipment.
  (g) Corridors throughout the smoke compartment are protected by an electrically supervised automatic smoke detection system in accordance with 19.3.4, or the fixed furniture spaces are arranged and located to allow direct supervision by the facility staff from a nurses' station or similar space.
  (h) The smoke compartment is protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.8.

19.2.3.5 The aisle, corridor, or ramp shall be arranged to avoid any obstructions to the convenient removal of nonambulatory persons carried on stretchers or on mattresses serving as stretchers.

19.2.3.6 The minimum clear width for doors in the means of egress from hospitals, nursing homes, limited care facilities, psychiatric hospital sleeping rooms, and diagnostic and treatment areas, such as x-ray, surgery, or physical therapy, shall be not less than 32 in. (810 mm) wide.

19.2.3.7 The requirement of 19.2.3.6 shall not apply where otherwise permitted by the following:

(1) Existing 34 in. (865 mm) doors shall be permitted.
(2) Existing 28 in. (710 mm) corridor doors in facilities where the fire plans do not require evacuation by bed, gurney, or wheelchair shall be permitted.

19.2.4 Number of Means of Egress.

19.2.4.1 The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.

19.2.4.2 Not less than two exits shall be provided on every story.

19.2.4.3 Not less than two separate exits shall be accessible from every part of every story.

19.2.4.4* Not less than two exits shall be accessible from each smoke compartment, and egress shall be permitted through an adjacent compartment(s), provided that the two required egress paths are arranged so that both do not pass through the same adjacent smoke compartment.

19.2.5 Arrangement of Means of Egress.

19.2.5.1 General. Arrangement of means of egress shall comply with Section 7.5.

19.2.5.2* Dead-End Corridors. Existing dead-end corridors not exceeding 30 ft (9.1 m) shall be permitted. Existing dead-end corridors exceeding 30 ft (9.1 m) shall be permitted to continue in use if it is impractical and unfeasible to alter them.

19.2.5.3 Reserved.

19.2.5.4* Intervening Rooms or Spaces. Every corridor shall provide access to not less than two approved exits in accordance with Sections 7.4 and 7.5 without passing through any intervening rooms or spaces other than corridors or lobbies.

19.2.5.5 Two Means of Egress.

19.2.5.5.1 Sleeping rooms of more than 1000 ft^2 (93 m^2) shall have not less than two exit access doors remotely located from each other.

19.2.5.5.2 Non-sleeping rooms of more than 2500 ft^2 (230 m^2) shall have not less than two exit access doors remotely located from each other.

19.2.5.6 Corridor Access.

19.2.5.6.1* Every habitable room shall have an exit access door leading directly to an exit access corridor, unless otherwise provided in 19.2.5.6.2, 19.2.5.6.3, and 19.2.5.6.4.

19.2.5.6.2 Exit access from a patient sleeping room with not more than eight patient beds shall be permitted to pass through one intervening room to reach an exit access corridor, provided that the intervening room is equipped with an approved automatic smoke detection system in accordance with Section 9.6, or the furnishings and furniture, in combination with all other combustibles within the area, are of such minimum quantity and arrangements that a fully developed fire is unlikely to occur.

19.2.5.6.3 Rooms having an exit door opening directly to the outside from the room at the finished ground level shall not be required to have an exit access door leading directly to an exit access corridor.

19.2.5.6.4 Rooms within suites complying with 19.2.5.7 shall not be required to have an exit access door leading directly to an exit access corridor.

19.2.5.7 Suites.

19.2.5.7.1 General.

19.2.5.7.1.1 Suite Permission. Suites complying with 19.2.5.7 shall be permitted to be used to meet the corridor access requirements of 19.2.5.6.

19.2.5.7.1.2* Suite Separation. Suites shall be separated from the remainder of the building, and from other suites, by one of the following:

(1) Walls and doors meeting the requirements of 19.3.6.2 through 19.3.6.5
(2) Existing approved barriers and doors that limit the transfer of smoke

19.2.5.7.1.3 Suite Hazardous Contents Areas.

(A)* Intervening rooms shall not be hazardous areas as defined by 19.3.2.

(B) Hazardous areas within a suite shall be separated from the remainder of the suite in accordance with 19.3.2.1, unless otherwise provided in 19.2.5.7.1.3(C) or 19.2.5.7.1.3(D).

(C)* Hazardous areas within a suite shall not be required to be separated from the remainder of the suite where complying with both of the following:

(1) The suite is primarily a hazardous area.
(2) The suite is separated from the rest of the health care facility as required for a hazardous area by 19.3.2.1.

(D)* Spaces containing sterile surgical materials limited to a one-day supply in operating suites or similar spaces that are sprinklered in accordance with 19.3.5.7 shall be permitted to be open to the remainder of the suite without separation.

19.2.5.7.1.4 Suite Subdivision. The subdivision of suites shall be by means of noncombustible or limited-combustible partitions or partitions constructed with fire-retardant-treated wood enclosed with noncombustible or limited-combustible materials, and such partitions shall not be required to be fire rated.

19.2.5.7.2 Sleeping Suites. Sleeping suites shall be in accordance with the following:

(1) Sleeping suites for patient care shall comply with the provisions of 19.2.5.7.2.1 through 19.2.5.7.2.4.
(2) Sleeping suites not for patient care shall comply with the provisions of 19.2.5.7.4.

19.2.5.7.2.1 Sleeping Suite Supervision.

(A) Sleeping suites shall be provided with constant staff supervision within the suite.

(B)* Sleeping suites shall be arranged in accordance with one of the following:

(1)*Patient sleeping rooms within sleeping suites shall provide one of the following:
   (a) The patient sleeping rooms shall be arranged to allow for direct supervision from a normally attended location within the suite, such as is provided by glass walls, and cubicle curtains shall be permitted.
   (b) Any patient sleeping rooms without the direct supervision required by 19.2.5.7.2.1(B)(1)(a) shall be provided with smoke detection in accordance with Section 9.6 and 19.3.4.
(2) Sleeping suites shall be provided with a total (complete) coverage automatic smoke detection system in accordance with 9.6.2.9 and 19.3.4.

19.2.5.7.2.2 Sleeping Suite Means of Egress.

(A)* Sleeping suites shall have exit access to a corridor complying with 19.3.6 or to a horizontal exit, directly from the suite.

(B) Sleeping suites of more than 1000 ft^2 (93 m^2) shall have not less than two exit access doors remotely located from each other.

(C)* For suites requiring two exit access doors, one of the exit access doors from the suite shall be permitted to be to one of the following:

(1) An exit stair
(2) An exit passageway
(3) An exit door to the exterior
(4) Another suite, provided that the separation between the suites complies with the corridor requirements of 19.3.6.2 through 19.3.6.5

19.2.5.7.2.3 Sleeping Suite Maximum Size.

(A) Sleeping suites shall not exceed 5000 ft^2 (460 m^2), unless otherwise provided in 19.2.5.7.2.3(B) or 19.2.5.7.2.3(C).

(B) Sleeping suites shall not exceed 7500 ft^2 (700 m^2) where the smoke compartment is protected throughout by one of the following:

(1) Approved electrically supervised sprinkler system in accordance with 19.3.5.7 and total (complete) coverage automatic smoke detection in accordance with 9.6.2.9 and 19.3.4
(2) Approved electrically supervised sprinkler system protection complying with 19.3.5.8

(C) Sleeping suites greater than 7500 ft^2 (700 m^2), and not exceeding 10,000 ft^2 (930 m^2), shall be permitted where all of the following are provided in the suite:

(1)*Direct visual supervision in accordance with 19.2.5.7.2.1(B)(1)(a)
(2) Total (complete) coverage automatic smoke detection in accordance with 9.6.2.9 and 19.3.4
(3) Approved electrically supervised sprinkler system protection complying with 19.3.5.8

19.2.5.7.2.4 Sleeping Suite Travel Distance.

(A) Travel distance between any point in a sleeping suite and an exit access door to another suite, an exit access corridor door, or a horizontal exit door from that suite shall not exceed 100 ft (30 m).

(B) Travel distance between any point in a sleeping suite and an exit shall not exceed the following:

(1) 150 ft (46 m) if the building is not protected throughout by an approved electrically supervised sprinkler system complying with 19.3.5.7
(2) 200 ft (61 m) if the building is protected throughout by an approved electrically supervised sprinkler system complying with 19.3.5.7

19.2.5.7.3 Patient Care Non-Sleeping Suites. Non-sleeping suites shall be in accordance with the following:

(1) Non-sleeping suites for patient care shall comply with the provisions of 19.2.5.7.3.1 through 19.2.5.7.3.3.
(2) Non-sleeping suites not for patient care shall comply with the provisions of 19.2.5.7.4.

19.2.5.7.3.1 Patient Care Non-Sleeping Suite Means of Egress.

(A) Patient care non-sleeping suites shall have exit access to a corridor complying with 19.3.6 or to a horizontal exit, directly from the suite.

(B) Patient care non-sleeping suites of more than 2500 ft^2 (230 m^2) shall have not less than two exit access doors remotely located from each other.

(C)* For suites requiring two exit access doors, one of the exit access doors shall be permitted to be to one of the following:

(1) An exit stair
(2) An exit passageway
(3) An exit door to the exterior
(4) Another suite, provided that the separation between the suites complies with the corridor requirements of 19.3.6.2 through 19.3.6.5.

19.2.5.7.3.2 Patient Care Non-Sleeping Suite Maximum Size. Non-sleeping suites shall not exceed 10,000 ft^2 (930 m^2), unless otherwise provided in 19.2.5.7.3.2(A) or 19.2.5.7.3.2(B).

(A) Non-sleeping suites greater than 10,000 ft^2 (930 m^2) and not exceeding 12,500 ft^2 (1161 m^2) shall be permitted where the smoke compartment is protected throughout by one of the following:

(1) Approved electrically supervised sprinkler system in accordance with 19.3.5.7 and total (complete) coverage automatic smoke detection in accordance with 9.6.2.9 and 19.3.4
(2) Approved electrically supervised sprinkler system protection complying with 19.3.5.8

(B) Non-sleeping suites greater than 12,500 ft^2(1161 m^2) and not exceeding 15,000 ft^2 (1394 m^2) shall be permitted where both of the following are provided in the suite:

(1) Total (complete) coverage automatic smoke detection in accordance with 9.6.2.9 and 19.3.4
(2) Approved electrically supervised sprinkler system protection complying with 19.3.5.8

19.2.5.7.3.3 Patient Care Non-Sleeping Suite Travel Distance.

(A) Travel distance within a non-sleeping suite to an exit access door to another suite, an exit access corridor door, or a horizontal exit door from the suite shall not exceed 100 ft (30 m).

(B) Travel distance between any point in a non-sleeping suite and an exit shall not exceed the following:

(1) 150 ft (46 m) if the building is not protected throughout by an approved electrically supervised sprinkler system complying with 19.3.5.7
(2) 200 ft (61 m) if the building is protected throughout by an approved electrically supervised sprinkler system complying with 19.3.5.7

19.2.5.7.4 Non-Patient-Care Suites. The egress provisions for non-patient-care suites shall be in accordance with the primary use and occupancy of the space.

19.2.6 Travel Distance to Exits.

19.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

19.2.6.2 Travel distance shall comply with 19.2.6.2.1 through 19.2.6.2.4.

19.2.6.2.1 The travel distance between any point in a room and an exit shall not exceed 150 ft (46 m), unless otherwise permitted by 19.2.6.2.2.

19.2.6.2.2 The maximum travel distance specified in 19.2.6.2.1 shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7.

19.2.6.2.3 The travel distance between any point in a health care sleeping room and an exit access door in that room shall not exceed 50 ft (15 m).

19.2.6.2.4 The travel distance within suites shall be in accordance with 19.2.5.7.

19.2.7 Discharge from Exits. Discharge from exits shall be arranged in accordance with Section 7.7.

19.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

19.2.9 Emergency Lighting.

19.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9.

19.2.9.2 Reserved.

19.2.10 Marking of Means of Egress.

19.2.10.1 Means of egress shall have signs in accordance with Section 7.10, unless otherwise permitted by 19.2.10.2, 19.2.10.3, or 19.2.10.4.

19.2.10.2 Where the path of egress travel is obvious, signs shall not be required in one-story buildings with an occupant load of fewer than 30 persons.

19.2.10.3 Where the path of egress travel is obvious, signs shall not be required at gates in outside secured areas.

19.2.10.4 Access to exits within rooms or sleeping suites shall not be required to be marked where staff is responsible for relocating or evacuating occupants.

19.2.11 Special Means of Egress Features. (Reserved)

19.3 Protection.

19.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed or protected in accordance with Section 8.6, unless otherwise modified by 19.3.1.1 through 19.3.1.8.

19.3.1.1 Where enclosure is provided, the construction shall have not less than a 1-hour fire resistance rating.

19.3.1.2 Unprotected vertical openings in accordance with 8.6.9.1 shall be permitted.

19.3.1.3 Subparagraph 8.6.7(1)(b) shall not apply to patient sleeping and treatment rooms.

19.3.1.4 Multilevel patient sleeping areas in psychiatric facilities shall be permitted without enclosure protection between levels, provided that all of the following conditions are met:

(1) The entire normally occupied area, including all communicating floor levels, is sufficiently open and unobstructed so that a fire or other dangerous condition in any part is obvious to the occupants or supervisory personnel in the area.
(2) The egress capacity provides simultaneously for all the occupants of all communicating levels and areas, with all communicating levels in the same fire area being considered as a single floor area for purposes of determination of required egress capacity.
(3) The height between the highest and lowest finished floor levels does not exceed 13 ft (3960 mm), and the number of levels is permitted to be unrestricted.

19.3.1.5 Unprotected openings in accordance with 8.6.6 shall not be permitted.

19.3.1.6 Where a full enclosure of a stairway that is not a required exit is impracticable, the required enclosure shall be permitted to be limited to that necessary to prevent a fire originating in any story from spreading to any other story.

19.3.1.7 A door in a stair enclosure shall be self-closing and shall normally be kept in the closed position, unless otherwise permitted by 19.3.1.8.

19.3.1.8 Doors in stair enclosures shall be permitted to be held open under the conditions specified by 19.2.2.2.7 and 19.2.2.2.8.

19.3.2 Protection from Hazards.

19.3.2.1 Hazardous Areas. Any hazardous areas shall be safeguarded by a fire barrier having a 1-hour fire resistance rating or shall be provided with an automatic extinguishing system in accordance with 8.7.1.

19.3.2.1.1 An automatic extinguishing system, where used in hazardous areas, shall be permitted to be in accordance with 19.3.5.9.

19.3.2.1.2* Where the sprinkler option of 19.3.2.1 is used, the areas shall be separated from other spaces by smoke partitions in accordance with Section 8.4.

19.3.2.1.3 The doors shall be self-closing or automatic-closing.

19.3.2.1.4 Doors in rated enclosures shall be permitted to have nonrated, factory- or field-applied protective plates extending not more than 48 in. (1220 mm) above the bottom of the door.

19.3.2.1.5 Hazardous areas shall include, but shall not be restricted to, the following:

(1) Boiler and fuel-fired heater rooms
(2) Central/bulk laundries larger than 100 ft^2 (9.3 m^2)
(3) Paint shops
(4) Repair shops
(5) Rooms with soiled linen in volume exceeding 64 gal (242 L)
(6) Rooms with collected trash in volume exceeding 64 gal (242 L)
(7) Rooms or spaces larger than 50 ft^2 (4.6 m^2), including repair shops, used for storage of combustible supplies and equipment in quantities deemed hazardous by the authority having jurisdiction
(8) Laboratories employing flammable or combustible materials in quantities less than those that would be considered a severe hazard

19.3.2.2 Laboratories.

19.3.2.2.1 Laboratories in which chemicals are handled or stored shall comply with the operational requirements of NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

19.3.2.2.2 Laboratories employing quantities of flammable, combustible, or hazardous materials that are considered a severe hazard shall be protected in accordance with 8.7.1.1.

19.3.2.3 Hyperbaric Chambers. Health care occupancies housing hyperbaric chambers shall comply with 8.7.5.

19.3.2.4 Medical Gas. Medical gas storage shall be in accordance with Section 8.7 and the provisions of NFPA 99, *Health Care Facilities Code*, applicable to operation, maintenance, and testing.

19.3.2.5 Cooking Facilities.

19.3.2.5.1 Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 19.3.2.5.2, 19.3.2.5.3, or 19.3.2.5.4.

19.3.2.5.2* Where residential cooking equipment is used for food warming or limited cooking, the equipment shall not be required to be protected in accordance with 9.2.3, and the presence of the equipment shall not require the area to be protected as a hazardous area.

19.3.2.5.3* Within a smoke compartment, where residential or commercial cooking equipment is used to prepare meals for 30 or fewer persons, one cooking facility shall be permitted to be open to the corridor, provided that all of the following conditions are met:

(1) The portion of the health care facility served by the cooking facility is limited to 30 beds and is separated from other portions of the health care facility by a smoke barrier constructed in accordance with 19.3.7.3, 19.3.7.6, and 19.3.7.8.
(2) The cooktop or range is equipped with a range hood of a width at least equal to the width of the cooking surface, with grease baffles or other grease-collecting and clean-out capability.
(3)*The hood systems have a minimum airflow of 500 cfm (14,000 L/min).
(4) The hood systems that are not ducted to the exterior additionally have a charcoal filter to remove smoke and odor.
(5) The cooktop or range complies with all of the following:
  (a) The cooktop or range is protected with a fire suppression system listed in accordance with ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment*, or is tested and meets all requirements of UL 300A, *Extinguishing System Units for Residential Range Top Cooking Surfaces*, in accordance with the applicable testing document's scope.
  (b) A manual release of the extinguishing system is provided in accordance with Section 10.5 of NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.
  (c) An interlock is provided to turn off all sources of fuel and electrical power to the cooktop or range when the suppression system is activated.
(6)*The use of solid fuel for cooking is prohibited.
(7) Deep-fat frying is prohibited.
(8) Portable fire extinguishers in accordance with NFPA 96 are located in all kitchen areas.
(9)*A switch meeting all of the following is provided:
  (a) A locked switch, or a switch located in a restricted location, is provided within the cooking facility that deactivates the cooktop or range.
  (b) The switch is used to deactivate the cooktop or range whenever the kitchen is not under staff supervision.
  (c) The switch is on a timer, not exceeding a 120-minute capacity, that automatically deactivates the cooktop or range, independent of staff action.
(10) Procedures for the use, inspection, testing, and maintenance of the cooking equipment are in accordance with Chapter 11 of NFPA 96 and the manufacturer's instructions are followed.
(11)*Not less than two AC-powered photoelectric smoke alarms with battery backup, interconnected in accordance with 9.6.2.10.3, and equipped with a silence feature are located not closer than 20 ft (6.1 m) and not further than 25 ft (7.6 m) from the cooktop or range.
(12)*The smoke alarms required by 19.3.2.5.3(11) are permitted to be located outside the kitchen area where such placement is necessary for compliance with the 20 ft (7.6 m) minimum distance criterion.
(13)*A single system smoke detector is permitted to be installed in lieu of the smoke alarms required in 19.3.2.5.3(11) provided the following criteria are met:
  (a) The detector is located not closer than 20 ft (6.1 m) and not further than 25 ft (7.6 m) from the cooktop or range.
  (b) The detector is permitted to initiate a local audible alarm signal only.
  (c) The detector is not required to initiate a building-wide occupant notification signal.
  (d) The detector is not required to notify the emergency forces.
  (e) The local audible signal initiated by the detector is permitted to be silenced and reset by a button on the detector or by a switch installed within 10 ft (3.0 m) of the system smoke detector.
(14) System smoke detectors that are required to be installed in corridors or spaces open to the corridor by other sections of this chapter are not used to meet the requirements of 19.3.2.5.3(11) and are located not closer than 25 ft (7.6 m) to the cooktop or range.
(15) The smoke compartment is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

19.3.2.5.4* Within a smoke compartment, residential or commercial cooking equipment that is used to prepare meals for 30 or fewer persons shall be permitted, provided that the cooking facility complies with all of the following conditions:

(1) The space containing the cooking equipment is not a sleeping room.
(2) The space containing the cooking equipment shall be separated from the corridor by partitions complying with 19.3.6.2 through 19.3.6.5.
(3) The requirements of 19.3.2.5.3(1) through (10) and (13) are met.

19.3.2.5.5* Where cooking facilities are protected in accordance with 9.2.3, the presence of the cooking equipment shall not cause the room or space housing the equipment to be classified as a hazardous area with respect to the requirements of 19.3.2.1, and the room or space shall not be permitted to be open to the corridor.

19.3.3 Interior Finish.

19.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

19.3.3.2* Interior Wall and Ceiling Finish. Existing interior wall and ceiling finish materials complying with Section 10.2 shall be permitted to be Class A or Class B.

19.3.3.3 Interior Floor Finish. No restrictions shall apply to existing interior floor finish.

19.3.4 Detection, Alarm, and Communications Systems.

19.3.4.1 General. Health care occupancies shall be provided with a fire alarm system in accordance with Section 9.6.

19.3.4.2* Initiation.

19.3.4.2.1 Initiation of the required fire alarm systems shall be by manual means in accordance with 9.6.2 and by means of any required sprinkler system waterflow alarms, detection devices, or detection systems, unless otherwise permitted by 19.3.4.2.2 through 19.3.4.2.5.

19.3.4.2.2 Manual fire alarm boxes in patient sleeping areas shall not be required at exits if located at all nurses' control stations or other continuously attended staff location, provided that both of the following criteria are met:

(1) Such manual fire alarm boxes are visible and continuously accessible.
(2) Travel distances required by 9.6.2.5 are not exceeded.

19.3.4.2.3 The system smoke detector installed in accordance with 19.3.2.5.3(13) shall not be required to initiate the fire alarm system.

19.3.4.2.4 Fixed extinguishing systems protecting commercial cooking equipment in kitchens that are protected by a complete automatic sprinkler system shall not be required to initiate the fire alarm system.

19.3.4.2.5 Detectors required by 19.7.5.3 and 19.7.5.5 shall not be required to initiate the fire alarm system.

19.3.4.3 Notification. Positive alarm sequence in accordance with 9.6.3.4 shall be permitted in health care occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

19.3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 9.6.3, unless otherwise modified by the following:

(1)*In lieu of audible alarm signals, visible alarm-indicating appliances shall be permitted to be used in critical care areas.
(2) Where visual devices have been installed in patient sleeping areas in place of an audible alarm, they shall be permitted where approved by the authority having jurisdiction.
(3) The provision of 19.3.2.5.3(13)(c) shall be permitted to be used.

19.3.4.3.2 Emergency Forces Notification.

19.3.4.3.2.1 Emergency forces notification shall be accomplished in accordance with 9.6.4, except that the provision of 19.3.2.5.3(13)(d) shall be permitted to be used.

19.3.4.3.2.2 Smoke detection devices or smoke detection systems equipped with reconfirmation features shall not be required to automatically notify the fire department, unless the alarm condition is reconfirmed after a period not exceeding 120 seconds.

19.3.4.3.3 Reserved.

19.3.4.4 Fire Safety Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically any control functions to be performed by that device. *(See 9.6.5.)*

19.3.4.5 Detection.

19.3.4.5.1 Corridors. An approved automatic smoke detection system in accordance with Section 9.6 shall be installed in all corridors of limited care facilities, unless otherwise permitted by one of the following:

(1) Where each patient sleeping room is protected by an approved smoke detection system, and a smoke detector is provided at smoke barriers and horizontal exits in accordance with Section 9.6, the corridor smoke detection system shall not be required on the patient sleeping room floors.
(2) Smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7 shall be permitted.

19.3.4.5.2 Detection in Spaces Open to Corridors. See 19.3.6.1.

19.3.5 Extinguishment Requirements.

19.3.5.1 Buildings containing nursing homes shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, unless otherwise permitted by 19.3.5.5.

19.3.5.2 High-rise buildings shall comply with 19.4.2.

19.3.5.3 Where required by 19.1.6, buildings containing hospitals or limited care facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, unless otherwise permitted by 19.3.5.5.

19.3.5.4* The sprinkler system required by 19.3.5.1 or 19.3.5.3 shall be installed in accordance with 9.7.1.1(1).

19.3.5.5 In Type I and Type II construction, alternative protection measures shall be permitted to be substituted for sprinkler protection in specified areas where the authority having jurisdiction has prohibited sprinklers, without causing a building to be classified as nonsprinklered.

19.3.5.6 Reserved.

19.3.5.7* Where this *Code* permits exceptions for fully sprinklered buildings or smoke compartments, the sprinkler system shall meet all of the following criteria:

(1) It shall be in accordance with Section 9.7.
(2) It shall be installed in accordance with 9.7.1.1(1), unless it is an approved existing system.
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.
(5) In Type I and Type II construction, where the authority having jurisdiction has prohibited sprinklers, approved alternative protection measures shall be permitted to be substituted for sprinkler protection in specified areas without causing a building to be classified as nonsprinklered.

19.3.5.8* Where this *Code* permits exceptions for fully sprinklered buildings or smoke compartments and specifically references this paragraph, the sprinkler system shall meet all of the following criteria:

(1) It shall be installed throughout the building or smoke compartment in accordance with Section 9.7.
(2) It shall be installed in accordance with 9.7.1.1(1), unless it is an approved existing system.
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.
(5) It shall be equipped with listed quick-response or listed residential sprinklers throughout all smoke compartments containing patient sleeping rooms.
(6)*Standard-response sprinklers shall be permitted to be continued to be used in approved existing sprinkler systems where quick-response and residential sprinklers were not listed for use in such locations at the time of installation.
(7) Standard-response sprinklers shall be permitted for use in hazardous areas protected in accordance with 19.3.2.1.

19.3.5.9 Isolated hazardous areas shall be permitted to be protected in accordance with 9.7.1.2. For new installations in existing health care occupancies, where more than two sprinklers are installed in a single area, waterflow detection shall be provided to sound the building fire alarm or to notify, by a signal, any constantly attended location, such as PBX, security, or emergency room, at which the necessary corrective action shall be taken.

19.3.5.10* Sprinklers shall not be required in clothes closets of patient sleeping rooms in hospitals where the area of the closet does not exceed 6 ft^2 (0.55 m^2), provided that the distance from the sprinkler in the patient sleeping room to the back wall of the closet does not exceed the maximum distance permitted by NFPA 13, *Standard for the Installation of Sprinkler Systems*.

19.3.5.11* Newly introduced cubicle curtains in sprinklered areas shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

19.3.5.12 Portable fire extinguishers shall be provided in all health care occupancies in accordance with Section 9.9.

19.3.6 Corridors.

19.3.6.1 Corridor Separation. Corridors shall be separated from all other areas by partitions complying with 19.3.6.2 through 19.3.6.5 *(see also 19.2.5.4)*, unless otherwise permitted by one of the following:

(1) Smoke compartments protected throughout by an approved supervised automatic sprinkler system in accordance with 19.3.5.8 shall be permitted to have spaces that are unlimited in size and open to the corridor, provided that all of the following criteria are met:
   (a)*The spaces are not used for patient sleeping rooms, treatment rooms, or hazardous areas.
   (b) The corridors onto which the spaces open in the same smoke compartment are protected by an electrically supervised automatic smoke detection system in accordance with 19.3.4, or the smoke compartment in which the space is located is protected throughout by quick-response sprinklers.
   (c) The open space is protected by an electrically supervised automatic smoke detection system in accordance with 19.3.4, or the entire space is arranged and located to allow direct supervision by the facility staff from a nurses' station or similar space.
   (d) The space does not obstruct access to required exits.
(2) In smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.8, waiting areas shall be permitted to be open to the corridor, provided that all of the following criteria are met:
   (a) The aggregate waiting area in each smoke compartment does not exceed 600 ft^2 (55.7 m^2).
   (b) Each area is protected by an electrically supervised automatic smoke detection system in accordance with 19.3.4, or each area is arranged and located to allow direct supervision by the facility staff from a nursing station or similar space.
   (c) The area does not obstruct access to required exits.
(3)*This requirement shall not apply to spaces for nurses' stations.
(4) Gift shops not exceeding 500 ft^2 (46.4 m^2) shall be permitted to be open to the corridor or lobby, provided that one of the following criteria is met:
   (a) The building is protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.
   (b) The gift shop is protected throughout by an approved automatic sprinkler system in accordance with Section 9.7, and storage is separately protected.
(5) Limited care facilities in smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.8 shall be permitted to have group meeting or multipurpose therapeutic spaces open to the corridor, provided that all of the following criteria are met:
   (a) The space is not a hazardous area.
   (b) The space is protected by an electrically supervised automatic smoke detection system in accordance with 19.3.4, or the space is arranged and located to allow direct supervision by the facility staff from the nurses' station or similar location.
   (c) The space does not obstruct access to required exits.
(6) Cooking facilities in accordance with 19.3.2.5.3 shall be permitted to be open to the corridor.
(7) Spaces, other than patient sleeping rooms, treatment rooms, and hazardous areas, shall be permitted to be open to the corridor and unlimited in area, provided that all of the following criteria are met:
   (a) The space and the corridors onto which it opens, where located in the same smoke compartment, are protected by an electrically supervised automatic smoke detection system in accordance with 19.3.4.
   (b)*Each space is protected by automatic sprinklers, or the furnishings and furniture, in combination with all other combustibles within the area, are of such minimum quantity and arrangement that a fully developed fire is unlikely to occur.
   (c) The space does not obstruct access to required exits.
(8)*Waiting areas shall be permitted to be open to the corridor, provided that all of the following criteria are met:
   (a) Each area does not exceed 600 ft^2 (55.7 m^2).
   (b) The area is equipped with an electrically supervised automatic smoke detection system in accordance with 19.3.4.
   (c) The area does not obstruct any access to required exits.
(9) Group meeting or multipurpose therapeutic spaces, other than hazardous areas, that are under continuous supervision by facility staff shall be permitted to be open to the corridor, provided that all of the following criteria are met:
   (a) Each area does not exceed 1500 ft^2 (139 m^2).
   (b) Not more than one such space is permitted per smoke compartment.
   (c) The area is equipped with an electrically supervised automatic smoke detection system in accordance with 19.3.4.
   (d) The area does not obstruct access to required exits.

19.3.6.2 Construction of Corridor Walls.

19.3.6.2.1 Corridor walls shall be continuous from the floor to the underside of the floor or roof deck above; through any concealed spaces, such as those above suspended ceilings; and through interstitial structural and mechanical spaces, unless otherwise permitted by 19.3.6.2.4 through 19.3.6.2.8.

19.3.6.2.2* Corridor walls shall have a minimum ½-hour fire resistance rating.

19.3.6.2.3* Corridor walls shall form a barrier to limit the transfer of smoke.

19.3.6.2.4* In smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7, a corridor shall be permitted to be separated from all other areas by non-fire-rated partitions and shall be permitted to terminate at the ceiling where the ceiling is constructed to limit the transfer of smoke.

19.3.6.2.5 Existing corridor partitions shall be permitted to terminate at ceilings that are not an integral part of a floor construction if 60 in. (1525 mm) or more of space exists between the top of the ceiling subsystem and the bottom of the floor or roof above, provided that all the following criteria are met:

(1) The ceiling is part of a fire-rated assembly tested to have a minimum 1-hour fire resistance rating in compliance with the provisions of Section 8.3.
(2) The corridor partitions form smoke-tight joints with the ceilings, and joint filler, if used, is noncombustible.
(3) Each compartment of interstitial space that constitutes a separate smoke area is vented, in a smoke emergency, to the outside by mechanical means having the capacity to provide not less than two air changes per hour but, in no case, a capacity less than 5000 ft^3/min (2.35 m^3/s).
(4) The interstitial space is not used for storage.
(5) The space is not used as a plenum for supply, exhaust, or return air, except as noted in 19.3.6.2.5(3).

19.3.6.2.6* Existing corridor partitions shall be permitted to terminate at monolithic ceilings that resist the passage of smoke where there is a smoke-tight joint between the top of the partition and the bottom of the ceiling.

19.3.6.2.7 Fixed fire window assemblies in accordance with Section 8.3 shall be permitted in corridor walls, unless otherwise permitted in 19.3.6.2.8.

19.3.6.2.8 There shall be no restrictions in area and fire resistance of glass and frames in smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7.

19.3.6.3* Corridor Doors.

19.3.6.3.1* Doors, including doors or panels to nurse servers and pass-through openings, protecting corridor openings in other than required enclosures of vertical openings, exits, or hazardous areas shall be doors constructed to resist the passage of smoke and shall be constructed of materials such as the following:

(1) 1¾ in. thick, solid-bonded core wood
(2) Material that resists fire for a minimum of 20 minutes.

19.3.6.3.2 The requirements of 19.3.6.3.1 shall not apply where otherwise permitted by either of the following:

(1) Doors to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials shall not be required to comply with 19.3.6.3.1.
(2) In smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7, the door construction materials requirements of 19.3.6.3.1 shall not be mandatory, but the doors shall be constructed to resist the passage of smoke.

19.3.6.3.3 Compliance with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, shall not be required.

19.3.6.3.4 A clearance between the bottom of the door and the floor covering not exceeding 1 in. (25 mm) shall be permitted for corridor doors.

19.3.6.3.5* Doors shall be provided with a means for keeping the door closed that is acceptable to the authority having jurisdiction, and the following requirements also shall apply:

(1) The device used shall be capable of keeping the door fully closed if a force of 5 lbf (22 N) is applied at the latch edge of the door.
(2) Roller latches shall be prohibited on corridor doors in buildings not fully protected by an approved automatic sprinkler system in accordance with 19.3.5.7.

19.3.6.3.6 The requirements of 19.3.6.3.5 shall not apply where otherwise permitted by either of the following:

(1) Doors to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials shall not be required to comply with 19.3.6.3.5.
(2) Existing roller latches demonstrated to keep the door closed against a force of 5 lbf (22 N) shall be permitted to be kept in service.

19.3.6.3.7 Powered doors that comply with the requirements of 7.2.1.9 shall be considered as complying with the requirements of 19.3.6.3.5, provided that both of the following criteria are met:

(1) The door is equipped with a means for keeping the door closed that is acceptable to the authority having jurisdiction.
(2) The device used is capable of keeping the door fully closed if a force of 5 lbf (22 N) is applied at the latch edge of a swinging door and applied in any direction to a sliding or folding door, whether or not power is applied.

19.3.6.3.8 Reserved.

19.3.6.3.9 Reserved.

19.3.6.3.10* Doors shall not be held open by devices other than those that release when the door is pushed or pulled.

19.3.6.3.11 Door-closing devices shall not be required on doors in corridor wall openings other than those serving required exits, smoke barriers, or enclosures of vertical openings and hazardous areas.

19.3.6.3.12* Nonrated, factory- or field-applied protective plates, unlimited in height, shall be permitted.

19.3.6.3.13 Dutch doors shall be permitted where they conform to 19.3.6.3 and meet all of the following criteria:

(1) Both the upper leaf and lower leaf are equipped with a latching device.
(2) The meeting edges of the upper and lower leaves are equipped with an astragal, a rabbet, or a bevel.
(3) Where protecting openings in enclosures around hazardous areas, the doors comply with NFPA 80, *Standard for Fire Doors and Other Opening Protectives*.

19.3.6.3.14 Door frames shall be labeled, shall be of steel construction, or shall be of other materials in compliance with the provisions of Section 8.3, unless otherwise permitted by 19.3.6.3.15.

19.3.6.3.15 Door frames in smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7 shall not be required to comply with 19.3.6.3.14.

19.3.6.3.16 Fixed fire window assemblies in accordance with Section 8.3 shall be permitted in corridor doors.

19.3.6.3.17 Restrictions in area and fire resistance of glass and frames required by Section 8.3 shall not apply in smoke compartments protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7.

19.3.6.4 Transfer Grilles.

19.3.6.4.1 Transfer grilles shall not be used in corridor walls or doors, unless otherwise permitted by 19.3.6.4.2.

19.3.6.4.2 Doors to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials shall be permitted to have ventilating louvers or to be undercut.

19.3.6.5 Openings.

19.3.6.5.1* Miscellaneous openings, such as mail slots, pharmacy pass-through windows, laboratory pass-through windows, and cashier pass-through windows, shall be permitted to be installed in vision panels or doors without special protection, provided that both of the following criteria are met:

(1) The aggregate area of openings per room does not exceed 20 in.^{2} (0.015 m^2).
(2) The openings are installed at or below half the distance from the floor to the room ceiling.

19.3.6.5.2 The alternative requirements of 19.3.6.5.1 shall not apply where otherwise modified by the following:

(1) Openings in smoke compartments containing patient bedrooms shall not be permitted to be installed in vision panels or doors without special protection.
(2) For rooms protected throughout by an approved, supervised automatic sprinkler system in accordance with 19.3.5.7, the aggregate area of openings per room shall not exceed 80 in.^{2} (0.05 m^2).

19.3.7 Subdivision of Building Spaces.

19.3.7.1 Smoke barriers shall be provided to divide every story used for sleeping rooms for more than 30 patients into not less than two smoke compartments *(see 19.2.4.4)*, and the following also shall apply:

(1) The size of any such smoke compartment shall not exceed 22,500 ft^2 (2100 m^2), and the travel distance from any point to reach a door in the required smoke barrier shall not exceed 200 ft (61 m).
(2) Where neither the length nor width of the smoke compartment exceeds 150 ft (46 m), the travel distance to reach the smoke barrier door shall not be limited.
(3) The area of an atrium separated in accordance with 8.6.7 shall not be limited in size.

19.3.7.2 For purposes of the requirements of 19.3.7, the number of health care occupants shall be determined by actual count of patient bed capacity.

19.3.7.3 Any required smoke barrier shall be constructed in accordance with Section 8.5 and shall have a minimum ½-hour fire resistance rating, unless otherwise permitted by one of the following:

(1) This requirement shall not apply where an atrium is used, and both of the following criteria also shall apply:
    (a) Smoke barriers shall be permitted to terminate at an atrium wall constructed in accordance with 8.6.7(1)(c).
    (b) Not less than two separate smoke compartments shall be provided on each floor.
(2)*Smoke dampers shall not be required in duct penetrations of smoke barriers in fully ducted heating, ventilating, and air-conditioning systems where an approved, supervised automatic sprinkler system in accordance with 19.3.5.8 has been provided for smoke compartments adjacent to the smoke barrier.

19.3.7.4 Reserved.

19.3.7.5 Accumulation space shall be provided in accordance with 19.3.7.5.1 and 19.3.7.5.2.

19.3.7.5.1 Not less than 30 net ft^2 (2.8 net m^2) per patient in a hospital or nursing home, or not less than 15 net ft^2 (1.4 net m^2) per resident in a limited care facility, shall be provided within the aggregate area of corridors, patient rooms, treatment rooms, lounge or dining areas, and other low hazard areas on each side of the smoke barrier.

19.3.7.5.2 On stories not housing bedridden or litterborne patients, not less than 6 net ft^2 (0.56 net m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments.

19.3.7.6 Openings in smoke barriers shall be protected using one of the following methods:

(1) Fire-rated glazing
(2) Existing wired glass panels in steel frames

19.3.7.6.1* Nonrated factory- or field-applied protective plates, unlimited in height, shall be permitted.

19.3.7.6.2 Vision panels, if provided, in doors shall be protected using one of the following methods:

(1) Fixed fire window assemblies in accordance with Section 8.5
(2) Existing wired glass panels in steel frames

19.3.7.7 Reserved.

19.3.7.8* Doors in smoke barriers shall comply with 8.5.4 and all of the following:

(1) The doors shall be self-closing or automatic-closing in accordance with 19.2.2.2.7.
(2) Latching hardware shall not be required
(3) The doors shall not be required to swing in the direction of egress travel.

19.3.7.9 Door openings in smoke barriers shall be protected using one of the following methods:

(1) Swinging door providing a clear width of not less than 32 in. (810 mm)
(2) Special-purpose horizontally sliding accordion or folding door assemblies complying with 7.2.1.14 and providing a clear width of not less than 32 in. (810 mm)

19.3.7.10 The requirement of 19.3.7.9 shall not apply to existing 34 in. (865 mm) doors.

19.3.8 Special Protection Features. (Reserved)

19.4 Special Provisions.

19.4.1 Limited Access Buildings. See Section 11.7 for requirements for limited access buildings.

19.4.2 High-Rise Buildings.

19.4.2.1 All high-rise buildings containing health care occupancies shall be protected throughout by an approved, supervised automatic sprinkler system installed in accordance with

Section 9.7 within 12 years of the adoption of this *Code*, except as otherwise provided in 19.4.2.2 or 19.4.2.3.

19.4.2.2* Where a jurisdiction adopts this edition of the *Code* and previously adopted the 2012 edition, the sprinklering required by 19.4.2.1 shall be installed within 9 years of the adoption of this *Code*.

19.4.2.3* Where a jurisdiction adopts this edition of the *Code* and previously adopted the 2009 edition, the sprinklering required by 19.4.2.1 shall be installed within 6 years of the adoption of this *Code*.

19.4.3* Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following conditions are met:

(1) Where dispensers are installed in a corridor, the corridor shall have a minimum width of 6 ft (1830 mm).
(2) The maximum individual dispenser fluid capacity shall be as follows:
    (a) 0.32 gal (1.2 L) for dispensers in rooms, corridors, and areas open to corridors
    (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) Where aerosol containers are used, the maximum capacity of the aerosol dispenser shall be 18 oz (0.51 kg) and shall be limited to Level 1 aerosols as defined in NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.
(4) Dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(5) Not more than an aggregate 10 gal (37.8 L) of alcohol-based hand-rub solution or 1135 oz (32.2 kg) of Level 1 aerosols, or a combination of liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gal (37.8 L) or 1135 oz (32.2 kg), shall be in use outside of a storage cabinet in a single smoke compartment, except as otherwise provided in 19.4.3(6).
(6) One dispenser complying with 18.4.3(2) or (3) per room and located in that room shall not be included in the aggregated quantity addressed in 19.4.3(5).
(7) Storage of quantities greater than 5 gal (18.9 L) in a single smoke compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(8) Dispensers shall not be installed in the following locations:
    (a) Above an ignition source within a 1 in. (25 mm) horizontal distance from each side of the ignition source
    (b) To the side of an ignition source within a 1 in. (25 mm) horizontal distance from the ignition source
    (c) Beneath an ignition source within a 1 in. (25 mm) vertical distance from the ignition source
(9) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered smoke compartments.
(10) The alcohol-based hand-rub solution shall not exceed 95 percent alcohol content by volume.
(11) Operation of the dispenser shall comply with the following criteria:
    (a) The dispenser shall not release its contents except when the dispenser is activated, either manually or automatically by touch-free activation.
    (b) Any activation of the dispenser shall occur only when an object is placed within 4 in. (100 mm) of the sensing device.
    (c) An object placed within the activation zone and left in place shall not cause more than one activation.
    (d) The dispenser shall not dispense more solution than the amount required for hand hygiene consistent with label instructions.
    (e) The dispenser shall be designed, constructed, and operated in a manner that ensures that accidental or malicious activation of the dispensing device is minimized.
    (f) The dispenser shall be tested in accordance with the manufacturer's care and use instructions each time a new refill is installed.

19.5 Building Services.

19.5.1 Utilities.

19.5.1.1 Utilities shall comply with the provisions of Section 9.1.

19.5.1.2 Existing installations shall be permitted to be continued in service, provided that the systems do not present a serious hazard to life.

19.5.2 Heating, Ventilating, and Air-Conditioning.

19.5.2.1 Heating, ventilating, and air-conditioning shall comply with the provisions of Section 9.2 and shall be installed in accordance with the manufacturer's specifications, unless otherwise modified by 19.5.2.2.

19.5.2.2* Any heating device, other than a central heating plant, shall be designed and installed so that combustible material cannot be ignited by the device or its appurtenances, and the following requirements also shall apply:

(1) If fuel-fired, such heating devices shall comply with the following:
    (a) They shall be chimney connected or vent connected.
    (b) They shall take air for combustion directly from the outside.
    (c) They shall be designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area.
(2) Any heating device shall have safety features to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperature or ignition failure.

19.5.2.3 The requirements of 19.5.2.2 shall not apply where otherwise permitted by the following:

(1) Approved, suspended unit heaters shall be permitted in locations other than means of egress and patient sleeping areas, provided that both of the following criteria are met:
    (a) Such heaters are located high enough to be out of the reach of persons using the area.
    (b) Such heaters are equipped with the safety features required by 19.5.2.2(2).
(2) Direct-vent gas fireplaces, as defined in NFPA 54, *National Fuel Gas Code*, shall be permitted inside of smoke compartments containing patient sleeping areas, provided that all of the following criteria are met:
    (a) All such devices shall be installed, maintained, and used in accordance with 9.2.2.
    (b) No such device shall be located inside of a patient sleeping room.
    (c) The smoke compartment in which the direct-vent gas fireplace is located shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1) with listed quick-response or listed residential sprinklers.

(d)*The direct-vent fireplace shall include a sealed glass front with a wire mesh panel or screen.
(e)*The controls for the direct-vent gas fireplace shall be locked or located in a restricted location.
(f) Electrically supervised carbon monoxide detection in accordance with Section 9.12 shall be provided in the room where the fireplace is located.

(3) Solid fuel–burning fireplaces shall be permitted and used only in areas other than patient sleeping areas, provided that all of the following criteria are met:
(a) Such areas are separated from patient sleeping spaces by construction having not less than a 1-hour fire resistance rating.
(b) The fireplace complies with the provisions of 9.2.2.
(c) The fireplace is equipped with a fireplace enclosure guaranteed against breakage up to a temperature of 650°F (343°C) and constructed of heat-tempered glass or other approved material.
(d) Electrically supervised carbon monoxide detection in accordance with Section 9.12 is provided in the room where the fireplace is located.

(4) If, in the opinion of the authority having jurisdiction, special hazards are present, a lock on the enclosure specified in 19.5.2.3(3)(c) and other safety precautions shall be permitted to be required.

19.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

19.5.4 Waste Chutes, Incinerators, and Laundry Chutes.

19.5.4.1 Existing chutes or linen chutes, including pneumatic waste and linen systems, that open directly onto any corridor shall be sealed by fire-resistive construction to prevent further use or shall be provided with a fire door assembly having a minimum 1-hour fire protection rating. All new chutes shall comply with Section 9.5.

19.5.4.2 Reserved.

19.5.4.3 Any waste chute or linen chute, including pneumatic waste and linen systems, shall be provided with automatic extinguishing protection in accordance with Section 9.7. *(See Section 9.5.)*

19.5.4.4 Any chute shall discharge into a chute discharge room used for no other purpose and shall be protected in accordance with Section 8.7 unless otherwise provided in 19.5.4.5.

19.5.4.5 Existing laundry chutes shall be permitted to discharge into the same room as rubish discharge chutes, provided that the room is protected by automatic sprinklers in accordance with 19.3.5.9 or 19.3.5.7.

19.5.4.6 Existing flue-fed incinerators shall be sealed by fire-resistive construction to prevent further use.

19.6 Reserved.

19.7* Operating Features.

19.7.1 Evacuation and Relocation Plan and Fire Drills.

19.7.1.1 The administration of every health care occupancy shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for their evacuation from the building when necessary.

19.7.1.2 All employees shall be periodically instructed and kept informed with respect to their duties under the plan required by 19.7.1.1.

19.7.1.3 A copy of the plan required by 19.7.1.1 shall be readily available at all times in the telephone operator's location or at the security center.

19.7.1.4* Fire drills in health care occupancies shall include the transmission of a fire alarm signal and simulation of emergency fire conditions.

19.7.1.5 Infirm or bedridden patients shall not be required to be moved during drills to safe areas or to the exterior of the building.

19.7.1.6 Drills shall be conducted quarterly on each shift to familiarize facility personnel (nurses, interns, maintenance engineers, and administrative staff) with the signals and emergency action required under varied conditions.

19.7.1.7 When drills are conducted between 9:00 p.m. and 6:00 a.m. (2100 hours and 0600 hours), a coded announcement shall be permitted to be used instead of audible alarms.

19.7.1.8 Employees of health care occupancies shall be instructed in life safety procedures and devices.

19.7.2 Procedure in Case of Fire.

19.7.2.1* Protection of Patients.

19.7.2.1.1 For health care occupancies, the proper protection of patients shall require the prompt and effective response of health care personnel.

19.7.2.1.2 The basic response required of staff shall include the following:

(1) Removal of all occupants directly involved with the fire emergency
(2) Transmission of an appropriate fire alarm signal to warn other building occupants and summon staff
(3) Confinement of the effects of the fire by closing doors to isolate the fire area
(4) Relocation of patients as detailed in the health care occupancy's fire safety plan

19.7.2.2 Fire Safety Plan. A written health care occupancy fire safety plan shall provide for all of the following:

(1) Use of alarms
(2) Transmission of alarms to fire department
(3) Emergency phone call to fire department
(4) Response to alarms
(5) Isolation of fire
(6) Evacuation of immediate area
(7) Evacuation of smoke compartment
(8) Preparation of floors and building for evacuation
(9) Extinguishment of fire
(10) Location and operation of doors disguised with murals as permitted by 19.2.2.2.7

19.7.2.3 Staff Response.

19.7.2.3.1 All health care occupancy personnel shall be instructed in the use of and response to fire alarms.

19.7.2.3.2 All health care occupancy personnel shall be instructed in the use of the code phrase to ensure transmission of an alarm under any of the following conditions:

(1) When the individual who discovers a fire must immediately go to the aid of an endangered person
(2) During a malfunction of the building fire alarm system

19.7.2.3.3 Personnel hearing the code announced shall first activate the building fire alarm using the nearest manual fire alarm box and then shall execute immediately their duties as outlined in the fire safety plan.

19.7.3 Maintenance of Means of Egress.

19.7.3.1 Proper maintenance shall be provided to ensure the dependability of the method of evacuation selected.

19.7.3.2 Health care occupancies that find it necessary to lock means of egress doors shall, at all times, maintain an adequate staff qualified to release locks and direct occupants from the immediate danger area to a place of safety in case of fire or other emergency.

19.7.3.3* Where required by the authority having jurisdiction, a floor plan shall be provided to indicate the location of all required means of egress corridors in smoke compartments having spaces not separated from the corridor by partitions.

19.7.4* Smoking. Smoking regulations shall be adopted and shall include not less than the following provisions:

(1) Smoking shall be prohibited in any room, ward, or individual enclosed space where flammable liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and such areas shall be posted with signs that read NO SMOKING or shall be posted with the international symbol for no smoking.
(2) In health care occupancies where smoking is prohibited and signs are prominently placed at all major entrances, secondary signs with language that prohibits smoking shall not be required.
(3) Smoking by patients classified as not responsible shall be prohibited.
(4) The requirement of 19.7.4(3) shall not apply where the patient is under direct supervision.
(5) Ashtrays of noncombustible material and safe design shall be provided in all areas where smoking is permitted.
(6) Metal containers with self-closing cover devices into which ashtrays can be emptied shall be readily available to all areas where smoking is permitted.

19.7.5 Furnishings, Mattresses, and Decorations.

19.7.5.1* Draperies, curtains, and other loosely hanging fabrics and films serving as furnishings or decorations in health care occupancies shall be in accordance with the provisions of 10.3.1 *(see 19.3.5.11)*, and the following also shall apply:

(1) Such curtains shall include cubicle curtains.
(2) Such curtains shall not include curtains at showers and baths.
(3) Such draperies and curtains shall not include draperies and curtains at windows in patient sleeping rooms in smoke compartments sprinklered in accordance with 19.3.5.
(4) Such draperies and curtains shall not include draperies and curtains in other rooms or areas where the draperies and curtains comply with all of the following:
   (a) Individual drapery or curtain panel area does not exceed 48 ft^2 (4.5 m^2).
   (b) Total area of drapery and curtain panels per room or area does not exceed 20 percent of the aggregate area of the wall on which they are located.
   (c) Smoke compartment in which draperies or curtains are located is sprinklered in accordance with 19.3.5.

19.7.5.2 Newly introduced upholstered furniture within health care occupancies shall comply with one of the following provisions, unless otherwise provided in 19.7.5.3:

(1) The furniture shall meet the criteria specified in 10.3.2.1 and 10.3.3.
(2) The furniture shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

19.7.5.3 The requirements of 19.7.5.2, 10.3.2.1, and 10.3.3 shall not apply to upholstered furniture belonging to the patient in sleeping rooms of nursing homes where the following criteria are met:

(1) A smoke detector shall be installed where the patient sleeping room is not protected by automatic sprinklers.
(2) Battery-powered single-station smoke detectors shall be permitted.

19.7.5.4 Newly introduced mattresses within health care occupancies shall comply with one of the following provisions, unless otherwise provided in 19.7.5.5:

(1) The mattresses shall meet the criteria specified in 10.3.2.2 and 10.3.4.
(2) The mattresses shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

19.7.5.5 The requirements of 19.7.5.4, 10.3.2.2, and 10.3.4 shall not apply to mattresses belonging to the patient in sleeping rooms of nursing homes where the following criteria are met:

(1) A smoke detector shall be installed where the patient sleeping room is not protected by automatic sprinklers.
(2) Battery-powered single-station smoke detectors shall be permitted.

19.7.5.6 Combustible decorations shall be prohibited in any health care occupancy, unless one of the following criteria is met:

(1) They are flame-retardant or are treated with approved fire-retardant coating that is listed and labeled for application to the material to which it is applied.
(2)*The decorations meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*
(3) The decorations exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages,* using the 20 kW ignition source.
(4)*The decorations, such as photographs, paintings, and other art, are attached directly to the walls, ceiling, and non-fire-rated doors in accordance with the following:
   (a) Decorations on non-fire-rated doors do not interfere with the operation or any required latching of the door and do not exceed the area limitations of 19.7.5.6(4)(b), (c), or (d).
   (b) Decorations do not exceed 20 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is not protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

(c) Decorations do not exceed 30 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.
(d) Decorations do not exceed 50 percent of the wall, ceiling, and door areas inside patient sleeping rooms, having a capacity not exceeding four persons, in a smoke compartment that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

(5)*They are decorations, such as photographs and paintings, in such limited quantities that a hazard of fire development or spread is not present.

19.7.5.7 Soiled Linen and Trash Receptacles.

19.7.5.7.1 Soiled linen or trash collection receptacles shall not exceed 32 gal (121 L) in capacity and shall meet all of the following requirements:

(1) The average density of container capacity in a room or space shall not exceed 0.5 gal/ft^2 (20.4 L/m^2).
(2) A capacity of 32 gal (121 L) shall not be exceeded within any 64 ft^2 (6 m^2) area.
(3)*Mobile soiled linen or trash collection receptacles with capacities greater than 32 gal (121 L) shall be located in a room protected as a hazardous area when not attended.
(4) Container size and density shall not be limited in hazardous areas.

19.7.5.7.2* Containers used solely for recycling clean waste or for patient records awaiting destruction shall be permitted to be excluded from the requirements of 19.7.5.7.1 where all the following conditions are met:

(1) Each container shall be limited to a maximum capacity of 96 gal (363 L), except as permitted by 19.7.5.7.2(2) or (3).
(2)*Containers with capacities greater than 96 gal (363 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size shall not be limited in hazardous areas.
(4) Containers for combustibles shall be labeled and listed as meeting the requirements of FM Approval Standard 6921, *Containers for Combustible Waste*; however, such testing, listing, and labeling shall not be limited to FM Approvals.

19.7.5.7.3 The provisions of 10.3.9, applicable to containers for waste, or linen, shall not apply.

19.7.6 Maintenance and Testing. See 4.6.12.

19.7.7* Engineered Smoke Control Systems.

19.7.7.1 Existing engineered smoke control systems, unless specifically exempted by the authority having jurisdiction, shall be tested in accordance with established engineering principles.

19.7.7.2 Systems not meeting the performance requirements of the testing specified in 19.7.7.1 shall be continued in operation only with the specific approval of the authority having jurisdiction.

19.7.8* Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all health care occupancies, unless both of the following criteria are met:

(1) Such devices are used only in nonsleeping staff and employee areas.
(2) The heating elements of such devices do not exceed 212°F (100°C).

19.7.9 Construction, Repair, and Improvement Operations.

19.7.9.1 Construction, repair, and improvement operations shall comply with 4.6.10.

19.7.9.2 The means of egress in any area undergoing construction, repair, or improvements shall be inspected daily for compliance with 7.1.10.1 and shall also comply with NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations.*

Chapter 20 New Ambulatory Health Care Occupancies

20.1 General Requirements.

20.1.1 Application.

20.1.1.1 General.

20.1.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as ambulatory health care occupancies. *(See 1.3.1.)*

20.1.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

20.1.1.1.3 General. The provisions of Chapter 4, General, shall apply.

20.1.1.1.4 Buildings, or sections of buildings, that primarily house patients who, in the opinion of the governing body of the facility and the governmental agency having jurisdiction, are capable of exercising judgment and appropriate physical action for self-preservation under emergency conditions shall be permitted to comply with chapters of this *Code* other than Chapter 20.

20.1.1.1.5 It shall be recognized that, in buildings providing treatment for certain types of patients or having detention rooms or a security section, it might be necessary to lock doors and bar windows to confine and protect building inhabitants. In such instances, the authority having jurisdiction shall make appropriate modifications to those sections of this *Code* that would otherwise require means of egress to be kept unlocked.

20.1.1.1.6* The requirements of this chapter shall apply based on the assumption that staff is available in all patient-occupied areas to perform certain fire safety functions as required in other paragraphs of this chapter.

20.1.1.2* Goals and Objectives. The goals and objectives of Sections 4.1 and 4.2 shall be met with due consideration for functional requirements, which are accomplished by limiting the development and spread of a fire emergency to the room of fire origin and reducing the need for occupant evacuation, except from the room of fire origin.

20.1.1.3 Total Concept.

20.1.1.3.1 All ambulatory health care facilities shall be designed, constructed, maintained, and operated to minimize the possibility of a fire emergency requiring the evacuation of occupants.

20.1.1.3.2 Because the safety of ambulatory health care occupants cannot be ensured adequately by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities; adequate, trained staff; and development of operating and maintenance procedures composed of the following:

(1) Design, construction, and compartmentation
(2) Provision for detection, alarm, and extinguishment
(3) Fire prevention and planning, training, and drilling programs for the isolation of fire, transfer of occupants to areas of refuge, or evacuation of the building

20.1.1.4 Additions, Conversions, Modernization, Renovation, and Construction Operations.

20.1.1.4.1 Additions.

20.1.1.4.1.1 Additions shall be separated from any existing structure not conforming to the provisions within Chapter 21 by a fire barrier having not less than a 2-hour fire resistance rating and constructed of materials as required for the addition. *(See 4.6.5 and 4.6.7.)*

20.1.1.4.1.2 Doors in barriers required by 20.1.1.4.1.1 shall normally be kept closed, unless otherwise permitted by 20.1.1.4.1.3.

20.1.1.4.1.3 Doors shall be permitted to be held open if they meet the requirements of 20.2.2.2.2.

20.1.1.4.2 Changes of Occupancy. A change from a hospital or nursing home to an ambulatory health care occupancy shall not be considered a change in occupancy or occupancy subclassification.

20.1.1.4.3 Renovations, Alterations, and Modernizations. *(See 4.6.7.)*

20.1.1.4.4 Construction, Repair, and Improvement Operations. *(See 4.6.10.)*

20.1.2 Classification of Occupancy. *(See 6.1.6 and 20.1.4.2.)*

20.1.3 Multiple Occupancies.

20.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

20.1.3.2* Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis, provided both of the following are met:

(1) The provision is not used for occupancy separations involving industrial and storage occupancies.
(2) Smoke partitions serving as atrium walls are not permitted to serve as enclosures for hazardous areas.

20.1.3.3 Sections of ambulatory health care facilities shall be permitted to be classified as other occupancies, provided that they meet both of the following conditions:

(1) They are not intended to serve ambulatory health care occupants for purposes of treatment or customary access by patients incapable of self-preservation.
(2) They are separated from areas of ambulatory health care occupancies by construction having a minimum 1-hour fire resistance rating.

20.1.3.4 All means of egress from ambulatory health care occupancies that traverse nonambulatory health care spaces shall conform to the requirements of this *Code* for ambulatory health care occupancies, unless otherwise permitted by 20.1.3.5.

20.1.3.5 Exit through a horizontal exit into other contiguous occupancies that do not conform to ambulatory health care egress provisions but that do comply with requirements set forth in the appropriate occupancy chapter of this *Code* shall be permitted, provided that the occupancy does not contain high hazard contents.

20.1.3.6 Egress provisions for areas of ambulatory health care facilities that correspond to other occupancies shall meet the corresponding requirements of this *Code* for such occupancies, and, where the clinical needs of the occupant necessitate the locking of means of egress, staff shall be present for the supervised release of occupants during all times of use.

20.1.3.7 Any area with a hazard of contents classified higher than that of the ambulatory health care occupancy and located in the same building shall be protected as required in 20.3.3.

20.1.3.8 Non-health care–related occupancies classified as containing high hazard contents shall not be permitted in buildings housing ambulatory health care occupancies.

20.1.4 Definitions.

20.1.4.1 General. For definitions, see Chapter 3, Definitions.

20.1.4.2 Definition — Ambulatory Health Care Occupancy. *(See 3.3.190.1.)*

20.1.5 Classification of Hazard of Contents. The classification of hazard of contents shall be as defined in Section 6.2.

20.1.6 Minimum Construction Requirements.

20.1.6.1 Ambulatory health care occupancies shall be limited to the building construction types specified in Table 20.1.6.1, unless otherwise permitted by 20.1.6.6. *(See 8.2.1.)*

20.1.6.2 Any level below the level of exit discharge shall be separated from the level of exit discharge by not less than Type II (111), Type III (211), or Type V (111) construction *(see 8.2.1)*, unless both of the following criteria are met:

(1) Such levels are under the control of the ambulatory health care facility.
(2) Any hazardous spaces are protected in accordance with Section 8.7.

20.1.6.3 Interior nonbearing walls in buildings of Type I or Type II construction shall be constructed of noncombustible or limited-combustible materials, unless otherwise permitted by 20.1.6.4.

20.1.6.4 Interior nonbearing walls required to have a fire resistance rating of 2 hours or less shall be permitted to be fire-retardant-treated wood enclosed within noncombustible or limited-combustible materials, provided that such walls are not used as shaft enclosures.

20.1.6.5 All buildings with more than one level below the level of exit discharge shall have all such lower levels separated from the level of exit discharge by not less than Type II (111) construction.

20.1.6.6 Where new ambulatory health care occupancies are located in existing buildings, the authority having jurisdiction shall be permitted to accept construction systems of lesser fire resistance than those required by 20.1.6.1 through 20.1.6.5, provided that it can be demonstrated to the authority's satisfaction that prompt evacuation of the facility can be achieved in case of fire or that the exposing occupancies and materials of construction present no threat of fire penetration from such occupancy to the ambulatory health care facility or to the collapse of the structure.

Table 20.1.6.1 Construction Type Limitations

Construction Type	Sprinklered†	Stories in Height‡	
		1	≥2
I (442)	Yes	X	X
	No	X	X
I (332)	Yes	X	X
	No	X	X
II (222)	Yes	X	X
	No	X	X
II (111)	Yes	X	X
	No	X	X
II (000)	Yes	X	X
	No	X	NP
III (211)	Yes	X	X
	No	X	X
III (200)	Yes	X	X
	No	X	NP
IV (2HH)	Yes	X	X
	No	X	X
V (111)	Yes	X	X
	No	X	X
V (000)	Yes	X	X
	No	X	NP

X: Permitted. NP: Not permitted.
†Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7. *(See 20.3.5.)*
‡See 4.6.3.

20.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

20.2 Means of Egress Requirements.

20.2.1 General. Every aisle, passageway, corridor, exit discharge, exit location, and access shall be in accordance with Chapter 7, unless otherwise modified by 20.2.2 through 20.2.11.

20.2.2 Means of Egress Components.

20.2.2.1 Components Permitted. Means of egress components shall be limited to the types described in 20.2.2.2 through 20.2.2.12.

20.2.2.2 Doors.

20.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

20.2.2.2.2 Any door required to be self-closing shall be permitted to be held open only by an automatic release device that complies with 7.2.1.8.2. The required manual fire alarm system and the systems required by 7.2.1.8.2 shall be arranged to initiate the closing action of all such doors throughout the smoke compartment or throughout the entire facility.

20.2.2.2.3 Where doors in a stair enclosure are held open by an automatic release device as permitted in 20.2.2.2.2, initiation of a door-closing action on any level shall cause all doors at all levels in the stair enclosure to close.

20.2.2.2.4* Locks complying with 7.2.1.5.5 shall be permitted only on principal entrance/exit doors.

20.2.2.2.5 Reserved.

20.2.2.2.6 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

20.2.2.2.7 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

20.2.2.2.8 Elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 shall be permitted.

20.2.2.2.9 Horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) shall be permitted to be used as part of the required means of egress from a tenant space.

20.2.2.2.10 Reserved.

20.2.2.2.11 Revolving doors complying with 7.2.1.10 shall be permitted.

20.2.2.3 Stairs.

20.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

20.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

20.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

20.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

20.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

20.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

20.2.2.8 Reserved.

20.2.2.9 Reserved.

20.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

20.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

20.2.2.12 Areas of Refuge.

20.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted.

20.2.2.12.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), two rooms or spaces separated from each other by smoke-resistant partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

20.2.3 Capacity of Means of Egress.

20.2.3.1 The capacity of any required means of egress shall be determined in accordance with Section 7.3.

20.2.3.2 The clear width of any corridor or passageway required for exit access shall be not less than 44 in. (1120 mm).

20.2.3.3* Where minimum corridor width is 6 ft (1830 mm), projections not more than 6 in. (150 mm) from the corridor wall, above the handrail height, shall be permitted for the installation of hand-rub dispensing units in accordance with 20.4.3.

20.2.3.4 Doors in the means of egress from diagnostic or treatment areas, such as x-ray, surgical, or physical therapy, shall provide a clear width of not less than 32 in. (810 mm).

20.2.4 Number of Means of Egress.

20.2.4.1 The number of means of egress shall be in accordance with Section 7.4.

20.2.4.2 Not less than two exits of the types described in 20.2.2 that are remotely located from each other shall be provided for each floor or fire section of the building.

20.2.4.3 Not less than two exits of the types described in 20.2.2 shall be accessible from each smoke compartment.

20.2.4.4 Egress from smoke compartments addressed in 20.2.4.3 shall be permitted through adjacent compartments provided that the two required egress paths are arranged so that both do not pass through the same adjacent smoke compartment.

20.2.5 Arrangement of Means of Egress.

20.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

20.2.5.2 Dead-end corridors shall be permitted in accordance with 20.2.5.2.1 or 20.2.5.2.2.

20.2.5.2.1 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), dead-end corridors shall not exceed 50 ft (15 m).

20.2.5.2.2 In buildings other than those complying with 20.2.5.2.1, dead-end corridors shall not exceed 20 ft (6100 mm).

20.2.5.3 Limitations on common path of travel shall be in accordance with 20.2.5.3.1, 20.2.5.3.2, and 20.2.5.3.3.

20.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

20.2.5.3.2 Common path of travel shall not exceed 100 ft (30 m) within a single tenant space having an occupant load not exceeding 25 persons.

20.2.5.3.3 In buildings other than those complying with 20.2.5.3.1 or 20.2.5.3.2, common path of travel shall not exceed 75 ft (23 m).

20.2.6 Travel Distance to Exits.

20.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

20.2.6.2 Travel distance shall comply with 20.2.6.2.1 and 20.2.6.2.2.

20.2.6.2.1 The travel distance between any point in a room and an exit shall not exceed 150 ft (46 m).

20.2.6.2.2 The maximum travel distance in 20.2.6.2.1 shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7

20.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

20.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

20.2.9 Emergency Lighting and Essential Electrical Systems.

20.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9.

20.2.9.2 Where general anesthesia or life-support equipment is used, each ambulatory health care facility shall be provided with an essential electrical system in accordance with NFPA 99, *Health Care Facilities Code*, unless otherwise permitted by any of the following:

(1) Where battery-operated equipment is provided and acceptable to the authority having jurisdiction
(2) Where a facility uses life-support equipment for emergency purposes only

20.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

20.2.11 Special Means of Egress Features.

20.2.11.1 Reserved.

20.2.11.2 Lockups. Lockups in ambulatory health care occupancies shall comply with the requirements of 22.4.5.

20.3 Protection.

20.3.1 Protection of Vertical Openings.

20.3.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by 20.3.1.2.

20.3.1.2 Unenclosed vertical openings in accordance with 8.6.9.1 shall be permitted.

20.3.1.3 Floors that are below the street floor and are used for storage or other than an ambulatory health care occupancy shall have no unprotected openings to ambulatory health care occupancy floors.

20.3.2 Protection from Hazards.

20.3.2.1* General. Hazardous areas including, but not limited to, areas used for general storage, boiler or furnace rooms, and maintenance shops that include woodworking and painting areas shall be protected in accordance with Section 8.7.

20.3.2.2 Doors. Doors to hazardous areas shall be self-closing or automatic-closing in accordance with 20.2.2.2.2.

20.3.2.3* High Hazard Contents Areas. High hazard contents areas, as classified in Section 6.2, shall meet all of the following criteria:

(1) The area shall be separated from other parts of the building by fire barriers having a minimum 1-hour fire resistance rating, with all openings therein protected by self-closing fire door assemblies having a minimum ¾-hour fire protection rating.
(2) The area shall be protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2.

20.3.2.4 Laboratories. Laboratories in which chemicals are handled or stored shall comply with NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

20.3.2.5 Medical Gas. Areas where medical gas is stored or administered, and the operation, management, and maintenance of medical gases shall be in accordance with NFPA 99, *Health Care Facilities Code*.

20.3.2.6 Cooking Facilities. Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 20.3.2.7.

20.3.2.7 Domestic Cooking Equipment. Where domestic cooking equipment is used for food warming or limited cooking, protection or separation of food preparation facilities shall not be required.

20.3.3 Interior Finish.

20.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

20.3.3.2 Interior Wall and Ceiling Finish.

20.3.3.2.1 Interior wall and ceiling finish material complying with Section 10.2 shall be Class A or Class B in exits and in exit access corridors.

20.3.3.2.2 Interior wall and ceiling finishes shall be Class A, Class B, or Class C in areas other than those specified in 20.3.3.2.1.

20.3.3.3 Interior Floor Finish.

20.3.3.3.1 Interior floor finish shall comply with Section 10.2.

20.3.3.3.2 Interior floor finish in exit enclosures shall be Class I or Class II.

20.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

20.3.4 Detection, Alarm, and Communications Systems.

20.3.4.1 General. Ambulatory health care facilities shall be provided with fire alarm systems in accordance with Section 9.6, except as modified by 20.3.4.2 through 20.3.4.4.

20.3.4.2 Initiation. Initiation of the required fire alarm systems shall be by manual means in accordance with 9.6.2 and by means of any detection devices or detection systems required.

20.3.4.3 Notification. Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

20.3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically, without delay, in accordance with 9.6.3 upon operation of any fire alarm activating device.

20.3.4.3.2 Emergency Forces Notification.

20.3.4.3.2.1 Emergency forces notification shall be accomplished in accordance with 9.6.4.

20.3.4.3.2.2 Reserved.

20.3.4.4 Fire Safety Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically, without delay, any control functions required to be performed by that device. *(See 9.6.5.)*

20.3.5 Extinguishment Requirements.

20.3.5.1 Isolated hazardous areas shall be permitted to be protected in accordance with 9.7.1.2.

20.3.5.2 Where more than two sprinklers are installed in a single area for protection in accordance with 9.7.1.2, waterflow detection shall be provided to sound the building fire alarm or to notify, by a signal, any constantly attended location, such as PBX, security, or emergency room, at which the necessary corrective action shall be taken.

20.3.5.3 Portable fire extinguishers shall be provided in ambulatory health care facilities in accordance with Section 9.9.

20.3.6 Corridors.

20.3.6.1* Where access to exits is provided by corridors, such corridors shall be separated from use areas by fire barriers in accordance with Section 8.3 having a minimum 1-hour fire resistance rating, unless one of the following conditions exists:

(1)*Where exits are available from an open floor area
(2)*Within a space occupied by a single tenant
(3) Within buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)

20.3.6.2 Openings in corridor walls required by 20.3.6.1 to have a fire resistance rating shall be protected in accordance with Section 8.3, except as otherwise permitted in 20.3.6.2.1 or 20.3.6.2.2.

20.3.6.2.1 Miscellaneous openings, such as mail slots, pharmacy pass-through windows, laboratory pass-through windows, and cashier pass-through windows, shall be permitted to be installed in vision panels or doors without special protection, provided that both of the following criteria are met:

(1) The aggregate area of openings per room does not exceed 20 in.^{2} (0.015 m^2).
(2) The openings are installed at or below half the distance from the floor to the room ceiling.

20.3.6.2.2 For rooms protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7, the aggregate area of openings per room, as otherwise limited by 20.3.6.2.1, shall not exceed 80 in.^{2} (0.05 m^2).

20.3.7 Subdivision of Building Space.

20.3.7.1 Ambulatory health care occupancies shall be separated from other tenants and occupancies and shall meet all of the following requirements:

(1) Walls shall have not less than a 1-hour fire resistance rating and shall extend from the floor slab below to the floor or roof slab above.
(2) Doors shall be constructed of not less than 1¾ in. (44 mm) thick, solid-bonded wood core or the equivalent and shall be equipped with positive latches.
(3) Doors shall be self-closing and shall be kept in the closed position, except when in use.
(4) Any windows in the barriers shall be of fixed fire window assemblies in accordance with Section 8.3.

20.3.7.2 Every story of an ambulatory health care occupancy shall be divided into not less than two smoke compartments, unless otherwise permitted by one of the following:

(1) This requirement shall not apply where the area of the ambulatory health care occupancy is less than 5000 ft^2 (465 m^2) per story and that area is protected by an approved automatic smoke detection system.
(2) This requirement shall not apply where the area of the ambulatory health care occupancy is less than 10,000 ft^2

(929 m^2) per story and the building is protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.7.

(3) An area in an adjoining occupancy shall be permitted to serve as a smoke compartment for an ambulatory health care occupancy if all of the following criteria are met:
   (a) The separating wall and both compartments meet the requirements of 20.3.7.
   (b) The ambulatory health care occupancy is less than 22,500 ft^2 (2100 m^2).
   (c) Access from the ambulatory health care occupancy to the other occupancy is unrestricted.

20.3.7.3 Smoke compartments shall not exceed an area of 22,500 ft^2 (2100 m^2), and the travel distance from any point to reach a door in a smoke barrier shall not exceed 200 ft (61 m).

20.3.7.4 The area of an atrium separated in accordance with 8.6.7 shall not be limited in size.

20.3.7.5 Required smoke barriers shall be constructed in accordance with Section 8.5 and shall have a minimum 1-hour fire resistance rating, unless otherwise permitted by 20.3.7.7.

20.3.7.6 Smoke barriers shall be permitted to terminate at the required occupancy separation where the ambulatory health care occupancy is constructed as a separated multiple occupancy in accordance with 6.1.14.4 and the separation also meets the requirements for a smoke barrier.

20.3.7.7 Smoke dampers shall not be required in duct penetrations of smoke barriers in fully ducted heating, ventilating, and air-conditioning systems for buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

20.3.7.8 Windows in the smoke barrier shall be of fixed fire window assemblies in accordance with Section 8.3.

20.3.7.9 Not less than 15 net ft^2 (1.4 net m^2) per ambulatory health care facility occupant shall be provided within the aggregate area of corridors, patient rooms, treatment rooms, lounges, and other low hazard areas on each side of the smoke compartment for the total number of occupants in adjoining compartments.

20.3.7.10* Doors in smoke barriers shall be not less than 1¾ in. (44 mm) thick, solid-bonded wood core or the equivalent and shall be self-closing or automatic-closing in accordance with 20.2.2.2.2.

20.3.7.11 Latching hardware shall not be required on smoke barrier cross-corridor doors.

20.3.7.12 A vision panel consisting of fire-rated glazing in approved frames shall be provided in each cross-corridor swinging door and at each cross-corridor horizontal-sliding door in a smoke barrier.

20.3.7.13 Vision panels in doors in smoke barriers, if provided, shall be of fire-rated glazing in approved frames.

20.3.7.14* Rabbets, bevels, or astragals shall be required at the meeting edges, and stops shall be required at the head and sides of door frames in smoke barriers.

20.3.7.15 Center mullions shall be prohibited in smoke barrier door openings where pairs of cross-corridor doors are provided.

20.4 Special Provisions.

20.4.1 Limited Access or Underground Buildings. *(See Section 11.7.)*

20.4.2 High-Rise Buildings. High-rise buildings shall comply with Section 11.8.

20.4.3* Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following conditions are met:

(1) Where dispensers are installed in a corridor, the corridor shall have a minimum width of 6 ft (1830 mm).
(2) The maximum individual dispenser fluid capacity shall be as follows:
   (a) 0.32 gal (1.2 L) for dispensers in rooms, corridors, and areas open to corridors
   (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) Where aerosol containers are used, the maximum capacity of the aerosol dispenser shall be 18 oz (0.51 kg) and shall be limited to Level 1 aerosols as defined in NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products.*
(4) Dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(5) Not more than an aggregate 10 gal (37.8 L) of alcohol-based hand-rub solution or 1135 oz (32.2 kg) of Level 1 aerosols, or a combination of liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gal (37.8 L) or 1135 oz (32.2 kg), shall be in use outside of a storage cabinet in a single smoke compartment, except as otherwise provided in 20.4.3(6).
(6) One dispenser per room complying with 20.4.3(2) or (3), and located in the room, shall not be required to be included in the aggregated quantity specified in 20.4.3(5).
(7) Storage of quantities greater than 5 gal (18.9 L) in a single smoke compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code.*
(8) Dispensers shall not be installed in the following locations:
   (a) Above an ignition source within a 1 in. (25 mm) horizontal distance from each side of the ignition source
   (b) To the side of an ignition source within a 1 in. (25 mm) horizontal distance from the ignition source
   (c) Beneath an ignition source within a 1 in. (25 mm) vertical distance from the ignition source
(9) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered smoke compartments.
(10) The alcohol-based hand-rub solution shall not exceed 95 percent alcohol content by volume.
(11) Operation of the dispenser shall comply with the following criteria:
   (a) The dispenser shall not release its contents except when the dispenser is activated, either manually or automatically by touch-free activation.
   (b) Any activation of the dispenser shall occur only when an object is placed within 4 in. (100 mm) of the sensing device.
   (c) An object placed within the activation zone and left in place shall not cause more than one activation.
   (d) The dispenser shall not dispense more solution than the amount required for hand hygiene consistent with label instructions.
   (e) The dispenser shall be designed, constructed, and operated in a manner that ensures that accidental or malicious activation of the dispensing device is minimized.

(f) The dispenser shall be tested in accordance with the manufacturer's care and use instructions each time a new refill is installed.

20.5 Building Services.

20.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

20.5.2 Heating, Ventilating, and Air-Conditioning.

20.5.2.1 Heating, ventilating, and air-conditioning shall comply with the provisions of Section 9.2 and shall be installed in accordance with the manufacturer's specifications, unless otherwise modified by 20.5.2.2.

20.5.2.2 If fuel-fired, heating devices shall comply with all of the following:

(1) They shall be chimney connected or vent connected.
(2) They shall take air for combustion directly from the outside.
(3) They shall be designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area.

20.5.2.2.1 Any heating device shall have safety features to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperature or ignition failure.

20.5.2.2.2 Approved, suspended unit heaters shall be permitted in locations other than means of egress and patient treatment areas, provided that both of the following criteria are met:

(1) Such heaters are located high enough to be out of the reach of persons using the area.
(2) Such heaters are equipped with the safety features required by 20.5.2.2.1.

20.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

20.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

20.6 Reserved.

20.7* Operating Features.

20.7.1 Evacuation and Relocation Plan and Fire Drills.

20.7.1.1 The administration of every ambulatory health care facility shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for their evacuation from the building when necessary.

20.7.1.2 All employees shall be periodically instructed and kept informed with respect to their duties under the plan required by 20.7.1.1.

20.7.1.3 A copy of the plan required by 20.7.1.1 shall be readily available at all times when the facility is open.

20.7.1.4* Fire drills in ambulatory health care facilities shall include the simulation of emergency fire conditions.

20.7.1.5 Patients shall not be required to be moved during drills to safe areas or to the exterior of the building.

20.7.1.6 Drills shall be conducted quarterly on each shift to familiarize facility personnel (including but not limited to nurses, interns, maintenance engineers, and administrative staff) with the emergency action required under varied conditions.

20.7.1.7 Employees of ambulatory health care facilities shall be instructed in life safety procedures and devices.

20.7.2 Procedure in Case of Fire.

20.7.2.1* Protection of Patients.

20.7.2.1.1 For ambulatory health care facilities, the proper protection of patients shall require the prompt and effective response of ambulatory health care personnel.

20.7.2.1.2 The basic response required of staff shall include the following:

(1) Removal of all occupants directly involved with the fire emergency
(2) Transmission of an appropriate fire alarm signal to warn other building occupants and summon staff
(3) Confinement of the effects of the fire by closing doors to isolate the fire area
(4) Relocation of patients as detailed in the facility's fire safety plan

20.7.2.2 Fire Safety Plan. A written fire safety plan shall provide for all of the following:

(1) Use of alarms
(2) Transmission of alarms to fire department
(3) Response to alarms
(4) Isolation of fire
(5) Evacuation of immediate area
(6) Evacuation of smoke compartment
(7) Preparation of floors and building for evacuation
(8) Extinguishment of fire

20.7.2.3 Staff Response.

20.7.2.3.1 All personnel shall be instructed in the use of and response to fire alarms.

20.7.2.3.2 All personnel shall be instructed in the use of the code phrase to ensure transmission of an alarm under either of the following conditions:

(1) When the individual who discovers a fire must immediately go to the aid of an endangered person
(2) During a malfunction of the building fire alarm system

20.7.2.3.3 Personnel hearing the code announced shall first activate the building fire alarm using the nearest fire alarm box and then shall execute immediately their duties as outlined in the fire safety plan.

20.7.3 Maintenance of Exits.

20.7.3.1 Proper maintenance shall be provided to ensure the dependability of the method of evacuation selected.

20.7.3.2 Ambulatory health care occupancies that find it necessary to lock exits shall, at all times, maintain an adequate staff qualified to release locks and direct occupants from the immediate danger area to a place of safety in case of fire or other emergency.

20.7.4* Smoking. Smoking regulations shall be adopted and shall include not less than the following provisions:

(1) Smoking shall be prohibited in any room, ward, or compartment where flammable liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and such areas shall be posted with signs that read NO SMOKING or shall be posted with the international symbol for no smoking.

(2) In ambulatory health care facilities where smoking is prohibited and signs are placed at all major entrances, secondary signs with language that prohibits smoking shall not be required.
(3) Smoking by patients classified as not responsible shall be prohibited.
(4) The requirement of 20.7.4(3) shall not apply where the patient is under direct supervision.
(5) Ashtrays of noncombustible material and safe design shall be provided in all areas where smoking is permitted.
(6) Metal containers with self-closing cover devices into which ashtrays can be emptied shall be readily available to all areas where smoking is permitted.

20.7.5 Furnishings, Mattresses, and Decorations.

20.7.5.1* Draperies, curtains, and other loosely hanging fabrics and films serving as furnishings or decorations in ambulatory health care occupancies shall be in accordance with the provisions of 10.3.1, and the following also shall apply:

(1) Such curtains shall include cubicle curtains.
(2) Such curtains shall not include curtains at showers.

20.7.5.2 Newly introduced upholstered furniture shall comply with 10.3.2.1 and one of the following provisions:

(1) The furniture shall meet the criteria specified in 10.3.3.
(2) The furniture shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

20.7.5.3 Newly introduced mattresses shall comply with 10.3.2.2 and one of the following provisions:

(1) The mattresses shall meet the criteria specified in 10.3.4.
(2) The mattresses shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

20.7.5.4 Combustible decorations shall be prohibited, unless one of the following criteria is met:

(1) They are flame-retardant.
(2) The decorations meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(3) The decorations exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(4)*The decorations, such as photographs, paintings, and other art, are attached directly to the walls, ceiling, and non-fire-rated doors in accordance with the following:
   (a) Decorations on non-fire-rated doors do not interfere with the operation or any required latching of the door and do not exceed the area limitations of 20.7.5.4(4)(b) or (c).
   (b) Decorations do not exceed 20 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is not protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.
   (c) Decorations do not exceed 30 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is protected throughout by an approved supervised automatic sprinkler system in accordance with Section 9.7.

20.7.5.5 Soiled Linen and Trash Receptacles.

20.7.5.5.1 Soiled linen or trash collection receptacles shall not exceed 32 gal (121 L) in capacity, and all of the following also shall apply:

(1) The average density of container capacity in a room or space shall not exceed 0.5 gal/ft^2 (20.4 L/m^2).
(2) A capacity of 32 gal (121 L) shall not be exceeded within any 64 ft^2 (6 m^2) area.
(3) Mobile soiled linen or trash collection receptacles with capacities greater than 32 gal (121 L) shall be located in a room protected as a hazardous area when not attended.
(4) Container size and density shall not be limited in hazardous areas.

20.7.5.5.2* Containers used solely for recycling clean waste or for patient records awaiting destruction shall be permitted to be excluded from the requirements of 20.7.5.5.1 where all the following conditions are met:

(1) Each container shall be limited to a maximum capacity of 96 gal (363 L), except as permitted by 20.7.5.5.2(2) or (3).
(2)*Containers with capacities greater than 96 gal (363 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size shall not be limited in hazardous areas.
(4) Containers for combustibles shall be labeled and listed as meeting the requirements of FM Approval Standard 6921, *Containers for Combustible Waste*; however, such testing, listing, and labeling shall not be limited to FM Approvals.

20.7.5.5.3 The provisions of 10.3.9, applicable to containers for waste, or linen, shall not apply.

20.7.6 Maintenance and Testing. *(See 4.6.12.)*

20.7.7* Engineered Smoke Control Systems.

20.7.7.1 New engineered smoke control systems shall be tested in accordance with established engineering principles and shall meet the performance requirements of such testing prior to acceptance.

20.7.7.2 Following acceptance, all engineered smoke control systems shall be tested periodically in accordance with recognized engineering principles.

20.7.7.3 Test documentation shall be maintained on the premises at all times.

20.7.8 Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all ambulatory health care occupancies, unless both of the following criteria are met:

(1) Such devices are used only in nonsleeping staff and employee areas.
(2) The heating elements of such devices do not exceed 212°F (100°C).

20.7.9 Construction, Repair, and Improvement Operations.

20.7.9.1 Construction, repair, and improvement operations shall comply with 4.6.10.

20.7.9.2 The means of egress in any area undergoing construction, repair, or improvements shall be inspected daily for compliance with 7.1.10.1 and shall also comply with NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

Chapter 21 Existing Ambulatory Health Care Occupancies

21.1 General Requirements.

21.1.1 Application.

21.1.1.1 General.

21.1.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as an ambulatory health care occupancy.

21.1.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

21.1.1.1.3 General. The provisions of Chapter 4, General, shall apply.

21.1.1.1.4 Buildings, or sections of buildings, that primarily house patients who, in the opinion of the governing body of the facility and the governmental agency having jurisdiction, are capable of exercising judgment and appropriate physical action for self-preservation under emergency conditions shall be permitted to comply with chapters of this *Code* other than Chapter 21.

21.1.1.1.5 It shall be recognized that, in buildings providing treatment for certain types of patients or having detention rooms or a security section, it might be necessary to lock doors and bar windows to confine and protect building inhabitants. In such instances, the authority having jurisdiction shall make appropriate modifications to those sections of this *Code* that would otherwise require means of egress to be kept unlocked.

21.1.1.1.6* The requirements of this chapter shall apply based on the assumption that staff is available in all patient-occupied areas to perform certain fire safety functions as required in other paragraphs of this chapter.

21.1.1.2* Goals and Objectives. The goals and objectives of Sections 4.1 and 4.2 shall be met with due consideration for functional requirements, which are accomplished by limiting the development and spread of a fire emergency to the room of fire origin and reducing the need for occupant evacuation, except from the room of fire origin.

21.1.1.3 Total Concept.

21.1.1.3.1 All ambulatory health care facilities shall be designed, constructed, maintained, and operated to minimize the possibility of a fire emergency requiring the evacuation of occupants.

21.1.1.3.2 Because the safety of ambulatory health care occupants cannot be ensured adequately by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities; adequate, trained staff; and development of operating and maintenance procedures composed of the following:

(1) Design, construction, and compartmentation
(2) Provision for detection, alarm, and extinguishment
(3) Fire prevention and planning, training, and drilling programs for the isolation of fire, transfer of occupants to areas of refuge, or evacuation of the building

21.1.1.4 Additions, Conversions, Modernization, Renovation, and Construction Operations.

21.1.1.4.1 Additions.

21.1.1.4.1.1 Additions shall be separated from any existing structure not conforming to the provisions within Chapter 21 by a fire barrier having not less than a 2-hour fire resistance rating and constructed of materials as required for the addition. *(See 4.6.5 and 4.6.7.)*

21.1.1.4.1.2 Doors in barriers required by 21.1.1.4.1.1 shall normally be kept closed, unless otherwise permitted by 21.1.1.4.1.3.

21.1.1.4.1.3 Doors shall be permitted to be held open if they meet the requirements of 21.2.2.2.2.

21.1.1.4.2 Changes of Occupancy. A change from a hospital or nursing home to an ambulatory health care occupancy shall not be considered a change in occupancy or occupancy subclassification.

21.1.1.4.3 Renovations, Alterations, and Modernizations. *(See 4.6.7.)*

21.1.1.4.4 Construction, Repair, and Improvement Operations. *(See 4.6.10.)*

21.1.2 Classification of Occupancy. *(See 6.1.6 and 21.1.4.2.)*

21.1.3 Multiple Occupancies.

21.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

21.1.3.2 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis, provided both of the following are met:

(1) The provision is not used for occupancy separations involving industrial and storage occupancies.
(2) Smoke partitions serving as atrium walls are not permitted to serve as enclosures for hazardous areas.

21.1.3.3* Sections of ambulatory health care facilities shall be permitted to be classified as other occupancies, provided that they meet both of the following conditions:

(1) They are not intended to serve ambulatory health care occupants for purposes of treatment or customary access by patients incapable of self-preservation.
(2) They are separated from areas of ambulatory health care occupancies by construction having a minimum 1-hour fire resistance rating.

21.1.3.4 All means of egress from ambulatory health care occupancies that traverse nonambulatory health care spaces shall conform to the requirements of this *Code* for ambulatory health care occupancies, unless otherwise permitted by 21.1.3.5.

21.1.3.5 Exit through a horizontal exit into other contiguous occupancies that do not conform with ambulatory health care egress provisions but that do comply with requirements set forth in the appropriate occupancy chapter of this *Code* shall be permitted, provided that the occupancy does not contain high hazard contents.

21.1.3.6 Egress provisions for areas of ambulatory health care facilities that correspond to other occupancies shall meet the corresponding requirements of this *Code* for such occupancies, and, where the clinical needs of the occupant necessitate the locking of means of egress, staff shall be present for the supervised release of occupants during all times of use.

21.1.3.7 Any area with a hazard of contents classified higher than that of the ambulatory health care occupancy and located in the same building shall be protected as required in 21.3.3.

21.1.3.8 Non-health care–related occupancies classified as containing high hazard contents shall not be permitted in buildings housing ambulatory health care occupancies.

21.1.4 Definitions.

21.1.4.1 General. For definitions, see Chapter 3, Definitions.

21.1.4.2 Definition — Ambulatory Health Care Occupancy. *(See 3.3.190.1.)*

21.1.5 Classification of Hazard of Contents. The classification of hazard of contents shall be as defined in Section 6.2.

21.1.6 Minimum Construction Requirements.

21.1.6.1 Ambulatory health care occupancies shall be limited to the building construction types specified in Table 21.1.6.1, unless otherwise permitted by 21.1.6.6. *(See 8.2.1.)*

Table 21.1.6.1 Construction Type Limitations

Construction Type	Sprinklered†	Stories in Height‡ 1	Stories in Height‡ ≥2
I (442)	Yes	X	X
	No	X	X
I (332)	Yes	X	X
	No	X	X
II (222)	Yes	X	X
	No	X	X
II (111)	Yes	X	X
	No	X	X
II (000)	Yes	X	X
	No	X	NP
III (211)	Yes	X	X
	No	X	X
III (200)	Yes	X	X
	No	X	NP
IV (2HH)	Yes	X	X
	No	X	X
V (111)	Yes	X	X
	No	X	X
V (000)	Yes	X	X
	No	X	NP

X: Permitted. NP: Not permitted.

†Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7. *(See 21.3.5.)*

‡See 4.6.3.

21.1.6.2 Any level below the level of exit discharge shall be separated from the level of exit discharge by not less than Type II (111), Type III (211), or Type V (111) construction *(see 8.2.1)*, unless both of the following criteria are met:

(1) Such levels are under the control of the ambulatory health care facility.
(2) Any hazardous spaces are protected in accordance with Section 8.7.

21.1.6.3 Interior nonbearing walls in buildings of Type I or Type II construction shall be constructed of noncombustible or limited-combustible materials, unless otherwise permitted by 21.1.6.4.

21.1.6.4 Interior nonbearing walls required to have a fire resistance rating of 2 hours or lessshall be permitted to be fire-retardant-treated wood enclosed within noncombustible or limited-combustible materials, provided that such walls are not used as shaft enclosures.

21.1.6.5 All buildings with more than one level below the level of exit discharge shall have all such lower levels separated from the level of exit discharge by not less than Type II (111) construction.

21.1.6.6 In existing buildings, the authority having jurisdiction shall be permitted to accept construction systems of lesser fire resistance than those required by 21.1.6.1 through 21.1.6.5, provided that it can be demonstrated to the authority's satisfaction that prompt evacuation of the facility can be achieved in case of fire or that the exposing occupancies and materials of construction present no threat of fire penetration from such occupancy to the ambulatory health care facility or to the collapse of the structure.

21.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

21.2 Means of Egress Requirements.

21.2.1 General. Every aisle, passageway, corridor, exit discharge, exit location, and access shall be in accordance with Chapter 7, unless otherwise modified by 21.2.2 through 21.2.11.

21.2.2 Means of Egress Components.

21.2.2.1 Components Permitted. Means of egress components shall be limited to the types described in 21.2.2.2 through 21.2.2.12.

21.2.2.2 Doors.

21.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

21.2.2.2.2 Any door required to be self-closing shall be permitted to be held open only by an automatic release device that complies with 7.2.1.8.2. The required manual fire alarm system and the systems required by 7.2.1.8.2 shall be arranged to initiate the closing action of all such doors throughout the smoke compartment or throughout the entire facility.

21.2.2.2.3 Where doors in a stair enclosure are held open by an automatic release device as permitted in 21.2.2.2.2, initiation of a door-closing action on any level shall cause all doors at all levels in the stair enclosure to close.

21.2.2.2.4* Locks complying with 7.2.1.5.5 shall be permitted only on principal entrance/exit doors.

21.2.2.2.5 The re-entry provisions of 7.2.1.5.8 shall not apply to any of the following:

(1) Existing ambulatory health care occupancies that are not in high-rise buildings
(2) Existing high-rise buildings that are protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1)
(3) Existing high-rise buildings having approved existing means for providing stair re-entry

21.2.2.2.6 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

21.2.2.2.7 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

21.2.2.2.8 Elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 shall be permitted.

21.2.2.2.9 Horizontal or vertical security grilles or doors complying with 7.2.1.4(3) shall be permitted to be used as part of the required means of egress from a tenant space.

21.2.2.2.10 Approved existing horizontal-sliding or vertical-rolling fire doors shall be permitted in the means of egress where they comply with all of the following conditions:

(1) They are held open by fusible links.
(2) The fusible links are rated at not less than 165°F (74°C).
(3) The fusible links are located not more than 10 ft (3050 mm) above the floor.
(4) The fusible links are in immediate proximity to the door opening.
(5) The fusible links are not located above a ceiling.
(6) The door is not credited with providing any protection under this *Code*.

21.2.2.2.11 Revolving doors complying with 7.2.1.10 shall be permitted.

21.2.2.2.12* A door in a horizontal exit shall not be required to swing in the direction of egress travel as specified in 7.2.4.3.8.1.

21.2.2.3 Stairs.

21.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

21.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

21.2.2.3.3 Winders complying with 7.2.2.2.4 shall be permitted.

21.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

21.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

21.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

21.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

21.2.2.8 Escalators and Moving Walks. Escalators and moving walks complying with 7.2.7 shall be permitted.

21.2.2.9 Fire Escape Stairs. (Reserved)

21.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

21.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

21.2.2.12 Areas of Refuge.

21.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted.

21.2.2.12.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), two rooms or spaces separated from each other by smoke-resistant partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

21.2.3 Capacity of Means of Egress.

21.2.3.1 The capacity of any required means of egress shall be determined in accordance with the provisions of Section 7.3.

21.2.3.2 The clear width of any corridor or passageway required for exit access shall be not less than 44 in. (1120 mm).

21.2.3.3* Where minimum corridor width is 6 ft (1830 mm), projections not more than 6 in. (150 mm) from the corridor wall, above the handrail height, shall be permitted for the installation of hand-rub dispensing units in accordance with 21.4.3.

21.2.3.4 Doors in the means of egress from diagnostic or treatment areas, such as x-ray, surgical, or physical therapy, shall provide a clear width of not less than 32 in. (810 mm), unless such doors are existing 34 in. (865 mm) doors.

21.2.4 Number of Means of Egress.

21.2.4.1 The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.

21.2.4.2 Not less than two exits of the types described in 21.2.2 that are remotely located from each other shall be provided for each floor or fire section of the building.

21.2.4.3 Not less than two exits of the types described in 21.2.2 shall be accessible from each smoke compartment.

21.2.4.4 Egress from smoke compartments addressed in 21.2.4.3 shall be permitted through adjacent compartments provided that the two required egress paths are arranged so that both do not pass through the same adjacent smoke compartment.

21.2.5 Arrangement of Means of Egress.

21.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

21.2.5.2 Dead-end corridors shall not exceed 50 ft (15 m).

21.2.5.3 Limitations on common path of travel shall be in accordance with 21.2.5.3.1, 21.2.5.3.2, and 21.2.5.3.3.

21.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) on a story protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1).

21.2.5.3.2 Common path of travel shall not be limited in a single-tenant space with an occupant load not exceeding 25 people.

21.2.5.3.3 In buildings other than those complying with 21.2.5.3.1 or 21.2.5.3.2, common path of travel shall not exceed 75 ft (23 m).

21.2.6 Travel Distance to Exits.

21.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

21.2.6.2 Travel distance shall comply with 21.2.6.2.1 and 21.2.6.2.2.

21.2.6.2.1 The travel distance between any point in a room and an exit shall not exceed 150 ft (46 m).

21.2.6.2.2 The maximum travel distance in 21.2.6.2.1 shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

21.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

21.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

21.2.9 Emergency Lighting and Essential Electrical Systems.

21.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9.

21.2.9.2 Where general anesthesia or life-support equipment is used, each ambulatory health care facility shall be provided with an essential electrical system in accordance with NFPA 99, *Health Care Facilities Code*, unless otherwise permitted by one of the following:

(1) Where battery-operated equipment is provided and acceptable to the authority having jurisdiction
(2) Where a facility uses life-support equipment for emergency purposes only

21.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

21.2.11 Special Means of Egress Features.

21.2.11.1 Reserved.

21.2.11.2 Lockups. Lockups in ambulatory health care occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

21.3 Protection.

21.3.1 Protection of Vertical Openings.

21.3.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by any of the following:

(1) Unenclosed vertical openings in accordance with 8.6.9.1 shall be permitted.
(2) Unprotected vertical openings shall be permitted in buildings complying with all of the following:
    (a) Where protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1)
    (b) Where no unprotected vertical opening serves as any part of any required means of egress
    (c) Where required exits consist of exit doors that discharge directly to the finished ground level in accordance with 7.2.1, outside stairs in accordance with 7.2.2, smokeproof enclosures in accordance with 7.2.3, or horizontal exits in accordance with 7.2.4

21.3.1.2 Floors that are below the street floor and are used for storage or other than an ambulatory health care occupancy shall have no unprotected openings to ambulatory health care occupancy floors.

21.3.2 Protection from Hazards.

21.3.2.1* General. Hazardous areas including, but not limited to, areas used for general storage, boiler or furnace rooms, and maintenance shops that include woodworking and painting areas shall be protected in accordance with Section 8.7.

21.3.2.2 Doors. Doors to hazardous areas shall be self-closing or automatic-closing in accordance with 21.2.2.2.2.

21.3.2.3* High Hazard Contents Areas. High hazard contents areas, as classified in Section 6.2, shall meet all of the following criteria:

(1) The area shall be separated from other parts of the building by fire barriers having a minimum 1-hour fire resistance rating, with all openings therein protected by self-closing fire door assemblies having a minimum ¾-hour fire protection rating.
(2) The area shall be protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2.

21.3.2.4 Medical Gas. Medical gas storage shall be in accordance with Section 8.7 and the provisions of NFPA 99, *Health Care Facilities Code*, applicable to operation, maintenance, and testing.

21.3.2.5 Laboratories.

21.3.2.5.1 Laboratories in which chemicals are handled or stored shall comply with the operational requirements of NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*.

21.3.2.5.2 Laboratories employing quantities of flammable, combustible, or hazardous materials that are considered as a severe hazard shall be protected in accordance with 8.7.1.1.

21.3.2.6 Cooking Facilities. Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 21.3.2.7.

21.3.2.7 Domestic Cooking Equipment. Where domestic cooking equipment is used for food warming or limited cooking, protection or separation of food preparation facilities shall not be required.

21.3.3 Interior Finish.

21.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

21.3.3.2 Interior Wall and Ceiling Finish.

21.3.3.2.1 Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in exits and in exit access corridors.

21.3.3.2.2 Interior wall and ceiling finishes shall be Class A, Class B, or Class C in areas other than those specified in 21.3.3.2.1.

21.3.3.3 Interior Floor Finish. (Reserved)

21.3.4 Detection, Alarm, and Communications Systems.

21.3.4.1 General. Ambulatory health care facilities shall be provided with fire alarm systems in accordance with Section 9.6, except as modified by 21.3.4.2 through 21.3.4.4.

21.3.4.2 Initiation. Initiation of the required fire alarm systems shall be by manual means in accordance with 9.6.2 and by means of any detection devices or detection systems required.

21.3.4.3 Notification. Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

21.3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically, without delay, in accordance with 9.6.3 upon operation of any fire alarm activating device.

21.3.4.3.2 Emergency Forces Notification.

21.3.4.3.2.1 Emergency forces notification shall be accomplished in accordance with 9.6.4.

21.3.4.3.2.2 Smoke detection devices or smoke detection systems equipped with reconfirmation features shall not be required to automatically notify the fire department, unless the alarm condition is reconfirmed after a period not exceeding 120 seconds.

21.3.4.4 Fire Safety Functions. Operation of any activating device in the required fire alarm system shall be arranged to accomplish automatically, without delay, any control functions required to be performed by that device. *(See 9.6.5.)*

21.3.5 Extinguishment Requirements.

21.3.5.1 Isolated hazardous areas shall be permitted to be protected in accordance with 9.7.1.2.

21.3.5.2 For new installations in existing ambulatory health care facilities, where more than two sprinklers are installed in a single area for protection in accordance with 9.7.1.2, waterflow detection shall be provided to sound the building fire alarm or to notify, by a signal, any constantly attended location, such as PBX, security, or emergency room, at which the necessary corrective action shall be taken.

21.3.5.3 Portable fire extinguishers shall be provided in ambulatory health care facilities in accordance with Section 9.9.

21.3.6 Corridors. (Reserved)

21.3.7 Subdivision of Building Space.

21.3.7.1 Ambulatory health care occupancies shall be separated from other tenants and occupancies and shall meet all of the following requirements:

(1) Walls shall have not less than a 1-hour fire resistance rating and shall extend from the floor slab below to the floor or roof slab above.
(2) Doors shall be constructed of not less than 1¾ in. (44 mm) thick, solid-bonded wood core or the equivalent and shall be equipped with positive latches.
(3) Doors shall be self-closing and shall be kept in the closed position, except when in use.
(4) Any windows in the barriers shall be of fixed fire window assemblies in accordance with Section 8.3.

21.3.7.2 Every story of an ambulatory health care occupancy shall be divided into not less than two smoke compartments, unless otherwise permitted by one of the following:

(1) This requirement shall not apply where the area of the ambulatory health care occupancy is less than 5000 ft^2 (465 m^2) per story and that area is protected by an approved automatic smoke detection system.
(2) This requirement shall not apply where the area of the ambulatory health care occupancy is less than 10,000 ft^2 (929 m^2) per story and the building is protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.7.
(3) An area in an adjoining occupancy shall be permitted to serve as a smoke compartment for an ambulatory health care occupancy if all of the following criteria are met:
    (a) The separating wall and both compartments meet the requirements of 21.3.7.
    (b) The ambulatory health care occupancy is less than 22,500 ft^2 (2100 m^2).
    (c) Access from the ambulatory health care occupancy to the other occupancy is unrestricted.

21.3.7.3 Reserved.

21.3.7.4 Reserved.

21.3.7.5 Required smoke barriers shall be constructed in accordance with Section 8.5 and shall have a minimum ½-hour fire resistance rating, unless otherwise permitted by 21.3.7.7.

21.3.7.6 Smoke barriers shall be permitted to terminate at the required occupancy separation where the ambulatory health care occupancy is constructed as a separated multiple occupancy in accordance with 6.1.14.4.

21.3.7.7 Smoke dampers shall not be required in duct penetrations of smoke barriers in fully ducted heating, ventilating, and air-conditioning systems where adjacent smoke compartments are protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

21.3.7.8 Windows in the smoke barrier shall be of fixed fire window assemblies in accordance with Section 8.3.

21.3.7.9 Reserved.

21.3.7.10* Doors in smoke barriers shall be not less than 1¾ in. (44 mm) thick, solid-bonded wood core or the equivalent and shall be self-closing or automatic-closing in accordance with 21.2.2.2.2.

21.3.7.11 Latching hardware shall not be required on smoke barrier cross-corridor doors, and doors shall not be required to swing in the direction of egress travel.

21.4 Special Provisions.

21.4.1 Limited Access or Underground Buildings. *(See Section 11.7.)*

21.4.2 High-Rise Buildings.

21.4.2.1 All high-rise buildings shall be provided with a reasonable degree of safety from fire, and such degree of safety shall be accomplished by one of the following means:

(1) Installation of a complete, approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(2) Installation of an engineered life safety system complying with all of the following:
    (a) The engineered life safety system shall be developed by a registered professional engineer experienced in fire and life safety systems design.
    (b) The life safety system shall be approved by the authority having jurisdiction and shall be permitted to include any or all of the following systems:
        i. Partial automatic sprinkler protection
        ii. Smoke detection alarms
        iii. Smoke control
        iv. Compartmentation
        v. Other approved systems

21.4.2.2* A limited, but reasonable, time shall be permitted for compliance with any part of 21.4.2.1, commensurate with the magnitude of expenditure and the disruption of services.

21.4.2.3 In addition to the requirements of 21.4.2.1 and 21.4.2.2, all buildings, regardless of height, shall comply with all other applicable provisions of this chapter.

21.4.3* Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be protected in accordance with 8.7.3.1, unless all of the following conditions are met:

(1) Where dispensers are installed in a corridor, the corridor shall have a minimum width of 6 ft (1830 mm).
(2) The maximum individual dispenser fluid capacity shall be as follows:
  (a) 0.32 gal (1.2 L) for dispensers in rooms, corridors, and areas open to corridors
  (b) 0.53 gal (2.0 L) for dispensers in suites of rooms
(3) Where aerosol containers are used, the maximum capacity of the aerosol dispenser shall be 18 oz (0.51 kg) and shall be limited to Level 1 aerosols as defined in NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*.
(4) Dispensers shall be separated from each other by horizontal spacing of not less than 48 in. (1220 mm).
(5) Not more than an aggregate 10 gal (37.8 L) of alcohol-based hand-rub solution or 1135 oz (32.2 kg) of Level 1 aerosols, or a combination of liquids and Level 1 aerosols not to exceed, in total, the equivalent of 10 gal (37.8 L) or 1135 oz (32.2 kg), shall be in use outside of a storage cabinet in a single smoke compartment, except as otherwise provided in 21.4.3(6).
(6) One dispenser per room complying with 21.4.3 (2) or (3), and located in the room, shall not be required to be included in the aggregated quantity specified in 21.4.3(5).
(7) Storage of quantities greater than 5 gal (18.9 L) in a single smoke compartment shall meet the requirements of NFPA 30, *Flammable and Combustible Liquids Code*.
(8) Dispensers shall not be installed in the following locations:
  (a) Above an ignition source within a 1 in. (25 mm) horizontal distance from each side of the ignition source
  (b) To the side of an ignition source within a 1 in. (25 mm) horizontal distance from the ignition source
  (c) Beneath an ignition source within a 1 in. (25 mm) vertical distance from the ignition source
(9) Dispensers installed directly over carpeted floors shall be permitted only in sprinklered smoke compartments.
(10) The alcohol-based hand-rub solution shall not exceed 95 percent alcohol content by volume.
(11) Operation of the dispenser shall comply with the following criteria:
  (a) The dispenser shall not release its contents except when the dispenser is activated, either manually or automatically by touch-free activation.
  (b) Any activation of the dispenser shall occur only when an object is placed within 4 in. (100 mm) of the sensing device.
  (c) An object placed within the activation zone and left in place shall not cause more than one activation.
  (d) The dispenser shall not dispense more solution than the amount required for hand hygiene consistent with label instructions.
  (e) The dispenser shall be designed, constructed, and operated in a manner that ensures that accidental or malicious activation of the dispensing device is minimized.
  (f) The dispenser shall be tested in accordance with the manufacturer's care and use instructions each time a new refill is installed.

21.5 Building Services.

21.5.1 Utilities.

21.5.1.1 Utilities shall comply with the provisions of Section 9.1.

21.5.1.2 Existing installations shall be permitted to be continued in service, provided that the systems do not present a serious hazard to life.

21.5.2 Heating, Ventilating, and Air-Conditioning.

21.5.2.1 Heating, ventilating, and air-conditioning shall comply with the provisions of Section 9.2 and shall be in accordance with the manufacturer's specifications, unless otherwise modified by 21.5.2.2.

21.5.2.2 If fuel-fired, heating devices shall comply with all of the following:

(1) They shall be chimney connected or vent connected.
(2) They shall take air for combustion directly from the outside.
(3) They shall be designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area.

21.5.2.2.1 Any heating device shall have safety features to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperature or ignition failure.

21.5.2.2.2 Approved, suspended unit heaters shall be permitted in locations other than means of egress and patient treatment areas, provided that both of the following criteria are met:

(1) Such heaters are located high enough to be out of the reach of persons using the area.
(2) Such heaters are equipped with the safety features required by 21.5.2.2.1.

21.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

21.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

21.6 Reserved.

21.7* Operating Features.

21.7.1 Evacuation and Relocation Plan and Fire Drills.

21.7.1.1 The administration of every ambulatory health care facility shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for their evacuation from the building when necessary.

21.7.1.2 All employees shall be periodically instructed and kept informed with respect to their duties under the plan required by 21.7.1.1.

21.7.1.3 A copy of the plan required by 21.7.1.1 shall be readily available at all times when the facility is open.

21.7.1.4* Fire drills in ambulatory health care facilities shall include simulation of emergency fire conditions.

21.7.1.5 Patients shall not be required to be moved during drills to safe areas or to the exterior of the building.

21.7.1.6 Drills shall be conducted quarterly on each shift to familiarize facility personnel (including but not limited to nurses, interns, maintenance engineers, and administrative staff) with the emergency action required under varied conditions.

21.7.1.7 Employees of ambulatory health care facilities shall be instructed in life safety procedures and devices.

21.7.2 Procedure in Case of Fire.

21.7.2.1* Protection of Patients.

21.7.2.1.1 For ambulatory health care facilities, the proper protection of patients shall require the prompt and effective response of ambulatory health care personnel.

21.7.2.1.2 The basic response required of staff shall include the following:

(1) Removal of all occupants directly involved with the fire emergency
(2) Transmission of an appropriate fire alarm signal to warn other building occupants and summon staff
(3) Confinement of the effects of the fire by closing doors to isolate the fire area
(4) Relocation of patients as detailed in the facility's fire safety plan

21.7.2.2 Fire Safety Plan. A written fire safety plan shall provide for all of the following:

(1) Use of alarms
(2) Transmission of alarms to fire department
(3) Response to alarms
(4) Isolation of fire
(5) Evacuation of immediate area
(6) Evacuation of smoke compartment
(7) Preparation of floors and building for evacuation
(8) Extinguishment of fire

21.7.2.3 Staff Response.

21.7.2.3.1 All personnel shall be instructed in the use of and response to fire alarms.

21.7.2.3.2 All personnel shall be instructed in the use of the code phrase to ensure transmission of an alarm under either of the following conditions:

(1) When the individual who discovers a fire must immediately go to the aid of an endangered person
(2) During a malfunction of the building fire alarm system

21.7.2.3.3 Personnel hearing the code announced shall first activate the building fire alarm using the nearest fire alarm box and then shall execute immediately their duties as outlined in the fire safety plan.

21.7.3 Maintenance of Exits.

21.7.3.1 Proper maintenance shall be provided to ensure the dependability of the method of evacuation selected.

21.7.3.2 Ambulatory health care occupancies that find it necessary to lock exits shall, at all times, maintain an adequate staff qualified to release locks and direct occupants from the immediate danger area to a place of safety in case of fire or other emergency.

21.7.4* Smoking. Smoking regulations shall be adopted and shall include not less than the following provisions:

(1) Smoking shall be prohibited in any room, ward, or compartment where flammable liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and such areas shall be posted with signs that read NO SMOKING or shall be posted with the international symbol for no smoking.
(2) In ambulatory health care facilities where smoking is prohibited and signs are placed at all major entrances, secondary signs with language that prohibits smoking shall not be required.
(3) Smoking by patients classified as not responsible shall be prohibited.
(4) The requirement of 21.7.4(3) shall not apply where the patient is under direct supervision.
(5) Ashtrays of noncombustible material and safe design shall be provided in all areas where smoking is permitted.
(6) Metal containers with self-closing cover devices into which ashtrays can be emptied shall be readily available to all areas where smoking is permitted.

21.7.5 Furnishings, Mattresses, and Decorations.

21.7.5.1* Draperies, curtains, and other loosely hanging fabrics and films serving as furnishings or decorations in ambulatory health care occupancies shall be in accordance with the provisions of 10.3.1, and the following also shall apply:

(1) Such curtains shall include cubicle curtains.
(2) Such curtains shall not include curtains at showers.

21.7.5.2 Newly introduced upholstered furniture shall comply with 10.3.2.1 and one of the following provisions:

(1) The furniture shall meet the criteria specified in 10.3.3.
(2) The furniture shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

21.7.5.3 Newly introduced mattresses shall comply with 10.3.2.2 and one of the following provisions:

(1) The mattresses shall meet the criteria specified in 10.3.4.
(2) The mattresses shall be in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

21.7.5.4 Combustible decorations shall be prohibited, unless one of the following criteria is met:

(1) They are flame-retardant.
(2) The decorations meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*.
(3) The decorations exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(4)*The decorations, such as photographs, paintings, and other art, are attached directly to the walls, ceiling, and non-fire-rated doors in accordance with the following:
   (a) Decorations on non-fire-rated doors do not interfere with the operation or any required latching of the door and do not exceed the area limitations of 21.7.5.4(4)(b) or (c).
   (b) Decorations do not exceed 20 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is not protected throughout by an approved automatic sprinkler system in accordance with Section 9.7.

(c) Decorations do not exceed 30 percent of the wall, ceiling, and door areas inside any room or space of a smoke compartment that is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

21.7.5.5 Soiled Linen and Trash Receptacles.

21.7.5.5.1 Soiled linen or trash collection receptacles shall not exceed 32 gal (121 L) in capacity, and all of the following also shall apply:

(1) The average density of container capacity in a room or space shall not exceed 0.5 gal/ft^2 (20.4 L/m^2).
(2) A capacity of 32 gal (121 L) shall not be exceeded within any 64 ft^2 (6 m^2) area.
(3) Mobile soiled linen or trash collection receptacles with capacities greater than 32 gal (121 L) shall be located in a room protected as a hazardous area when not attended.
(4) Container size and density shall not be limited in hazardous areas.

21.7.5.5.2* Containers used solely for recycling clean waste or for patient records awaiting destruction shall be permitted to be excluded from the requirements of 21.7.5.5.1 where all the following conditions are met:

(1) Each container shall be limited to a maximum capacity of 96 gal (363 L), except as permitted by 21.7.5.5.2(2) or (3).
(2)*Containers with capacities greater than 96 gal (363 L) shall be located in a room protected as a hazardous area when not attended.
(3) Container size shall not be limited in hazardous areas.
(4) Containers for combustibles shall be labeled and listed as meeting the requirements of FM Approval Standard 6921, *Containers for Combustible Waste*; however, such testing, listing, and labeling shall not be limited to FM Approvals.

21.7.5.5.3 The provisions of 10.3.9, applicable to containers for waste, or linen, shall not apply.

21.7.6 Maintenance and Testing. *(See 4.6.12.)*

21.7.7* Engineered Smoke Control Systems.

21.7.7.1 New engineered smoke control systems shall be tested in accordance with established engineering principles and shall meet the performance requirements of such testing prior to acceptance.

21.7.7.2 Following acceptance, all engineered smoke control systems shall be tested periodically in accordance with recognized engineering principles.

21.7.7.3 Test documentation shall be maintained on the premises at all times.

21.7.8 Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all ambulatory health care occupancies, unless both of the following criteria are met:

(1) Such devices are used only in nonsleeping staff and employee areas.
(2) The heating elements of such devices do not exceed 212°F (100°C).

21.7.9 Construction, Repair, and Improvement Operations.

21.7.9.1 Construction, repair, and improvement operations shall comply with 4.6.10.

21.7.9.2 The means of egress in any area undergoing construction, repair, or improvements shall be inspected daily for compliance with 7.1.10.1 and shall also comply with NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

Chapter 22 New Detention and Correctional Occupancies

22.1 General Requirements.

22.1.1 Application.

22.1.1.1 General.

22.1.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as detention or correctional occupancies. *(See 1.3.1.)*

22.1.1.1.2 Administration. The provisions of Chapter 1 shall apply.

22.1.1.1.3 General. The provisions of Chapter 4 shall apply.

22.1.1.1.4 This chapter establishes life safety requirements that shall apply to the design of all new detention and correctional facilities, other than the following:

(1) Use Condition I facilities protected as residential occupancies in accordance with 22.1.2.3
(2)*Facilities determined to have equivalent safety provided in accordance with Section 1.4

22.1.1.1.5 Detention and correctional occupancies shall include those used for purposes such as correctional institutions, detention facilities, community residential centers, training schools, work camps, and substance abuse centers where occupants are confined or housed under some degree of restraint or security.

22.1.1.1.6* Detention and correctional occupancies shall include those that provide sleeping facilities for one or more residents and are occupied by persons who are generally prevented from taking self-preservation action because of security measures not under the occupants' control.

22.1.1.1.7* Lockups in other than detention and correctional occupancies and health care occupancies shall comply with the requirements of 22.4.5.

22.1.1.2 Total Concept.

22.1.1.2.1 All detention and correctional facilities shall be designed, constructed, maintained, and operated to minimize the possibility of a fire emergency.

22.1.1.2.2 Because the safety of all occupants in detention and correctional facilities cannot be adequately ensured solely by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities; adequate, trained staff; and development of operating, security, and maintenance procedures composed of the following:

(1) Design, construction, and compartmentation
(2) Provision for detection, alarm, and extinguishment
(3) Fire prevention and planning, training, and drilling programs for the isolation of fire and the transfer of occupants to areas of refuge, for evacuation of the building, or for protection of the occupants in place

(4) Provision of security to the degree necessary for the safety of the public and the occupants of the facility

22.1.1.3 Additions. Additions shall be separated from any existing structure not conforming with the provisions of Chapter 23 by a fire barrier having not less than a 2-hour fire resistance rating constructed to the requirements of the addition, and the following also shall apply:

(1) Doors in such partitions shall normally be kept closed.
(2) Doors in such partitions shall be permitted to be held open if they meet the requirements of 7.2.1.8.2.

22.1.1.4 Modernizations or Renovations.

22.1.1.4.1 Modernizations and renovations shall be in accordance with 4.6.7, unless otherwise permitted by 22.1.1.4.2.

22.1.1.4.2 In nonsprinklered existing buildings, modernizations or renovations shall be permitted to comply with the nonsprinklered options contained in 22.4.4 in lieu of the sprinkler requirement of 22.3.5.2.

22.1.2 Classification of Occupancy. See 6.1.7.

22.1.2.1* For application of the life safety requirements of this chapter, the resident user category shall be divided into the groups specified in 22.1.2.1.1 through 22.1.2.1.5.

22.1.2.1.1 Use Condition I — Free Egress. Use Condition I shall be defined as a condition under which free movement is allowed from sleeping areas and other spaces where access or occupancy is permitted to the exterior via means of egress that meet the requirements of the *Code*.

22.1.2.1.2 Use Condition II — Zoned Egress. Use Condition II shall be defined as a condition under which free movement is allowed from sleeping areas and any other occupied smoke compartment to one or more other smoke compartments.

22.1.2.1.3 Use Condition III — Zoned Impeded Egress. Use Condition III shall be defined as a condition under which free movement is allowed within individual smoke compartments, such as within a residential unit comprised of individual sleeping rooms and a group activity space, with egress impeded by remote-controlled release of means of egress from such a smoke compartment to another smoke compartment.

22.1.2.1.4 Use Condition IV — Impeded Egress. Use Condition IV shall be defined as a condition under which free movement is restricted from an occupied space, and remote-controlled release is provided to allow movement from all sleeping rooms, activity spaces, and other occupied areas within the smoke compartment to another smoke compartment.

22.1.2.1.5 Use Condition V — Contained. Use Condition V shall be defined as a condition under which free movement is restricted from an occupied space, and staff-controlled manual release at each door is provided to allow movement from all sleeping rooms, activity spaces, and other occupied areas within the smoke compartment to another smoke compartment.

22.1.2.2* To be classified as Use Condition III or Use Condition IV, the arrangement, accessibility, and security of the release mechanism(s) used for emergency egress shall be such that the minimum available staff, at any time, can promptly release the locks.

22.1.2.3 Areas housing occupancies corresponding to Use Condition I shall conform to one of the following:

(1) Requirements of residential occupancies under this *Code*
(2)*Requirements of this chapter for Use Condition II facilities, provided that the staffing requirements of Section 22.7 are met

22.1.3* Multiple Occupancies.

22.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

22.1.3.2 Egress provisions for areas of detention and correctional facilities that correspond to other occupancies shall meet the corresponding requirements of this *Code* for such occupancies as modified by 22.1.3.2.1 and 22.1.3.2.2.

22.1.3.2.1 Where security operations necessitate the locking of required means of egress, staff in the building shall be provided with a means for the supervised release of occupants during all times of use.

22.1.3.2.2* Where security operations necessitate the locking of required means of egress, the following shall apply:

(1) Detention-grade hardware meeting the requirements of ASTM F 1577, *Standard Test Methods for Detention Locks for Swinging Doors*, shall be provided on swinging doors within the required means of egress.
(2) Sliding doors within the required means of egress shall be designed and engineered for detention and correctional use, and lock cylinders shall meet the cylinder test requirements of ASTM F 1577.

22.1.3.3 Sections of detention and correctional facilities shall be permitted to be classified as other occupancies, provided that they meet both of the following conditions:

(1) They are not intended to serve residents for sleeping purposes.
(2) They are separated from areas of detention or correctional occupancies by construction having not less than a 2-hour fire resistance rating.

22.1.3.4 All means of egress from detention and correctional occupancies that traverse other use areas shall, as a minimum, conform to the requirements of this *Code* for detention and correctional occupancies, unless otherwise permitted by 22.1.3.5.

22.1.3.5 Egress through a horizontal exit into other contiguous occupancies that do not conform with detention and correctional occupancy egress provisions but that do comply with requirements set forth in the appropriate occupancy chapter of this *Code* shall be permitted, provided that both of the following criteria apply:

(1) The occupancy shall not contain high hazard contents.
(2) The horizontal exit shall comply with the requirements of 22.2.2.5.

22.1.3.6 Any area with a hazard of contents classified higher than that of the detention or correctional occupancy and located in the same building shall be protected as required in 22.3.2.

22.1.3.7 Nondetention- or noncorrectional-related occupancies classified as containing high hazard contents shall not be permitted in buildings housing detention or correctional occupancies.

22.1.3.8 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

22.1.4 Definitions.

22.1.4.1 General. For definitions, see Chapter 3, Definitions.

22.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Detention and Correctional Residential Housing Area.** See 3.3.21.1.
(2) **Sally Port (Security Vestibule).** See 3.3.238.

22.1.5 Classification of Hazard of Contents. The classification of hazard of contents shall be as defined in Section 6.2.

22.1.6 Minimum Construction Requirements.

22.1.6.1 Detention and correctional occupancies shall be limited to the building construction types specified in Table 22.1.6.1 *(See 8.2.1.)*

22.1.6.2 All interior walls and partitions in Type I or Type II construction shall be of noncombustible or limited-combustible materials.

22.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, either shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

22.2 Means of Egress Requirements.

22.2.1 General. Means of egress shall comply with Chapter 7, unless otherwise provided or modified by Section 22.2.

22.2.2 Means of Egress Components.

22.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 22.2.2.2 through 22.2.2.11.

22.2.2.2 Doors. Doors complying with 7.2.1 shall be permitted, unless otherwise provided by 22.2.11.

Table 22.1.6.1 Construction Type Limitations

		Stories in Height‡					
Construction Type	**Sprinklered†**	**1 With Basement**	**1 Without Basement**	**2**	**3**	**>3 But Not High-Rise**	**High-Rise**
I (442)	Yes	X	X	X	X	X	X
	No	NP	NP	NP	NP	NP	NP
I (332)	Yes	X	X	X	X	X	X
	No	NP	NP	NP	NP	NP	NP
II (222)	Yes	X	X	X	X	X	X
	No	NP	NP	NP	NP	NP	NP
II (111)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP
II (000)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP
III (211)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP
III (200)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP
IV (2HH)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP
V (111)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP
V (000)	Yes	X	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP	NP

X: Permitted for Use Conditions II, III, IV, and V. *(See 22.1.2.3 for Use Condition I.)*
NP: Not permitted.
†Sprinklered throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1). *(See 22.3.5.)*
‡See 4.6.3.

22.2.2.3 Stairs.

22.2.2.3.1 Stairs shall be permitted as follows:

(1) Stairs complying with 7.2.2 shall be permitted.
(2) Noncombustible grated stair treads and landing floors shall be permitted.

22.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted for access to and between staff locations.

22.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

22.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 and the modifications of 22.2.2.5.1 and 22.2.2.5.2 shall be permitted.

22.2.2.5.1 Not less than 6 ft^2 (0.55 m^2) of accessible space per occupant shall be provided on each side of the horizontal exit for the total number of people in adjoining compartments.

22.2.2.5.2* Horizontal exits shall be permitted to comprise 100 percent of the exits required, provided that an exit, other than a horizontal exit, located in another (not necessarily adjacent) fire compartment is accessible without returning through the compartment of fire origin.

22.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

22.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

22.2.2.8 Reserved.

22.2.2.9 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

22.2.2.10 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

22.2.2.11 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

22.2.3 Capacity of Means of Egress.

22.2.3.1 The capacity of any required means of egress shall be in accordance with Section 7.3.

22.2.3.2 Aisles, corridors, and ramps required for egress shall be not less than 48 in. (1220 mm) in width.

22.2.3.3 Residents' sleeping room door widths shall be permitted to comply with 22.2.11.4.

22.2.4 Number of Means of Egress.

22.2.4.1 The number of means of egress shall be in accordance with Section 7.4.

22.2.4.2 Not less than two separate exits shall meet both of the following criteria:

(1) They shall be provided on every story.
(2) They shall be accessible from every part of every story, fire compartment, or smoke compartment; however, exit access travel shall be permitted to be common for the distances permitted as common path of travel by 22.2.5.3.

22.2.4.3 Not less than one approved exit shall be accessible from each fire compartment and each required smoke compartment into which residents are potentially moved in a fire emergency, with the exits arranged so that egress is possible without returning through the zone of fire origin.

22.2.5 Arrangement of Means of Egress. See also Section 7.5.

22.2.5.1 Every sleeping room shall have a door leading directly to an exit access corridor, unless otherwise permitted by one of the following:

(1) The requirement of 22.2.5.1 shall not apply if there is an exit door opening directly to the outside from a room at the finished ground level.
(2) One adjacent room, such as a day room, a group activity space, or other common space, shall be permitted to intervene, and the following also shall apply:
    (a) Where sleeping rooms directly adjoin a day room or group activity space that is used for access to an exit, such sleeping rooms shall be permitted to open directly to the day room or space.
    (b) Sleeping rooms permitted to open directly to the day room or space shall be permitted to be separated in elevation by a one-half story or full story height.

22.2.5.2 No exit or exit access shall contain a corridor, a hallway, or an aisle having a pocket or dead end exceeding 50 ft (15 m) for Use Condition II, Use Condition III, or Use Condition IV and 20 ft (6100 mm) for Use Condition V.

22.2.5.3 A common path of travel shall not exceed 100 ft (30 m).

22.2.5.4 A sally port shall be permitted in a means of egress where there are provisions for continuous and unobstructed travel through the sally port during an emergency egress condition.

22.2.6 Travel Distance to Exits. Travel distance shall comply with 22.2.6.1 through 22.2.6.7.

22.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

22.2.6.2 The travel distance between any room door required as an exit access and an exit shall not exceed 150 ft (46 m).

22.2.6.3 Reserved.

22.2.6.4 The travel distance between any point in a room and an exit shall not exceed 200 ft (61 m).

22.2.6.5 Reserved.

22.2.6.6 The travel distance between any point in a sleeping room to the door in that room shall not exceed 50 ft (15 m), unless otherwise permitted by 22.2.6.7.

22.2.6.7 The maximum travel distance limitation of 22.2.6.6 shall be permitted to be increased to 100 ft (30 m) in open dormitories, provided that both of the following criteria are met:

(1) The enclosing walls of the dormitory space shall be of smoke-tight construction.
(2) Not less than two exit access doors remotely located from each other shall be provided where travel distance to the exit access door from any point within the dormitory exceeds 50 ft (15 m).

22.2.7 Discharge from Exits.

22.2.7.1 Exits shall be permitted to discharge into a fenced or walled courtyard, provided that not more than two walls of the courtyard are the building walls from which egress is being made.

22.2.7.2 Enclosed yards or courts used for exit discharge in accordance with 22.2.7.1 shall be of sufficient size to accommodate all occupants at a distance of not less than 50 ft (15 m) from the building while providing a net area of 15 ft^2 (1.4 m^2) per person.

22.2.7.3 All exits shall be permitted to discharge through the level of exit discharge.

22.2.7.4 The requirements of 7.7.2 shall be waived, provided that not more than 50 percent of the exits discharge into a single fire compartment separated from other compartments by construction having not less than a 1-hour fire resistance rating.

22.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

22.2.9 Emergency Lighting. Emergency lighting shall be provided in accordance with Section 7.9.

22.2.10 Marking of Means of Egress. Exit marking shall be provided as follows:

(1) Exit signs shall be provided in areas accessible to the public in accordance with Section 7.10.
(2) Exit signs shall not be required in detention and correctional residential housing areas. *(See 3.3.21.1.)*

22.2.11 Special Features.

22.2.11.1 Doors within means of egress shall be in accordance with Chapter 7, unless otherwise provided in 22.2.11.2 through 22.2.11.12.

22.2.11.2 Doors shall be permitted to be locked in accordance with the applicable use condition.

22.2.11.3 Where egress doors are locked with key-operated locks, the provisions of 22.7.6 shall apply.

22.2.11.4* Doors to resident sleeping rooms shall be not less than 28 in. (710 mm) in clear width.

22.2.11.5 Reserved.

22.2.11.6 Doors in a means of egress shall be permitted to be of the horizontal-sliding type, provided that the force necessary to slide the door to its fully open position does not exceed 50 lbf (222 N) where a force of 50 lbf (222 N) is simultaneously applied perpendicular to the door.

22.2.11.7 Doors from areas of refuge to the exterior shall be permitted to be locked with key locks in lieu of locking methods described in 22.2.11.8, the keys to unlock such doors shall be maintained and available at the facility at all times, and the locks shall be operable from the outside.

22.2.11.8* Any remote-control release used in a means of egress shall be provided with a reliable means of operation to release locks on all doors and shall be remotely located from the resident living areas, unless otherwise permitted by 22.2.11.8.2.

22.2.11.8.1 The remote location of a remote-control release used in a means of egress shall provide sight and sound supervision of the resident living areas.

22.2.11.8.2 Remote-control locking and unlocking of occupied rooms in Use Condition IV shall not be required, provided that both of the following criteria are met:

(1) Not more than 10 locks need to be unlocked to relocate all occupants from one smoke compartment to an area of refuge as promptly as is required where remote-control unlocking is used. *(See 22.3.7.9 for requirements for smoke barrier doors.)*
(2) Unlocking of all necessary locks is accomplished with not more than two separate keys.

22.2.11.9 Remote-Control Release–Operated Doors.

22.2.11.9.1 All remote-control release–operated doors shall be provided with a redundant means of operation as follows:

(1) Power-operated sliding doors or power-operated locks shall be constructed so that, in the event of power failure, a manual mechanical means to release and open the doors is provided at each door, and either emergency power arranged in accordance with 22.2.11.9.2 is provided for the power operation or a remote-control manual mechanical release is provided.
(2) Mechanically operated sliding doors or mechanically operated locks shall be provided with a manual mechanical means at each door to release and open the door.

22.2.11.9.2 The emergency power required by 23.2.11.9.1(1) shall be arranged to provide the required power automatically in the event of any interruption of normal power due to any of the following:

(1) Failure of a public utility or other outside electrical power supply
(2) Opening of a circuit breaker or fuse
(3) Manual act(s), including accidental opening of a switch controlling normal lighting facilities

22.2.11.10 The provisions of 7.2.1.5.8 for stairway re-entry shall not apply.

22.2.11.11 Doors unlocked by means of remote control under emergency conditions shall not automatically relock when closed, unless specific action is taken at the remote-control location to enable doors to relock.

22.2.11.12 Emergency power shall be provided for all electric power–operated sliding doors and electric power–operated locks, unless otherwise permitted by 22.2.11.12.2.

22.2.11.12.1 The emergency power shall be arranged to automatically operate within 10 seconds upon failure of normal power and to maintain the necessary power source for a minimum of 1½ hours.

22.2.11.12.2 The emergency power specified in 22.2.11.12 shall not be required in facilities with 10 or fewer locks complying with 22.2.11.8.2.

22.3 Protection.

22.3.1 Protection of Vertical Openings. Any vertical opening shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by one of the following:

(1) Unprotected vertical openings in accordance with 8.6.9.1 shall be permitted.
(2)*In residential housing area smoke compartments, unprotected vertical openings shall be permitted in accordance with the conditions of 8.6.6, provided that the height between the lowest and highest finished floor levels does not exceed 23 ft (7010 mm), and the following also shall be permitted:
   (a) The number of levels shall not be restricted.
   (b) Residential housing areas subdivided in accordance with 22.3.8 shall be permitted to be considered as part of the communicating space.
   (c) The separation shall not be required to have a fire resistance rating. *[See 8.6.6(4)(b).]*

22.3.2 Protection from Hazards.

22.3.2.1* Any hazardous area shall be protected in accordance with Section 8.7. The areas described in Table 22.3.2.1 shall be protected as indicated.

Table 22.3.2.1 Hazardous Area Protection

Hazardous Area Description	Separation/ Protection†
Areas not incidental to resident housing	2 hours
Boiler and fuel-fired heater rooms	1 hour
Commercial cooking equipment	In accordance with 9.2.3
Commissaries	Smoke resistant
Employee locker rooms	Smoke resistant
Hobby/handicraft shops	Smoke resistant
Laundries >100 ft^2 (>9.3 m^2)	1 hour
Maintenance shops	Smoke resistant
Padded cells	1 hour
Soiled linen rooms	1 hour
Storage rooms >50 ft^2 (>4.6 m^2) but ≤100 ft^2 (≤9.3 m^2) storing combustible material	Smoke resistant
Storage rooms >100 ft^2 (>9.3 m^2) storing combustible materials	1 hour
Trash collection rooms	1 hour

†Minimum fire resistance rating.

22.3.2.2 Where Table 22.3.2.1 requires separations to be smoke resistant, the provision of 8.7.1.2 shall not apply.

22.3.2.3 Hazardous areas determined by the authority having jurisdiction as not incidental to residents' housing shall be separated by 2-hour fire resistance–rated barriers in conjunction with automatic sprinkler protection.

22.3.2.4 Where cooking facilities are protected in accordance with 9.2.3, kitchens shall not be required to be provided with roomwide protection.

22.3.2.5 Waste chutes, incinerators, and linen chutes shall be protected in accordance with Section 9.5.

22.3.3 Interior Finish.

22.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

22.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in corridors, in exits, and in any space not separated from corridors and exits by partitions capable of retarding the passage of smoke; and Class A, Class B, or Class C in all other areas. The provisions of 10.2.8.1 shall not apply.

22.3.3.3 Interior Floor Finish.

22.3.3.3.1 Interior floor finish shall comply with Section 10.2.

22.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors shall be not less than Class II. The provisions of 10.2.8.2 shall not apply.

22.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

22.3.4 Detection, Alarm, and Communications Systems.

22.3.4.1 General. Detention and correctional occupancies shall be provided with a fire alarm system in accordance with Section 9.6, except as modified by 22.3.4.2 through 22.3.4.4.3.

22.3.4.2 Initiation. Initiation of the required fire alarm system shall be by manual means in accordance with 9.6.2, by means of any required detection devices or detection systems, and by means of waterflow alarm in the sprinkler system required by 22.3.5.2, unless otherwise permitted by the following:

(1) Manual fire alarm boxes shall be permitted to be locked, provided that staff is present within the area when it is occupied and staff has keys readily available to unlock the boxes.
(2) Manual fire alarm boxes shall be permitted to be located in a staff location, provided that both of the following criteria are met:
    (a) The staff location is attended when the building is occupied.
    (b) The staff attendant has direct supervision of the sleeping area.

22.3.4.3 Notification.

22.3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 9.6.3, and the following also shall apply:

(1) A positive alarm sequence shall be permitted in accordance with 9.6.3.4.
(2)*Any smoke detectors required by this chapter shall be permitted to be arranged to alarm at a constantly attended location only and Table 23.3.8 shall not be required to accomplish general occupant notification.

22.3.4.3.2 Emergency Forces Notification.

22.3.4.3.2.1 Fire department notification shall be accomplished in accordance with 9.6.4, unless otherwise permitted by one of the following:

(1) A positive alarm sequence shall be permitted in accordance with 9.6.3.4.
(2) Any smoke detectors required by this chapter shall not be required to transmit an alarm to the fire department.
(3) This requirement shall not apply where staff is provided at a constantly attended location that meets one of the following criteria:
    (a) It has the capability to promptly notify the fire department.
    (b) It has direct communication with a control room having direct access to the fire department.

22.3.4.3.2.2 Where the provision of 22.3.4.3.2.1(3) is utilized, the fire plan, as required by 22.7.1.3, shall include procedures for logging of alarms and immediate notification of the fire department.

22.3.4.4* Detection. An approved automatic smoke detection system shall be in accordance with Section 9.6, as modified by 22.3.4.4.1 through 22.3.4.4.3, throughout all resident sleeping areas and adjacent day rooms, activity rooms, or contiguous common spaces.

22.3.4.4.1 Smoke detectors shall not be required in sleeping rooms with four or fewer occupants.

22.3.4.4.2 Other arrangements and positioning of smoke detectors shall be permitted to prevent damage or tampering, or for other purposes.

22.3.4.4.2.1 Other arrangements, as specified in 22.3.4.4.2, shall be capable of detecting any fire, and the placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangements required by the installation standards referenced in Section 9.6.

22.3.4.4.2.2 Detectors shall be permitted to be located in exhaust ducts from cells, behind grilles, or in other locations.

22.3.4.4.2.3 The equivalent performance of the design permitted by 22.3.4.4.2.2 shall be acceptable to the authority having jurisdiction in accordance with the equivalency concepts specified in Section 1.4.

22.3.4.4.3* Smoke detectors shall not be required in Use Condition II open dormitories where staff is present within the dormitory whenever the dormitory is occupied.

22.3.5 Extinguishment Requirements.

22.3.5.1 High-rise buildings shall comply with 22.4.3.

22.3.5.2 All buildings classified as Use Condition II, Use Condition III, Use Condition IV, or Use Condition V shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 22.3.5.3.

22.3.5.3 The automatic sprinkler system required by 22.3.5.2 shall meet all of the following criteria:

(1) It shall be in accordance with Section 9.7.
(2) It shall be installed in accordance with 9.7.1.1(1).
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.

22.3.5.4 Portable fire extinguishers shall be provided in accordance with Section 9.9, unless otherwise permitted by the following:

(1)*Access to portable fire extinguishers shall be permitted to be locked.
(2)*Portable fire extinguishers shall be permitted to be located at staff locations only.

22.3.5.5 Standpipe and hose systems shall be provided in accordance with Section 9.10 as follows, unless otherwise permitted by 22.3.5.6:

(1) Class I standpipe systems shall be provided for any building three or more stories in height.
(2) Class III standpipe and hose systems shall be provided for all nonsprinklered buildings three or more stories in height.

22.3.5.6 The requirements of 22.3.5.5 shall not apply where otherwise permitted by the following:

(1) Formed hose, 1 in. (25 mm) in diameter, on hose reels shall be permitted to provide Class II service.
(2) Separate Class I and Class II systems shall be permitted in lieu of a Class III system.

22.3.6 Corridors. See 22.3.8.

22.3.7 Subdivision of Building Spaces.

22.3.7.1 Smoke barriers shall be provided to divide every story used for sleeping by residents, or any other story having an occupant load of 50 or more persons, into not less than two compartments, unless otherwise permitted by one of the following:

(1) Protection shall be permitted to be accomplished using horizontal exits. *(See 7.2.4.)*
(2)*The requirement for subdivision of building space shall be permitted to be fulfilled by one of the following:
   (a) Smoke compartments having exit to a public way, where such exit serves only one area and has no openings to other areas
   (b) Building separated from the resident housing area by a 2-hour fire resistance rating or 50 ft (15 m) of open space
   (c) Secured, open area having a holding space located 50 ft (15 m) from the housing area that provides 15 ft^2 (1.4 m^2) or more of refuge area for each person (resident, staff, visitors) potentially present at the time of a fire

22.3.7.2 Doors used to access the areas specified in 22.3.7.1(2)(a), (b), and (c) shall meet the requirements for doors at smoke barriers for the applicable use condition.

22.3.7.3 Where smoke barriers are required by 22.3.7.1, they shall be provided in accordance with both of the following criteria:

(1) They shall limit the occupant load to not more than 200 residents in any smoke compartment.
(2) They shall limit the travel distance to a door in a smoke barrier in accordance with both of the following criteria:
   (a) The distance from any room door required as exit access shall not exceed 150 ft (46 m).
   (b) The distance from any point in a room shall not exceed 200 ft (61 mm).

22.3.7.4 Reserved.

22.3.7.5* Any required smoke barrier shall be constructed in accordance with Section 8.5, shall be of substantial construction, and shall have structural fire resistance.

22.3.7.6 Openings in smoke barriers shall be protected in accordance with Section 8.5, unless otherwise permitted by the following:

(1)*The total number of vision panels in any barrier shall not be restricted.
(2) Sliding doors in smoke barriers that are designed to normally be kept closed and are remotely operated from a continuously attended location shall not be required to be self-closing.

22.3.7.7 Not less than 6 net ft^2 (0.55 net m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments, and this space shall be readily available wherever occupants are moved across the smoke barrier in a fire emergency.

22.3.7.8 Doors in smoke barriers shall meet all of the following criteria:

(1) The doors shall provide resistance to the passage of smoke.
(2) Swinging doors shall be self-latching, or the opening resistance of the door shall be not less than 5 lbf (22 N).
(3) Sliding doors shall be exempt from the latching requirement of 8.5.4.3.

22.3.7.9 Doors in smoke barriers shall conform with the requirements for doors in means of egress as specified in Section 22.2 and shall have locking and release arrangements according to the applicable use condition. The provisions of 22.2.11.8.2 shall not be used for smoke barrier doors serving a smoke compartment containing more than 20 persons.

22.3.7.10 Vision panels shall be provided in smoke barriers at points where the barrier crosses an exit access corridor.

22.3.7.11 Smoke dampers shall be provided in accordance with 8.5.5, unless otherwise permitted by 22.3.7.12.

22.3.7.12 Arrangements and positioning of smoke detectors required by 22.3.7.11 shall be permitted to prevent damage or tampering, or for other purposes, provided that both of the following criteria are met:

(1) Such arrangements shall be capable of detecting any fire.
(2) The placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangement required by *NFPA 72, National Fire Alarm and Signaling Code*, as referenced in 8.5.5.7.1.

22.3.8* Special Protection Features — Subdivision of Resident Housing Spaces. Subdivision of facility spaces shall comply with Table 22.3.8.

22.4 Special Provisions.

22.4.1 Limited Access Structures. The provisions of Section 11.7 for limited access structures shall not apply.

22.4.2 Underground Buildings. See Section 11.7 for requirements for underground buildings.

22.4.3 High-Rise Buildings. High-rise buildings shall comply with Section 11.8.

22.4.4 Nonsprinklered Existing Building Renovations.

22.4.4.1 General. Modernizations or renovations of nonsprinklered existing buildings shall be permitted to meet the requirements of this chapter, as modified by 22.4.4.2 through 22.4.4.13, in lieu of the sprinkler requirement of 22.3.5.2.

22.4.4.2 Minimum Construction Requirements (Nonsprinklered Buildings).

22.4.4.2.1 Detention and correctional occupancies in nonsprinklered buildings shall be limited to the building construction types specified in Table 22.4.4.2.1. *(See 8.2.1.)*

22.4.4.2.2 A residential housing area complying with 22.4.4.6 shall be considered as one story in height for purposes of applying Table 22.4.4.2.1.

22.4.4.3* Horizontal Exit Duct Penetrations (Nonsprinklered Buildings). Ducts shall be permitted to penetrate horizontal exits in accordance with 7.2.4.3.5(3) if protected by combination fire dampers/smoke leakage–rated dampers that meet the smoke damper actuation requirements of 8.5.5.

22.4.4.4 Common Path of Travel (Nonsprinklered Buildings). A common path of travel shall not exceed 50 ft (15 m).

Table 22.3.8 Subdivision of Resident Housing Spaces

Feature	Use Condition II	Use Condition III		Use Condition IV		Use Condition V
Room to room separation	NR	NR		NR		SR
Room face to corridor separation	NR	NR		NR		SR
Room face to common space separation	NR	NR ≤50 ft (≤15 m)†	SR >50 ft (>15 m)†	NR ≤50 ft (≤15 m)†	SR >50 ft (>15 m)†	SR
Common space to corridor separation	NR	NR		NR		SR
Total openings in solid room face where room face is required to be smoke resistant or fire rated‡	0.85 ft^2 (0.08 m^2)	0.85 ft^2 (0.08 m^2)		0.85 ft^2 (0.08 m^2)		0.85 ft^2 (0.08 m^2) where meeting one of the following: (1) Kept in closed position, except when in use by staff (2) Closable from the inside (3) Provided with smoke control

NR: No requirement. SR: Smoke resistant.

Notes:

(1) Doors in openings in partitions required to be smoke resistant (SR) in accordance with Table 22.3.8 are required to be substantial doors of construction that resists the passage of smoke. Latches and door closers are not required on cell doors.

(2) Under Use Condition II, Use Condition III, or Use Condition IV, a space subdivided by open construction (any combination of grating doors and grating walls or solid walls) is permitted to be considered one room if housing not more than 16 persons. The perimeter walls of such space are required to be of smoke-resistant construction. Smoke detection is required to be provided in such space. Under Use Condition IV, common walls between sleeping areas within the space are required to be smoke resistant, and grating doors and fronts are permitted to be used. Under Use Condition II and Use Condition III, open dormitories are permitted to house more than 16 persons, as permitted by other sections of this chapter.

(3) Where barriers are required to be smoke resistant (SR), the provisions of Sections 8.4 and 8.5 do not apply.

†Travel distance through the common space to the exit access corridor.

‡"Total openings in solid room face" include all openings (e.g, undercuts, food passes, grilles), the total of which is not to exceed 0.85 ft^2 (0.08 m^2). All openings are required to be 36 in. (915 mm) or less above the floor.

Table 22.4.4.2.1 Construction Type Limitations — Nonsprinklered Buildings

		Stories in Height†					
Construction Type	**Sprinklered**	**1 With Basement**	**1 Without Basement**	**2**	**3**	**>3 But Not High-Rise**	**High-Rise**
I (442)	Yes	NA	NA	NA	NA	NA	NA
	No	X	X	X	X	X	NP
I (332)	Yes	NA	NA	NA	NA	NA	NA
	No	X	X	X	X	X	NP
II (222)	Yes	NA	NA	NA	NA	NA	NA
	No	X	X	X	X	X	NP
II (111)	Yes	NA	NA	NA	NA	NA	NA
	No	X1	X	X1	NP	NP	NP
II (000)	Yes	NA	NA	NA	NA	NA	NA
	No	NP	NP	NP	NP	NP	NP
III (211)	Yes	NA	NA	NA	NA	NA	NA
	No	X1	X1	X1	NP	NP	NP
III (200)	Yes	NA	NA	NA	NA	NA	NA
	No	NP	NP	NP	NP	NP	NP
IV (2HH)	Yes	NA	NA	NA	NA	NA	NA
	No	X1	X1	X1	NP	NP	NP
V (111)	Yes	NA	NA	NA	NA	NA	NA
	No	X1	X1	X1	NP	NP	NP
V (000)	Yes	NA	NA	NA	NA	NA	NA
	No	NP	NP	NP	NP	NP	NP

NA: Not applicable. NP: Not permitted.
X: Permitted for Use Conditions II, III, IV, and V. *(See 22.1.2.3 for Use Condition I.)*
X1: Permitted for Use Conditions II, III, and IV. Use Condition V not permitted. *(See 22.1.2.3 for Use Condition I.)*
†See 4.6.3.

22.4.4.5 Travel Distance to Exits (Nonsprinklered Buildings).

22.4.4.5.1 The travel distance between any room door required as an exit access and an exit shall not exceed 100 ft (30 m).

22.4.4.5.2 The travel distance between any point in a room and an exit shall not exceed 150 ft (46 m).

22.4.4.6 Protection of Vertical Openings (Nonsprinklered Buildings).

22.4.4.6.1 Multilevel residential housing areas without enclosure protection between levels shall be permitted, provided that the conditions of 22.4.4.6.2 through 22.4.4.6.4 are met.

22.4.4.6.2* The entire normally occupied area, including all communicating floor levels, shall be sufficiently open and unobstructed so that a fire or other dangerous condition in any part is obvious to the occupants or supervisory personnel in the area.

22.4.4.6.3 Egress capacity shall simultaneously accommodate all occupants of all communicating levels and areas, with all communicating levels in the same fire area considered as a single floor area for purposes of determining required egress capacity.

22.4.4.6.4* The height between the highest and lowest finished floor levels shall not exceed 13 ft (3960 mm). The number of levels shall not be restricted.

22.4.4.7 Hazardous Areas (Nonsprinklered Buildings). Any hazardous area shall be protected in accordance with Section 8.7. The areas described in Table 22.4.4.7 shall be protected as indicated.

22.4.4.8 Interior Finish (Nonsprinklered Buildings).

22.4.4.8.1 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A in corridors, in exits, and in any space not separated from corridors and exits by partitions capable of retarding the passage of smoke; and Class A, Class B, or Class C in all other areas.

22.4.4.8.2 Interior Floor Finish.

22.4.4.8.2.1 Interior floor finish shall comply with Section 10.2.

Table 22.4.4.7 Hazardous Area Protection — Nonsprinklered Buildings

Hazardous Area Description	Separation/Protection†
Areas not incidental to resident housing	2 hours
Boiler and fuel-fired heater rooms	2 hours or 1 hour and sprinklers
Central or bulk laundries >100 ft^2 (>9.3 m^2)	2 hours or 1 hour and sprinklers
Commercial cooking equipment	In accordance with 9.2.3
Commissaries	1 hour or sprinklers
Employee locker rooms	1 hour or sprinklers
Hobby/handicraft shops	1 hour or sprinklers
Maintenance shops	1 hour or sprinklers
Padded cells	2 hours or 1 hour and sprinklers
Soiled linen rooms	2 hours or 1 hour and sprinklers
Storage rooms >50 ft^2 (>4.6 m^2) but ≤100 ft^2 (≤9.3 m^2) storing combustible material	1 hour or sprinklers
Storage rooms >100 ft^2 (>9.3 m^2) storing combustible materials	2 hours or 1 hour and sprinklers
Trash collection rooms	2 hours or 1 hour and sprinklers

†Minimum fire resistance rating.

22.4.4.8.2.2 Interior floor finish in exit enclosures and exit access corridors shall be not less than Class I.

22.4.4.8.2.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

22.4.4.9 Detection, Alarm, and Communications Systems (Nonsprinklered Buildings).

22.4.4.9.1 Initiation. Initiation of the fire alarm system required by 22.3.4.1 shall be by manual means in accordance with 9.6.2 and by means of any required detection devices or detection systems, unless otherwise permitted by the following:

(1) Manual fire alarm boxes shall be permitted to be locked, provided that staff is present within the area when it is occupied and staff has keys readily available to unlock the boxes.
(2) Manual fire alarm boxes shall be permitted to be located in a staff location, provided that both of the following criteria are met:
  (a) The staff location is attended when the building is occupied.
  (b) The staff attendant has direct supervision of the sleeping area.

22.4.4.9.2 Detection. An approved automatic smoke detection system shall be in accordance with Section 9.6, as modified by 22.4.4.9.2.1 and 22.4.4.9.2.2, throughout all resident sleeping areas and adjacent day rooms, activity rooms, or contiguous common spaces.

22.4.4.9.2.1 Smoke detectors shall not be required in sleeping rooms with four or fewer occupants in Use Condition II or Use Condition III.

22.4.4.9.2.2 Other arrangements and positioning of smoke detectors shall be permitted to prevent damage or tampering, or for other purposes. Such arrangements shall be capable of detecting any fire, and the placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangements required by the installation standards referenced in Section 9.6. Detectors shall be permitted to be located in exhaust ducts from cells, behind grilles, or in other locations. The equivalent performance of the design, however, shall be acceptable to the authority having jurisdiction in accordance with the equivalency concepts specified in Section 1.4.

22.4.4.10 Subdivision of Building Spaces (Nonsprinklered Buildings). Where smoke barriers are required by 22.3.7.1, they shall be provided in accordance with both of the following criteria:

(1) They shall limit the occupant load to not more than 200 residents in any smoke compartment.
(2) They shall limit the travel distance to a door in a smoke barrier in accordance with both of the following criteria:
  (a) The distance from any room door required as exit access shall not exceed 100 ft (30 m).
  (b) The distance from any point in a room shall not exceed 150 ft (46 m).

22.4.4.11* Subdivision of Resident Housing Spaces (Nonsprinklered Buildings). Subdivision of facility spaces shall comply with Table 22.4.4.11.

22.4.4.12 Limited Access Structures (Nonsprinklered Buildings).

22.4.4.12.1 Limited access structures used as detention and correctional occupancies shall comply with 22.4.4.12.2. The provisions of Section 11.7 for limited access structures shall not apply.

22.4.4.12.2 Any one of the following means shall be provided to evacuate smoke from the smoke compartment of fire origin:

(1) Operable windows on not less than two sides of the building, spaced not more than 30 ft (9.1 m) apart, that provide openings with dimensions of not less than 22 in. (560 mm) in width and 24 in. (610 mm) in height
(2)*Manual or automatic smoke vents
(3) Engineered smoke control system
(4) Mechanical exhaust system providing not less than six air changes per hour
(5) Other method acceptable to the authority having jurisdiction

22.4.4.13 Furnishings, Mattresses, and Decorations (Nonsprinklered Buildings).

22.4.4.13.1 Newly introduced upholstered furniture within detention and correctional occupancies shall meet the criteria specified in 10.3.2.1(2) and 10.3.3.

22.4.4.13.2* Newly introduced mattresses within detention and correctional occupancies shall meet the criteria specified in 10.3.2.2 and 10.3.4.

22.4.5 Lockups.

22.4.5.1 General.

22.4.5.1.1 Lockups in occupancies, other than detention and correctional occupancies and health care occupancies, where the holding area has capacity for more than 50 detainees shall

Table 22.4.4.11 Subdivision of Resident Housing Spaces — Nonsprinklered Buildings

Feature	**Use Condition II**	**Use Condition III**	**Use Condition IV**	**Use Condition V**
Room to room separation	NR	NR	SR	FR(½)
Room face to corridor separation	SR	SR	SR	FR
Room face to common space separation	NR	NR ≤50 ft (≤15 m)† SR >50 ft (>15 m)†	SR	FR
Common space to corridor separation	FR	FR	FR	FR
Total openings in solid room face where room face is required to be smoke resistant or fire rated‡	0.85 ft^2 (0.08 m^2)	0.85 ft^2 (0.08 m^2)	0.85 ft^2 (0.08 m^2)	0.85 ft^2 (0.08 m^2) where meeting one of the following: (1) Kept in closed position, except when in use by staff (2) Closable from the inside (3) Provided with smoke control

NR: No requirement. SR: Smoke resistant. FR(½): Minimum ½-hour fire resistance rating. FR: Minimum 1-hour fire resistance rating.

Notes:

(1) Doors in openings in partitions required to be fire rated [FR(½), FR] in accordance with Table 22.4.4.11, in other than required enclosures of exits or hazardous areas, are required to be substantial doors of construction that resist fire for a minimum of 20 minutes. Vision panels with an existing installation of wired glass or glass with not less than 45-minute fire-rated glazing are permitted. Latches and door closers are not required on cell doors.

(2) Doors in openings in partitions required to be smoke resistant (SR) in accordance with Table 22.4.4.11 are required to be substantial doors of construction that resists the passage of smoke. Latches and door closers are not required on cell doors.

(3) Under Use Condition II, Use Condition III, or Use Condition IV, a space subdivided by open construction (any combination of grating doors and grating walls or solid walls) is permitted to be considered one room if housing not more than 16 persons. The perimeter walls of such space are required to be of smoke-resistant construction. Smoke detection is required to be provided in such space. Under Use Condition IV, common walls between sleeping areas within the space are required to be smoke resistant, and grating doors and fronts are permitted to be used. In Use Condition II and Use Condition III, open dormitories are permitted to house more than 16 persons, as permitted by other sections of this chapter.

(4) Where barriers are required to be smoke resistant (SR), the provisions of Sections 8.4 and 8.5 do not apply.

†Travel distance through the common space to the exit access corridor.

‡"Total openings in solid room face" include all openings (e.g., undercuts, food passes, grilles), the total of which is not to exceed 0.85 ft^2 (0.08 m^2). All openings are required to be 36 in. (915 mm) or less above the floor.

be classified as detention and correctional occupancies and shall comply with the requirements of Chapter 22.

22.4.5.1.2 Lockups in occupancies, other than detention and correctional occupancies and health care occupancies, where any individual is detained for 24 or more hours shall be classified as detention and correctional occupancies and shall comply with the requirements of Chapter 22.

22.4.5.1.3 Lockups in occupancies, other than detention and correctional occupancies and health care occupancies, where the holding area has capacity for not more than 50 detainees, and where no individual is detained for 24 hours or more, shall comply with 22.4.5.1.4 or 22.4.5.1.5.

22.4.5.1.4 The lockup shall be permitted to comply with the requirements for the predominant occupancy in which the lockup is placed, provided that all of the following criteria are met:

(1)*Doors and other physical restraints to free egress by detainees can be readily released by staff within 2 minutes of the onset of a fire or similar emergency.

(2) Staff is in sufficient proximity to the lockup so as to be able to effect the 2-minute release required by 22.4.5.1.4(1) whenever detainees occupy the lockup.

(3) Staff is authorized to effect the release required by 22.4.5.1.4(1).

(4) Staff is trained and practiced in effecting the release required by 22.4.5.1.4(1).

(5) Where the release required by 22.4.5.1.4(1) is effected by means of remote release, detainees are not to be restrained from evacuating without the assistance of others.

22.4.5.1.5 Where the lockup does not comply with all the criteria of 22.4.5.1.4, the requirements of 22.4.5.2 shall be met.

22.4.5.1.6 The fire department with responsibility for responding to a building that contains a lockup shall be notified of the presence of the lockup.

22.4.5.2 Alternate Provisions.

22.4.5.2.1 The requirements applicable to the predominant occupancy in which the lockup is placed shall be met.

22.4.5.2.2 Where security operations necessitate the locking of required means of egress, the following shall apply:

(1) Detention-grade hardware meeting the requirements of ASTM F 1577, *Standard Test Methods for Detention Locks for Swinging Doors*, shall be provided on swinging doors within the required means of egress.
(2) Sliding doors within the required means of egress shall be designed and engineered for detention and correctional use, and lock cylinders shall meet the cylinder test requirements of ASTM F 1577.

22.4.5.2.3 The lockup shall be provided with a complete smoke detection system in accordance with 9.6.2.9.

22.4.5.2.4 Where the requirements applicable to the predominant occupancy do not mandate a fire alarm system, the lockup shall be provided with a fire alarm system meeting all of the following criteria:

(1) The alarm system shall be in accordance with Section 9.6.
(2) Initiation of the alarm system shall be accomplished by all of the following:
    (a) Manual fire alarm boxes in accordance with 9.6.2
    (b) Smoke detection system required by 22.4.5.2.3
    (c) Automatic sprinkler system required by the provisions applicable to the predominant occupancy
(3) Staff and occupant notification shall be provided automatically in accordance with 9.6.3.
(4) Emergency force notification shall be provided in accordance with 9.6.4.

22.4.6* Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be permitted where both of the following criteria are met:

(1) The detention and correction facility permits their use.
(2) The installation meets the requirements in 8.7.3.3.

22.5 Building Services.

22.5.1 Utilities.

22.5.1.1 Utilities shall comply with the provisions of Section 9.1.

22.5.1.2 Alarms, emergency communications systems, and the illumination of generator set locations shall be provided with emergency power in accordance with *NFPA 70, National Electrical Code*.

22.5.2 Heating, Ventilating, and Air-Conditioning.

22.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2 and shall be installed in accordance with the manufacturer's specifications, unless otherwise modified by 22.5.2.2.

22.5.2.2 Portable space-heating devices shall be prohibited, unless otherwise permitted by 22.5.2.4.

22.5.2.3 Any heating device, other than a central heating plant, shall be designed and installed so that combustible material cannot be ignited by the device or its appurtenances, and both of the following requirements also shall apply:

(1) If fuel-fired, such heating devices shall comply with all of the following:
    (a) They shall be chimney connected or vent connected.
    (b) They shall take air for combustion directly from outside.
    (c) They shall be designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area.
(2) The heating system shall have safety devices to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperatures or ignition failure.

22.5.2.4 Approved, suspended unit heaters shall be permitted in locations other than means of egress and sleeping areas, provided that both of the following criteria are met:

(1) Such heaters are located high enough to be out of the reach of persons using the area.
(2) Such heaters are vent connected and equipped with the safety devices required by 22.5.2.3(2).

22.5.2.5 Combustion and ventilation air for boiler, incinerator, or heater rooms shall be taken directly from, and discharged directly to, the outside.

22.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

22.5.4 Waste Chutes, Incinerators, and Laundry Chutes.

22.5.4.1 Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

22.5.4.2 Waste chutes and linen chutes, including pneumatic waste and linen systems, shall be provided with automatic extinguishing protection in accordance with Section 9.7.

22.5.4.3 Waste chutes shall discharge into a chute discharge room used for no purpose other than collection of waste and shall be protected in accordance with Sections 8.7 and 9.5.

22.5.4.4 Incinerators shall not be directly flue-fed, and floor chutes shall not directly connect with the combustion chamber.

22.6 Reserved.

22.7 Operating Features.

22.7.1 Attendants, Evacuation Plan, and Fire Drills.

22.7.1.1 Detention and correctional facilities, or those portions of facilities having such occupancy, shall be provided with 24-hour staffing, and the following requirements also shall apply:

(1) Staff shall be within three floors or a 300 ft (91 m) horizontal distance of the access door of each resident housing area.
(2) For Use Condition III, Use Condition IV, and Use Condition V, the arrangement shall be such that the staff involved starts the release of locks necessary for emergency evacuation or rescue and initiates other necessary emergency actions within 2 minutes of alarm.
(3) The following shall apply to areas in which all locks are unlocked remotely in compliance with 22.2.11.8:
    (a) Staff shall not be required to be within three floors or 300 ft (91 m) of the access door.
    (b) The 10-lock, manual key exemption of 22.2.11.8.2 shall not be permitted to be used in conjunction with the alternative requirement of 22.7.1.1(3)(a).

22.7.1.2* Provisions shall be made so that residents in Use Condition III, Use Condition IV, and Use Condition V shall be able to notify staff of an emergency.

22.7.1.3* The administration of every detention or correctional facility shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for evacuation from the building when necessary.

22.7.1.3.1 All employees shall be instructed and drilled with respect to their duties under the plan.

22.7.1.3.2 The plan shall be coordinated with, and reviewed by, the fire department legally committed to serve the facility.

22.7.1.4 Employees of detention and correctional occupancies shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

22.7.1.4.1 The training specified in 22.7.1.4 shall be provided to new staff promptly upon commencement of duty.

22.7.1.4.2 Refresher training shall be provided to existing staff at not less than annual intervals.

22.7.2* Combustible Personal Property. Books, clothing, and other combustible personal property allowed in sleeping rooms shall be stored in closable metal lockers or an approved fire-resistant container.

22.7.3 Heat-Producing Appliances. The number of heat-producing appliances, such as toasters and hot plates, and the overall use of electrical power within a sleeping room shall be controlled by facility administration.

22.7.4* Furnishings, Mattresses, and Decorations.

22.7.4.1 Draperies and curtains, including privacy curtains, in detention and correctional occupancies shall be in accordance with the provisions of 10.3.1.

22.7.4.2 Newly introduced upholstered furniture within detention and correctional occupancies shall be tested in accordance with the provisions of 10.3.2.1(2).

22.7.4.3 Newly introduced mattresses within detention and correctional occupancies shall be tested in accordance with the provisions of 10.3.2.2.

22.7.4.4 Combustible decorations shall be prohibited in any detention or correctional occupancy unless flame-retardant.

22.7.4.5 Wastebaskets and other waste containers shall be of noncombustible or other approved materials. Waste containers with a capacity exceeding 20 gal (76 L) shall be provided with a noncombustible lid or lid of other approved material.

22.7.5 Keys. All keys necessary for unlocking doors installed in a means of egress shall be individually identified by both touch and sight.

22.7.6 Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all detention and correctional occupancies.

22.7.7 Door Inspection. Doors and door hardware in means of egress shall be inspected monthly by an appropriately trained person. The inspection shall be documented.

Chapter 23 Existing Detention and Correctional Occupancies

23.1 General Requirements.

23.1.1 Application.

23.1.1.1 General.

23.1.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as detention or correctional occupancies.

23.1.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

23.1.1.1.3 General. The provisions of Chapter 4, General, shall apply.

23.1.1.1.4 This chapter establishes life safety requirements that shall apply to all existing detention and correctional facilities, other than the following:

(1) Use Condition I facilities protected as residential occupancies in accordance with 23.1.2.3
(2)*Facilities determined to have equivalent safety provided in accordance with Section 1.4

23.1.1.1.5 Detention and correctional occupancies shall include those used for purposes such as correctional institutions, detention facilities, community residential centers, training schools, work camps, and substance abuse centers where occupants are confined or housed under some degree of restraint or security.

23.1.1.1.6* Detention and correctional occupancies shall include those that provide sleeping facilities for one or more residents and are occupied by persons who are generally prevented from taking self-preservation action because of security measures not under the occupants' control.

23.1.1.1.7* Lockups, other than approved existing lockups, in other than detention and correctional occupancies and health care occupancies shall comply with the requirements of 23.4.5.

23.1.1.2 Total Concept.

23.1.1.2.1 All detention and correctional facilities shall be designed, constructed, maintained, and operated to minimize the possibility of a fire emergency.

23.1.1.2.2 Because the safety of all occupants in detention and correctional facilities cannot be adequately ensured solely by dependence on evacuation of the building, their protection from fire shall be provided by appropriate arrangement of facilities; adequate, trained staff; and development of operating, security, and maintenance procedures composed of the following:

(1) Design, construction, and compartmentation
(2) Provision for detection, alarm, and extinguishment
(3) Fire prevention and planning, training, and drilling programs for the isolation of fire and the transfer of occupants to areas of refuge, for evacuation of the building, or for protection of the occupants in place
(4) Provision of security to the degree necessary for the safety of the public and the occupants of the facility

23.1.1.3 Additions. Additions shall be separated from any existing structure not conforming with the provisions of this chapter by a fire barrier having not less than a 2-hour fire resistance rating constructed to the requirements of the addition, and the following also shall apply:

(1) Doors in such partitions shall normally be kept closed.
(2) Doors shall be permitted to be held open if they meet the requirements of 7.2.1.8.2.

23.1.1.4 Modernizations or Renovations.

23.1.1.4.1 Modernizations and renovations shall be in accordance with 4.6.7, unless otherwise permitted by 23.1.1.4.2.

23.1.1.4.2 In nonsprinklered existing buildings, modernizations or renovations shall be permitted to comply with the nonsprinklered options contained in 22.4.4 in lieu of the sprinkler requirement of 22.3.5.2.

23.1.2 Classification of Occupancy. See 6.1.7.

23.1.2.1* For application of the life safety requirements that follow, the resident user category shall be divided into the groups specified in 23.1.2.1.1 through 23.1.2.1.5.

23.1.2.1.1 Use Condition I — Free Egress. Use Condition I shall be defined as a condition under which free movement is allowed from sleeping areas and other spaces where access or occupancy is permitted to the exterior via means of egress meeting the requirements of this *Code*.

23.1.2.1.2 Use Condition II — Zoned Egress. Use Condition II shall be defined as a condition under which free movement is allowed from sleeping areas and any other occupied smoke compartment to one or more other smoke compartments.

23.1.2.1.3 Use Condition III — Zoned Impeded Egress. Use Condition III shall be defined as a condition under which free movement is allowed within individual smoke compartments, such as within a residential unit comprised of individual sleeping rooms and a group activity space, with egress impeded by remote-controlled release of means of egress from such a smoke compartment to another smoke compartment.

23.1.2.1.4 Use Condition IV — Impeded Egress. Use Condition IV shall be defined as a condition under which free movement is restricted from an occupied space, and remote-controlled release is provided to allow movement from all sleeping rooms, activity spaces, and other occupied areas within the smoke compartment to another smoke compartment.

23.1.2.1.5 Use Condition V — Contained. Use Condition V shall be defined as a condition under which free movement is restricted from an occupied space, and staff-controlled manual release at each door is provided to allow movement from all sleeping rooms, activity spaces, and other occupied areas within the smoke compartment to another smoke compartment.

23.1.2.2* To be classified as Use Condition III or Use Condition IV, the arrangement, accessibility, and security of the release mechanism(s) used for emergency egress shall be such that the minimum available staff, at any time, can promptly release the locks.

23.1.2.3 Areas housing occupancies corresponding to Use Condition I shall conform to one of the following:

(1) Requirements of residential occupancies under this *Code*
(2)*Requirements of this chapter for Use Condition II facilities, provided that the staffing requirements of Section 23.7 are met

23.1.3* Multiple Occupancies.

23.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

23.1.3.2 Egress provisions for areas of detention and correctional facilities that correspond to other occupancies shall meet the corresponding requirements of this *Code* for such occupancies as modified by 23.1.3.2.1.

23.1.3.2.1* Where security operations necessitate the locking of required means of egress, staff in the building shall be provided with the means for the supervised release of occupants during all times of use.

23.1.3.2.2 Reserved.

23.1.3.3 Sections of detention and correctional facilities shall be permitted to be classified as other occupancies, provided that they meet both of the following conditions:

(1) They are not intended to serve residents for sleeping purposes.
(2) They are separated from areas of detention or correctional occupancies by construction having not less than a 2-hour fire resistance rating.

23.1.3.4 All means of egress from detention and correctional occupancies that traverse other use areas shall, as a minimum, conform to the requirements of this *Code* for detention and correctional occupancies, unless otherwise permitted by 23.1.3.5.

23.1.3.5 Egress through a horizontal exit into other contiguous occupancies that do not conform to detention and correctional occupancy egress provisions but that do comply with requirements set forth in the appropriate occupancy chapter of this *Code* shall be permitted, provided that both of the following criteria apply:

(1) The occupancy shall not contain high hazard contents.
(2) The horizontal exit shall comply with the requirements of 23.2.2.5.

23.1.3.6 Any area with a hazard of contents classified higher than that of the detention or correctional occupancy and located in the same building shall be protected as required in 23.3.2.

23.1.3.7 Nondetention- or noncorrectional-related occupancies classified as containing high hazard contents shall not be permitted in buildings housing detention or correctional occupancies.

23.1.3.8 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

23.1.4 Definitions.

23.1.4.1 General. For definitions, see Chapter 3, Definitions.

23.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Detention and Correctional Residential Housing Area.** See 3.3.21.1.
(2) **Sally Port (Security Vestibule).** See 3.3.238.

23.1.5 Classification of Hazard of Contents. The classification of hazard of contents shall be as defined in Section 6.2.

23.1.6 Minimum Construction Requirements.

23.1.6.1 Detention and correctional occupancies shall be limited to the building construction types specified in Table 23.1.6.1. *(See 8.2.1.)*

23.1.6.2 A residential housing area complying with 23.3.1.2 shall be considered as one story in height for purposes of applying 23.1.6.1.

Table 23.1.6.1 Construction Type Limitations

Construction Type	Sprinklered[a]	Stories in Height[b]					
		1 With Basement	1 Without Basement	2	3	>3 But Not High-Rise	High-Rise
I (442)[c, d]	Yes	X	X	X	X	X	X
	No	X	X	X	X	X	NP
I (332)[c, d]	Yes	X	X	X	X	X	X
	No	X	X	X	X	X	NP
II (222)[c, d]	Yes	X	X	X	X	X	X
	No	X	X	X	X	X	NP
II (111)[c, d]	Yes	X	X	X	X	X	X
	No	X1	X	X1	NP	NP	NP
II (000)[d]	Yes	X	X	X	X	X	X
	No	X1	X1	NP	NP	NP	NP
III (211)[d]	Yes	X	X	X	X	X	X
	No	X1	X	X1	NP	NP	NP
III (200)[d]	Yes	X	X	X	X	X	X
	No	X1	X1	NP	NP	NP	NP
IV (2HH)[d]	Yes	X	X	X	X	X	X
	No	X1	X	X1	NP	NP	NP
V (111)[d]	Yes	X	X	X	X	X	X
	No	X1	X	X1	NP	NP	NP
V (000)[d]	Yes	X	X	X	X	X	X
	No	X1	X1	NP	NP	NP	NP

NP: Not permitted.

X: Permitted for Use Conditions II, III, IV, and V. *(See 23.1.2.3 for Use Condition I.)*

X1: Permitted for Use Conditions II, III, and IV. Use Condition V not permitted. *(See 23.1.2.3 for Use Condition I.)*

[a]Entire building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1). *(See 23.3.5.)*

[b]See 4.6.3.

[c]Any building of Type I, Type II(222), or Type II(111) construction is permitted to include roofing systems involving combustible or steel supports, decking, or roofing, provided that all of the following are met:

(1) The roof covering meets not less than Class C requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.

(2) The roof is separated from all occupied portions of the building by a noncombustible floor assembly that includes not less than 2½ in. (64 mm) of concrete or gypsum fill, and the attic or other space so developed meets one of the following requirements:

(a) It is unoccupied.

(b) It is protected throughout by an approved automatic sprinkler system.

[d]In determining building construction type, exposed steel roof members located 16 ft (4875 mm) or more above the floor of the highest cell are permitted to be disregarded.

23.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, either shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

23.2 Means of Egress Requirements.

23.2.1 General. Means of egress shall comply with Chapter 7, unless otherwise provided or modified by Section 23.2.

23.2.2 Means of Egress Components.

23.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 23.2.2.2 through 23.2.2.11.

23.2.2.2 Doors. Doors complying with 7.2.1 shall be permitted, unless otherwise provided in 23.2.11.

23.2.2.3 Stairs.

23.2.2.3.1 Stairs shall be permitted as follows:

(1) Stairs complying with 7.2.2 shall be permitted.
(2) Noncombustible grated stair treads and landing floors shall be permitted.

23.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted for access to and between staff locations.

23.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

23.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 and the modifications of 23.2.2.5.1 through 23.2.2.5.4 shall be permitted.

23.2.2.5.1 Not less than 6 ft^2 (0.55 m^2) of accessible space per occupant shall be provided on each side of the horizontal exit for the total number of people in adjoining compartments.

23.2.2.5.2* Horizontal exits shall be permitted to comprise 100 percent of the exits required, provided that an exit, other than a horizontal exit, located in another (not necessarily adjacent) fire compartment is accessible without returning through the compartment of fire origin.

23.2.2.5.3* Ducts shall be permitted to penetrate horizontal exits in accordance with 7.2.4.3.5(3) if protected by combination fire dampers/smoke leakage–rated dampers that meet the smoke damper actuation requirements of 8.5.5.

23.2.2.5.4 A door in a horizontal exit shall not be required to swing with egress travel as specified in 7.2.4.3.8(1).

23.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

23.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

23.2.2.8 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted.

23.2.2.9 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

23.2.2.10 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

23.2.2.11 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

23.2.3 Capacity of Means of Egress.

23.2.3.1 The capacity of any required means of egress shall be in accordance with Section 7.3.

23.2.3.2 Aisles, corridors, and ramps required for egress shall be not less than 36 in. (915 mm) in width.

23.2.3.3 Residents' sleeping room door widths shall be permitted to comply with 23.2.11.4.

23.2.4 Number of Means of Egress.

23.2.4.1 The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.

23.2.4.2* Not less than two separate exits shall meet both of the following criteria:

(1) They shall be provided on every story.
(2) They shall be accessible from every part of every story, fire compartment, or smoke compartment; however, exit access travel shall be permitted to be common for the distances permitted as common path of travel by 23.2.5.3.

23.2.4.3* Not less than one approved exit shall be accessible from each fire compartment and each required smoke compartment into which residents are potentially moved in a fire emergency, with the exits arranged so that egress is possible without returning through the zone of fire origin.

23.2.5 Arrangement of Means of Egress. See also Section 7.5.

23.2.5.1 Every sleeping room shall have a door leading directly to an exit access corridor, unless otherwise permitted by one of the following:

(1) The requirement of 23.2.5.1 shall not apply if there is an exit door opening directly to the outside from a room at the finished ground level.
(2) One adjacent room, such as a day room, a group activity space, or other common space, shall be permitted to intervene, and the following also shall apply:
    (a) Where sleeping rooms directly adjoin a day room or group activity space that is used for access to an exit, such sleeping rooms shall be permitted to open directly to the day room or space.
    (b) Sleeping rooms permitted to open directly to the day room or space shall be permitted to be separated in elevation by a one-half story or full story height.

23.2.5.2* Existing dead-end corridors are undesirable and shall be altered wherever possible so that exits are accessible in not less than two different directions from all points in aisles, passageways, and corridors.

23.2.5.3 A common path of travel shall not exceed 50 ft (15 m), unless otherwise permitted by one of the following:

(1) A common path of travel shall be permitted for the first 100 ft (30 m) in smoke compartments protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3.
(2) A common path of travel shall be permitted to exceed 50 ft (15 m) in multilevel residential housing units in which each floor level, considered separately, has not less than one-half of its individual required egress capacity accessible by exit access leading directly out of that level without traversing another communicating floor level.
(3)*Approved existing common paths of travel that exceed 50 ft (15 m) shall be permitted to continue to be used.

23.2.5.4 A sally port shall be permitted in a means of egress where there are provisions for continuous and unobstructed travel through the sally port during an emergency egress condition.

23.2.6 Travel Distance to Exits. Travel distance shall comply with 23.2.6.1 through 23.2.6.7.

23.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

23.2.6.2 The travel distance between any room door required as an exit access and an exit or smoke barrier shall not exceed 100 ft (30 m), unless otherwise permitted by 23.2.6.3.

23.2.6.3 The maximum travel distance limitations of 23.2.6.2 shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3 or a smoke control system.

23.2.6.4 The travel distance between any point in a room and an exit or smoke barrier shall not exceed 150 ft (46 m), unless otherwise permitted by 23.2.6.5.

23.2.6.5 The maximum travel distance limitations of 23.2.6.4 shall be permitted to be increased by 50 ft (15 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3 or a smoke control system.

23.2.6.6 The travel distance between any point in a sleeping room to the door of that room shall not exceed 50 ft (15 m), unless otherwise permitted by 23.2.6.7.

23.2.6.7 The maximum travel distance limitations of 23.2.6.6 shall be permitted to be increased to 100 ft (30 m) in open dormitories, provided that both of the following criteria are met:

(1) The enclosing walls of the dormitory space shall be of smoke-tight construction.
(2) Not less than two exit access doors remotely located from each other shall be provided where travel distance to the exit access door from any point within the dormitory exceeds 50 ft (15 m).

23.2.7 Discharge from Exits.

23.2.7.1 Exits shall be permitted to discharge into a fenced or walled courtyard, provided that not more than two walls of the courtyard are the building walls from which egress is being made.

23.2.7.2 Enclosed yards or courts used for exit discharge in accordance with 23.2.7.1 shall be of sufficient size to accommodate all occupants at a distance of not less than 50 ft (15 m) from the building while providing a net area of 15 ft^2 (1.4 m^2) per person.

23.2.7.3 All exits shall be permitted to discharge through the level of exit discharge.

23.2.7.4 The requirements of 7.7.2 shall be waived, provided that not more than 50 percent of the exits discharge into a single fire compartment separated from other compartments by construction having not less than a 1-hour fire resistance rating.

23.2.7.5 Where all exits are permitted to discharge through areas on the level of discharge, all of the following criteria shall be met:

(1) A smoke barrier shall be provided to divide that level into not less than two compartments, with not less than one exit discharging into each compartment.
(2) Each smoke compartment shall have an exit discharge to the building exterior.
(3) The level of discharge shall be provided with automatic sprinkler protection.
(4) Any other portion of the level of discharge with access to the discharge area shall be provided with automatic sprinkler protection or shall be separated from the discharge area in accordance with the requirements for the enclosure of exits. *(See 7.1.3.2.1.)*

23.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

23.2.9 Emergency Lighting.

23.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9, unless otherwise permitted by 23.2.9.2.

23.2.9.2 Emergency lighting of not less than a 1-hour duration shall be permitted to be provided.

23.2.10 Marking of Means of Egress. Exit marking shall be provided as follows:

(1) Exit signs shall be provided in areas accessible to the public in accordance with Section 7.10.
(2) Exit signs shall not be required in detention and correctional residential housing areas. *(See 3.3.21.1.)*

23.2.11 Special Features.

23.2.11.1 Doors within means of egress shall be in accordance with Chapter 7, unless otherwise provided in 23.2.11.2 through 23.2.11.10.

23.2.11.2 Doors shall be permitted to be locked in accordance with the applicable use condition.

23.2.11.3 Where egress doors are locked with key-operated locks, the provisions of 23.7.6 shall apply.

23.2.11.4* Doors to resident sleeping rooms shall be not less than 28 in. (710 mm) in clear width.

23.2.11.5 Existing doors to resident sleeping rooms housing four or fewer residents shall be permitted to be not less than 19 in. (485 mm) in clear width.

23.2.11.6 Doors in a means of egress shall be permitted to be of the horizontal-sliding type, provided that the force necessary to slide the door to its fully open position does not exceed 50 lbf (222 N) where a force of 50 lbf (222 N) is simultaneously applied perpendicular to the door.

23.2.11.7 Doors from areas of refuge to the exterior shall be permitted to be locked with key locks in lieu of locking methods described in 23.2.11.8, the keys to unlock such doors shall be maintained and available at the facility at all times, and the locks shall be operable from the outside.

23.2.11.8* Any remote-control release used in a means of egress shall be provided with a reliable means of operation to release locks on all doors and shall be remotely located from the resident living area, unless otherwise permitted by 23.2.11.8.2.

23.2.11.8.1 The remote location of a remote-control release used in a means of egress shall provide sight and sound supervision of the resident living areas.

23.2.11.8.2 Remote-control locking and unlocking of occupied rooms in Use Condition IV shall not be required, provided that both of the following criteria are met:

(1) Not more than 10 locks need to be unlocked to relocate all occupants from one smoke compartment to an area of refuge as promptly as is required where remote-control

unlocking is used. *(See 23.3.7.9 for requirements for smoke barrier doors.)*
(2) Unlocking of all necessary locks is accomplished with not more than two separate keys.

23.2.11.9 Remote-Control Release–Operated Doors.

23.2.11.9.1 All remote-control release–operated doors shall be provided with a redundant means of operation as follows:

(1) Power-operated sliding doors or power-operated locks shall be constructed so that, in the event of power failure, a manual mechanical means to release and open the doors is provided at each door, and either emergency power arranged in accordance with 23.2.11.9.2 is provided for the power operation or a remote-control manual mechanical release is provided.
(2) A combination of the emergency power–operated release of selected individual doors and remote-control manual mechanical ganged release specified in 23.2.11.9.1(1) shall be permitted without mechanical release means at each door.
(3) Mechanically operated sliding doors or mechanically operated locks shall be provided with a manual mechanical means at each door to release and open the door.

23.2.11.9.2 The emergency power required by 23.2.11.9.1(1) shall be arranged to provide the required power automatically in the event of any interruption of normal power due to any of the following:

(1) Failure of a public utility or other outside electrical power supply
(2) Opening of a circuit breaker or fuse
(3) Manual act(s), including accidental opening of a switch controlling normal lighting facilities

23.2.11.10 The provisions of 7.2.1.5.8 for stairway re-entry shall not apply.

23.3 Protection.

23.3.1 Protection of Vertical Openings.

23.3.1.1 Any vertical opening shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by one of the following:

(1) Unprotected vertical openings in accordance with 8.6.9.1 shall be permitted.
(2) In residential housing area smoke compartments protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3, unprotected vertical openings shall be permitted in accordance with the conditions of 8.6.6, provided that the height between the lowest and highest finished floor levels does not exceed 23 ft (7010 mm), and the following also shall be permitted:
   (a) The number of levels shall not be restricted.
   (b) Residential housing areas subdivided in accordance with 23.3.8 shall be permitted to be considered as part of the communicating space.
   (c) The separation shall not be required to have a fire resistance rating. *[See 8.6.6(4)(b).]*
(3) The requirement of 23.3.1.1 shall not apply to multilevel residential housing areas in accordance with 23.3.1.2.
(4) Where full enclosure is impractical, the required enclosure shall be permitted to be limited to that necessary to prevent a fire originating in any story from spreading to any other story.
(5) Enclosures in detention and correctional occupancies shall have a minimum 1-hour fire resistance rating and shall be protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3.

23.3.1.2 Multilevel residential housing areas without enclosure protection between levels shall be permitted, provided that the conditions of 23.3.1.2.1 through 23.3.1.2.3 are met.

23.3.1.2.1* The entire normally occupied area, including all communicating floor levels, shall be sufficiently open and unobstructed so that a fire or other dangerous condition in any part is obvious to the occupants or supervisory personnel in the area.

23.3.1.2.2 Egress capacity shall simultaneously accommodate all occupants of all communicating levels and areas, with all communicating levels in the same fire area considered as a single floor area for purposes of determining required egress capacity.

23.3.1.2.3* The height between the highest and lowest finished floor levels shall not exceed 13 ft (3960 mm). The number of levels shall not be restricted.

23.3.1.3* A multitiered, open cell block shall be considered as a one-story building where one of the following criteria is met:

(1) A smoke control system is provided to maintain the level of smoke from potential cell fires at not less than 60 in. (1525 mm) above the floor level of any occupied tier involving space that is classified as follows:
   (a) Use Condition IV or Use Condition V
   (b) Use Condition III, unless all persons housed in such space can pass through a free access smoke barrier or freely pass below the calculated smoke level with not more than 50 ft (15 m) of travel from their cells
(2) The entire building, including cells, is provided with complete automatic sprinkler protection in accordance with 23.3.5.3.

23.3.2 Protection from Hazards.

23.3.2.1* Any hazardous area shall be protected in accordance with Section 8.7. The areas described in Table 23.3.2.1 shall be protected as indicated.

23.3.2.2 Reserved.

23.3.2.3 Hazardous areas determined by the authority having jurisdiction as not incidental to residents' housing shall be separated by 2-hour fire resistance–rated barriers in conjunction with automatic sprinkler protection.

23.3.2.4 Where cooking facilities are protected in accordance with 9.2.3, kitchens shall not be required to be provided with roomwide protection.

23.3.2.5 Waste chutes, incinerators, and linen chutes shall be protected in accordance with Section 9.5.

23.3.3 Interior Finish.

23.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

23.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in corridors, in exits, and in any space not separated from corridors and exits by partitions capable of retarding the passage of smoke; and Class A, Class B, or Class C in all other areas.

Table 23.3.2.1 Hazardous Area Protection

Hazardous Area Description	Separation/Protection†
Areas not incidental to resident housing	2 hours
Boiler and fuel-fired heater rooms	1 hour or sprinklers
Central or bulk laundries >100 ft^2 (>9.3 m^2)	1 hour or sprinklers
Commercial cooking equipment	In accordance with 9.2.3
Commissaries	1 hour or sprinklers
Employee locker rooms	1 hour or sprinklers
Hobby/handicraft shops	1 hour or sprinklers
Maintenance shops	1 hour or sprinklers
Padded cells	1 hour and sprinklers
Soiled linen rooms	1 hour or sprinklers
Storage rooms >50 ft^2 (>4.6 m^2) storing combustible material	1 hour or sprinklers
Trash collection rooms	1 hour or sprinklers

†Minimum fire resistance rating.

23.3.3.3 Interior Floor Finish.

23.3.3.3.1 Interior floor finish complying with Section 10.2 shall be Class I or Class II in corridors and exits.

23.3.3.3.2 Existing floor finish material of Class A or Class B in nonsprinklered smoke compartments and Class A, Class B, or Class C in sprinklered smoke compartments shall be permitted to be continued to be used, provided that it has been evaluated based on tests performed in accordance with 10.2.3.

23.3.4 Detection, Alarm, and Communications Systems.

23.3.4.1 General. Detention and correctional occupancies shall be provided with a fire alarm system in accordance with Section 9.6, except as modified by 23.3.4.2 through 23.3.4.4.4.

23.3.4.2 Initiation. Initiation of the required fire alarm system shall be by manual means in accordance with 9.6.2 and by means of any required detection devices or detection systems, unless otherwise permitted by the following:

(1) Manual fire alarm boxes shall be permitted to be locked, provided that staff is present within the area when it is occupied and staff has keys readily available to unlock the boxes.
(2) Manual fire alarm boxes shall be permitted to be located in a staff location, provided that both of the following criteria are met:
   (a) The staff location is attended when the building is occupied.
   (b) The staff attendant has direct supervision of the sleeping area.

23.3.4.3 Notification.

23.3.4.3.1 Occupant Notification. Occupant notification shall be accomplished automatically in accordance with 9.6.3, and the following also shall apply:

(1) A positive alarm sequence shall be permitted in accordance with 9.6.3.4.
(2)*Any smoke detectors required by this chapter shall be permitted to be arranged to alarm at a constantly attended location only and shall not be required to accomplish general occupant notification.

23.3.4.3.2 Emergency Forces Notification.

23.3.4.3.2.1 Fire department notification shall be accomplished in accordance with 9.6.4, unless otherwise permitted by one of the following:

(1) A positive alarm sequence shall be permitted in accordance with 9.6.3.4.
(2) Any smoke detectors required by this chapter shall not be required to transmit an alarm to the fire department.
(3) This requirement shall not apply where staff is provided at a constantly attended location that meets one of the following criteria:
   (a) It has the capability to promptly notify the fire department.
   (b) It has direct communication with a control room having direct access to the fire department.

23.3.4.3.2.2 Where the provision of 23.3.4.3.2.1(3) is utilized, the fire plan, as required by 23.7.1.3, shall include procedures for logging of alarms and immediate notification of the fire department.

23.3.4.4 Detection. An approved automatic smoke detection system shall be in accordance with Section 9.6, as modified by 23.3.4.4.1 through 23.3.4.4.4, throughout all resident housing areas.

23.3.4.4.1 Smoke detectors shall not be required in sleeping rooms with four or fewer occupants in Use Condition II or Use Condition III.

23.3.4.4.2 Other arrangements and positioning of smoke detectors shall be permitted to prevent damage or tampering, or for other purposes.

23.3.4.4.2.1 Other arrangements, as specified in 23.3.4.4.2, shall be capable of detecting any fire, and the placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangements required by the installation standards referenced in Section 9.6.

23.3.4.4.2.2 Detectors shall be permitted to be located in exhaust ducts from cells, behind grilles, or in other locations.

23.3.4.4.2.3 The equivalent performance of the design permitted by 23.3.4.4.2.2 shall be acceptable to the authority having jurisdiction in accordance with the equivalency concepts specified in Section 1.4.

23.3.4.4.3* Smoke detectors shall not be required in Use Condition II open dormitories where staff is present within the dormitory whenever the dormitory is occupied and the building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 23.3.5.3.

23.3.4.4.4 In smoke compartments protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3, smoke detectors shall not be required, except in corridors, common spaces, and sleeping rooms with more than four occupants.

23.3.5 Extinguishment Requirements.

23.3.5.1 High-rise buildings shall comply with 23.4.3.

23.3.5.2* Where required by Table 23.1.6.1, facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 23.3.5.3.

23.3.5.3 Where this *Code* permits exceptions for fully sprinklered detention and correctional occupancies or sprinklered smoke compartments, the sprinkler system shall meet all of the following criteria:

(1) It shall be in accordance with Section 9.7.
(2) It shall be installed in accordance with 9.7.1.1(1).
(3) It shall be electrically connected to the fire alarm system.
(4) It shall be fully supervised.

23.3.5.4 Portable fire extinguishers shall be provided in accordance with Section 9.9, unless otherwise permitted by the following:

(1)*Permitted to be locked.
(2)*Portable fire extinguishers shall be permitted to be located at staff locations only.

23.3.5.5 Standpipe and hose systems shall be provided in accordance with Section 9.10 as follows, unless otherwise permitted by 23.3.5.6:

(1) Class I standpipe systems shall be provided for any building three or more stories in height.
(2) Class III standpipe and hose systems shall be provided for all nonsprinklered buildings three or more stories in height.

23.3.5.6 The requirements of 23.3.5.5 shall not apply where otherwise permitted by the following:

(1) Formed hose, 1 in. (25 mm) in diameter, on hose reels shall be permitted to provide Class II service.
(2) Separate Class I and Class II systems shall be permitted in lieu of a Class III system.

23.3.6 Corridors. See 23.3.8.

23.3.7 Subdivision of Building Spaces.

23.3.7.1* Smoke barriers shall be provided to divide every story used for sleeping by 10 or more residents, or any other story having an occupant load of 50 or more persons, into not less than two compartments, unless otherwise permitted by one of the following:

(1) Protection shall be permitted to be accomplished using horizontal exits. *(See 7.2.4.)*
(2)*The requirement for subdivision of building space shall be permitted to be fulfilled by one of the following:
   (a) Smoke compartments having exit to a public way, where such exit serves only one area and has no openings to other areas
   (b) Building separated from the resident housing area by a 2-hour fire resistance rating or 50 ft (15 m) of open space
   (c) Secured, open area having a holding space located 50 ft (15 m) from the housing area that provides 15 ft^2 (1.4 m^2) or more of refuge area for each person (resident, staff, visitors) potentially present at the time of a fire

23.3.7.2 Doors used to access the areas specified in 23.3.7.1(2)(a), (b), and (c) shall meet the requirements for doors at smoke barriers for the applicable use condition.

23.3.7.3 Where smoke barriers are required by 23.3.7.1, they shall be provided in accordance with both of the following criteria:

(1) They shall limit the occupant load to not more than 200 residents in any smoke compartment.
(2)*They shall limit the travel distance to a door in a smoke barrier, unless otherwise permitted by 23.3.7.4, in accordance with both of the following criteria:
   (a) The distance from any room door required as exit access shall not exceed 100 ft (30 m).
   (b) The distance from any point in a room shall not exceed 150 ft (46 m).

23.3.7.4 The maximum travel distance to a door in a smoke barrier shall be permitted to be increased by 50 ft (15 m) in smoke compartments protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3 or an automatic smoke control system.

23.3.7.5* Any required smoke barrier shall be constructed in accordance with Section 8.5, shall be of substantial construction, and shall have structural fire resistance.

23.3.7.6 Openings in smoke barriers shall be protected in accordance with Section 8.5, unless otherwise permitted by the following:

(1)*The total number of vision panels in any barrier shall not be restricted.
(2) Sliding doors in smoke barriers that are designed to normally be kept closed and are remotely operated from a continuously attended location shall not be required to be self-closing.

23.3.7.7 Not less than 6 net ft^2 (0.55 net m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments, and this space shall be readily available wherever occupants are moved across the smoke barrier in a fire emergency.

23.3.7.8 Doors in smoke barriers shall meet all of the following criteria:

(1) The doors shall provide resistance to the passage of smoke.
(2) Swinging doors shall be self-latching, or the opening resistance of the door shall be not less than 5 lbf (22 N).
(3) Sliding doors shall be exempt from the latching requirement of 8.5.4.3.
(4) The doors shall not be required to swing in the direction of egress travel.

23.3.7.9 Doors in smoke barriers shall conform with the requirements for doors in means of egress as specified in Section 23.2 and shall have locking and release arrangements according to the applicable use condition. The provisions of 23.2.11.8.2 shall not be used for smoke barrier doors serving a smoke compartment containing more than 20 persons.

23.3.7.10 Vision panels shall be provided in smoke barriers at points where the barrier crosses an exit access corridor.

23.3.7.11 Smoke dampers shall be provided in accordance with 8.5.5, unless otherwise permitted by 23.3.7.12.

23.3.7.12 Arrangements and positioning of smoke detectors required by 23.3.7.11 shall be permitted to prevent damage or tampering, or for other purposes, provided that both of the following criteria are met:

(1) Such arrangements shall be capable of detecting any fire.
(2) The placement of detectors shall be such that the speed of detection is equivalent to that provided by the spacing and arrangement required by *NFPA 72, National Fire Alarm and Signaling Code*, as referenced in 8.5.5.7.1.

23.3.8* Special Protection Features— Subdivision of Resident Housing Spaces. Subdivision of facility spaces shall comply with Table 23.3.8.

23.4 Special Provisions.

23.4.1 Limited Access Structures.

23.4.1.1 Limited access structures used as detention and correctional occupancies shall comply with 23.4.1.2, unless otherwise permitted by one of the following:

(1) The provisions of Section 11.7 for limited access structures shall not apply.

(2) The requirement of 23.4.1.1 shall not apply to buildings protected throughout by an approved automatic sprinkler system in accordance with 23.3.5.3.

23.4.1.2 Any one of the following means shall be provided to evacuate smoke from the smoke compartment of fire origin:

(1) Operable windows on not less than two sides of the building, spaced not more than 30 ft (9.1 m) apart, that provide openings with dimensions of not less than 22 in. (560 mm) in width and 24 in. (610 mm) in height

Table 23.3.8 Subdivision of Resident Housing Spaces

	Use Condition							
	II		III		IV		V	
Feature	NS	AS	NS	AS	NS	AS	NS	AS
Room to room separation	NR	NR	NR	NR	SR	NR	SR	SR[a]
Room face to corridor separation	NR	NR	SR[b]	NR	SR[b]	NR	FR[b]	SR[a]
Room face to common space separation	NR	NR	NR ≤50 ft (≤15 m)[c] SR[b] >50 ft (>15 m)[c]	NR ≤50 ft (≤15 m)[c] SR[b] >50 ft (>15 m)[c]	SR[b]	NR ≤50 ft (≤15 m)[c] SR[a] >50 ft (>15 m)[c]	SR[b]	SR[a]
Common space to corridor separation	SR	NR	SR	NR	SR	NR	FR	SR[a]
Total openings in solid room face where room face is required to be smoke resistant or fire rated[d]	0.85 ft^2 (0.08 m^2)		0.85 ft^2 (0.08 m^2)		0.85 ft^2 (0.08 m^2)		0.85 ft^2 (0.08 m^2) where meeting one of the following: (1) Kept in closed position, except when in use by staff (2) Closable from the inside (3) Provided with smoke control	

NS: Not protected by automatic sprinklers. AS: Protected by automatic sprinklers. NR: No requirement. SR: Smoke resistant. FR: Minimum 1-hour fire resistance rating.

Notes:

(1) Doors in openings in partitions required to be fire rated (FR) in accordance with Table 23.3.8, in other than required enclosures of exits or hazardous areas, are required to be substantial doors of construction that resists fire for a minimum of 20 minutes. Vision panels with wired glass or glass with not less than 45-minute fire-rated glazing are permitted. Latches and door closers are not required on cell doors.

(2) Doors in openings in partitions required to be smoke resistant (SR) in accordance with Table 23.3.8 are required to be substantial doors of construction that resists the passage of smoke. Latches and door closers are not required on cell doors.

(3) Under Use Condition II, Use Condition III, or Use Condition IV, a space subdivided by open construction (any combination of grating doors and grating walls or solid walls) is permitted to be considered one room if housing not more than 16 persons. The perimeter walls of such space are required to be of smoke-resistant construction. Smoke detection is required to be provided in such space. Under Use Condition IV, common walls between sleeping areas within the space are required to be smoke resistant, and grating doors and fronts are permitted to be used. Under Use Condition II and Use Condition III, open dormitories are permitted to house more than 16 persons, as permitted by other sections of this chapter.

(4) Where barriers are required to be smoke resistant (SR), the provisions of Sections 8.4 and 8.5 do not apply.

[a]Might be no requirement (NR) where one of the following is provided:

(1) Approved automatic smoke detection system installed in all corridors and common spaces

(2) Multitiered cell blocks meeting the requirements of 23.3.1.3

[b]Might be no requirement (NR) in multitiered, open cell blocks meeting the requirements of 23.3.1.3.

[c]Travel distance through the common space to the exit access corridor.

[d]"Total openings in solid room face" include all openings (e.g., undercuts, food passes, grilles), the total of which is not to exceed 0.85 ft^2 (0.08 m^2). All openings are required to be 36 in. (915 mm) or less above the floor.

(2)*Manual or automatic smoke vents
(3) Engineered smoke control system
(4) Mechanical exhaust system providing not less than six air changes per hour
(5) Other method acceptable to the authority having jurisdiction

23.4.2 Underground Buildings. See Section 11.7 for requirements for underground buildings.

23.4.3 High-Rise Buildings. Existing high-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 23.3.5.3. A sprinkler control valve and a waterflow device shall be provided for each floor.

23.4.4 Reserved.

23.4.5 Lockups.

23.4.5.1 General.

23.4.5.1.1 Lockups in occupancies, other than detention and correctional occupancies and health care occupancies, where the holding area has capacity for more than 50 detainees shall be classified as detention and correctional occupancies and shall comply with the requirements of Chapter 23.

23.4.5.1.2 Lockups in occupancies, other than detention and correctional occupancies and health care occupancies, where any individual is detained for 24 or more hours shall be classified as detention and correctional occupancies and shall comply with the requirements of Chapter 23.

23.4.5.1.3 Lockups in occupancies, other than detention and correctional occupancies and health care occupancies, where the holding area has capacity for not more than 50 detainees, and where no individual is detained for 24 hours or more, shall comply with 23.4.5.1.4 or 23.4.5.1.5.

23.4.5.1.4 The lockup shall be permitted to comply with the requirements for the predominant occupancy in which the lockup is placed, provided that all of the following criteria are met:

(1)*Doors and other physical restraints to free egress by detainees can be readily released by staff within 2 minutes of the onset of a fire or similar emergency.
(2) Staff is in sufficient proximity to the lockup so as to be able to effect the 2-minute release required by 23.4.5.1.4(1) whenever detainees occupy the lockup.
(3) Staff is authorized to effect the release required by 23.4.5.1.4(1).
(4) Staff is trained and practiced in effecting the release required by 23.4.5.1.4(1).
(5) Where the release required by 23.4.5.1.4(1) is effected by means of remote release, detainees are not to be restrained from evacuating without the assistance of others.

23.4.5.1.5 Where the lockup does not comply with all the criteria of 23.4.5.1.4, the requirements of 23.4.5.2 shall be met.

23.4.5.1.6 The fire department with responsibility for responding to a building that contains a lockup shall be notified of the presence of the lockup.

23.4.5.2 Alternate Provisions.

23.4.5.2.1 The requirements applicable to the predominant occupancy in which the lockup is placed shall be met.

23.4.5.2.2 Where security operations necessitate the locking of required means of egress, the following shall apply:

(1) Detention-grade hardware meeting the requirements of ASTM F 1577, *Standard Test Methods for Detention Locks for Swinging Doors*, shall be provided on swinging doors within the required means of egress.
(2) Sliding doors within the required means of egress shall be designed and engineered for detention and correctional use, and lock cylinders shall meet the cylinder test requirements of ASTM F 1577.

23.4.5.2.3 The lockup shall be provided with a complete smoke detection system in accordance with 9.6.2.9.

23.4.5.2.4 Where the requirements applicable to the predominant occupancy do not require a fire alarm system, the lockup shall be provided with a fire alarm system meeting all of the following criteria:

(1) The alarm system shall be in accordance with Section 9.6.
(2) Initiation of the alarm system shall be accomplished by all of the following:
    (a) Manual fire alarm boxes in accordance with 9.6.2
    (b) Smoke detection system required by 23.4.5.2.3
    (c) Automatic sprinkler system required by the provisions applicable to the predominant occupancy
(3) Staff and occupant notification shall be provided automatically in accordance with 9.6.3.
(4) Emergency force notification shall be provided in accordance with 9.6.4.

23.4.6* Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers shall be permitted where both of the following criteria are met:

(1) The detention and correction facility permits their use.
(2) The installation meets the requirements in 8.7.3.3.

23.5 Building Services.

23.5.1 Utilities.

23.5.1.1 Utilities shall comply with the provisions of Section 9.1.

23.5.1.2 Alarms, emergency communications systems, and the illumination of generator set installations shall be provided with emergency power in accordance with *NFPA 70, National Electrical Code*, unless otherwise permitted by 23.5.1.3.

23.5.1.3 Systems complying with earlier editions of *NFPA 70, National Electrical Code*, and not presenting a life safety hazard shall be permitted to continue to be used.

23.5.2 Heating, Ventilating, and Air-Conditioning.

23.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2 and shall be installed in accordance with the manufacturer's specifications, unless otherwise permitted by one of the following:

(1) The requirement of 23.5.2.1 shall not apply where otherwise modified by 23.5.2.2.
(2) Systems complying with earlier editions of the applicable codes and not presenting a life safety hazard shall be permitted to continue to be used.

23.5.2.2 Portable space-heating devices shall be prohibited, unless otherwise permitted by 23.5.2.4.

23.5.2.3 Any heating device, other than a central heating plant, shall be designed and installed so that combustible material cannot be ignited by the device or its appurtenances, and both of the following requirements also shall apply:

(1) If fuel-fired, such heating devices shall comply with all of the following:
   (a) They shall be chimney connected or vent connected.
   (b) They shall take air for combustion directly from outside.
   (c) They shall be designed and installed to provide for complete separation of the combustion system from the atmosphere of the occupied area.
(2) The heating system shall have safety devices to immediately stop the flow of fuel and shut down the equipment in case of either excessive temperatures or ignition failure.

23.5.2.4 Approved, suspended unit heaters shall be permitted in locations other than means of egress and sleeping areas, provided that both of the following criteria are met:

(1) Such heaters are located high enough to be out of the reach of persons using the area.
(2) Such heaters are vent connected and equipped with the safety devices required by 23.5.2.3(2).

23.5.2.5 Combustion and ventilation air for boiler, incinerator, or heater rooms shall be taken directly from, and discharged directly to, the outside.

23.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

23.5.4 Waste Chutes, Incinerators, and Laundry Chutes.

23.5.4.1 Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

23.5.4.2 Waste chutes and linen chutes, including pneumatic waste and linen systems, shall be provided with automatic extinguishing protection in accordance with Section 9.7.

23.5.4.3 Waste chutes shall discharge into a chute discharge room used for no purpose other than collection of waste and protected in accordance with Sections 8.7 and 9.5.

23.5.4.4 Incinerators shall not be directly flue-fed, and floor chutes shall not directly connect with the combustion chamber.

23.6 Reserved.

23.7 Operating Features.

23.7.1 Attendants, Evacuation Plan, and Fire Drills.

23.7.1.1 Detention and correctional facilities, or those portions of facilities having such occupancy, shall be provided with 24-hour staffing, and the following requirements also shall apply:

(1) Staff shall be within three floors or a 300 ft (91 m) horizontal distance of the access door of each resident housing area.
(2) For Use Condition III, Use Condition IV, and Use Condition V, the arrangement shall be such that the staff involved starts the release of locks necessary for emergency evacuation or rescue and initiates other necessary emergency actions within 2 minutes of alarm.
(3) The following shall apply to areas in which all locks are unlocked remotely in compliance with 23.2.11.8:
   (a) Staff shall not be required to be within three floors or 300 ft (91 m) of the access door.
   (b) The 10-lock, manual key exemption of 23.2.11.8.2 shall not be permitted to be used in conjunction with the alternative requirement of 23.7.1.1(3)(a).

23.7.1.2* Provisions shall be made so that residents in Use Condition III, Use Condition IV, and Use Condition V shall be able to notify staff of an emergency.

23.7.1.3* The administration of every detention or correctional facility shall have, in effect and available to all supervisory personnel, written copies of a plan for the protection of all persons in the event of fire, for their evacuation to areas of refuge, and for evacuation from the building when necessary.

23.7.1.3.1 All employees shall be instructed and drilled with respect to their duties under the plan.

23.7.1.3.2 The plan shall be coordinated with, and reviewed by, the fire department legally committed to serve the facility.

23.7.1.4 Employees of detention and correctional occupancies shall be instructed in the proper use of portable fire extinguishers and other manual fire suppression equipment.

23.7.1.4.1 The training specified in 23.7.1.4 shall be provided to new staff promptly upon commencement of duty.

23.7.1.4.2 Refresher training shall be provided to existing staff at not less than annual intervals.

23.7.2* Combustible Personal Property. Books, clothing, and other combustible personal property allowed in sleeping rooms shall be stored in closable metal lockers or an approved fire-resistant container.

23.7.3 Heat-Producing Appliances. The number of heat-producing appliances, such as toasters and hot plates, and the overall use of electrical power within a sleeping room shall be controlled by facility administration.

23.7.4 Furnishings, Mattresses, and Decorations.

23.7.4.1 Draperies and curtains, including privacy curtains, in detention and correctional occupancies shall be in accordance with the provisions of 10.3.1.

23.7.4.2 Newly introduced upholstered furniture within detention and correctional occupancies shall meet the criteria specified in 10.3.2.1(2) and 10.3.3.

23.7.4.3* Newly introduced mattresses within detention and correctional occupancies shall meet the criteria specified in 10.3.2.2 and 10.3.4.

23.7.4.4 Combustible decorations shall be prohibited in any detention or correctional occupancy unless flame-retardant.

23.7.4.5 Wastebaskets and other waste containers shall be of noncombustible or other approved materials. Waste containers with a capacity exceeding 20 gal (76 L) shall be provided with a noncombustible lid or lid of other approved material.

23.7.5 Portable Space-Heating Devices. Portable space-heating devices shall be prohibited in all detention and correctional occupancies.

23.7.6 Door Inspection. Doors and door hardware in means of egress shall be inspected monthly by an appropriately trained person. The inspection shall be documented.

Chapter 24 One- and Two-Family Dwellings

24.1 General Requirements.

24.1.1 Application.

24.1.1.1 This chapter shall apply to one- and two-family dwellings.

24.1.1.2* One- and two-family dwellings shall be limited to buildings containing not more than two dwelling units in which each dwelling unit is occupied by members of a single family with not more than three outsiders, if any, accommodated in rented rooms.

24.1.1.3 The requirements of this chapter shall apply to new buildings and to existing or modified buildings used as a one- or two-family dwelling according to the provisions of 1.3.1.

24.1.1.4 Administration. The provisions of Chapter 1 shall apply.

24.1.1.5 General. The provisions of Chapter 4 shall apply.

24.1.2 Classification of Occupancy. See 6.1.8 and 24.1.1.1.

24.1.3 Multiple Occupancies.

24.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

24.1.3.2 No dwelling unit of a residential occupancy shall have its sole means of egress pass through any nonresidential occupancy in the same building, unless otherwise permitted by 24.1.3.2.1 or 24.1.3.2.2.

24.1.3.2.1 In buildings that are protected by an automatic sprinkler system in accordance with Section 9.7, dwelling units of a residential occupancy shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The dwelling unit of the residential occupancy shall comply with Chapter 24.
(2) The sole means of egress from the dwelling unit of the residential occupancy shall not pass through a high hazard contents area, as defined in 6.2.2.4.

24.1.3.2.2 In buildings that are not protected by an automatic sprinkler system in accordance with Section 9.7, dwelling units of a residential occupancy shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The sole means of egress from the dwelling unit of the residential occupancy to the exterior shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.
(2) The dwelling unit of the residential occupancy shall comply with Chapter 24.
(3) The sole means of egress from the dwelling unit of the residential occupancy shall not pass through a high hazard contents area, as defined in 6.2.2.4.

24.1.3.3 Multiple dwelling units of a residential occupancy shall be permitted to be located above a nonresidential occupancy only where one of the following conditions exists:

(1) Where the dwelling unit of the residential occupancy and exits therefrom are separated from the nonresidential occupancy by construction having a minimum 1-hour fire resistance rating
(2) Where the nonresidential occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(3) Where the nonresidential occupancy is protected by an automatic fire detection system in accordance with Section 9.6

24.1.3.4 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

24.1.4 Definitions.

24.1.4.1 General. For definitions, see Chapter 3, Definitions.

24.1.4.2 Special Definitions. Special terms applicable to this chapter are defined in Chapter 3 of this *Code*. Where necessary, other terms are defined in the text.

24.1.5 Classification of Hazard of Contents. The contents of residential occupancies shall be classified as ordinary hazard in accordance with 6.2.2.

24.1.6 Minimum Construction Requirements. (Reserved)

24.1.7 Occupant Load. (Reserved)

24.2* Means of Escape Requirements.

24.2.1 General. The provisions of Chapter 7 shall not apply to means of escape, unless specifically referenced in this chapter.

24.2.2 Number and Types of Means of Escape.

24.2.2.1 Number of Means of Escape.

24.2.2.1.1 In dwellings or dwelling units of two rooms or more, every sleeping room and every living area shall have not less than one primary means of escape and one secondary means of escape.

24.2.2.1.2 A secondary means of escape shall not be required where one of the following conditions is met:

(1) The bedroom or living area has a door leading directly to the outside of the building at or to the finished ground level.
(2) The dwelling unit is protected throughout by an approved automatic sprinkler system in accordance with 24.3.5.

24.2.2.2 Primary Means of Escape. The primary means of escape shall be a door, stairway, or ramp providing a means of unobstructed travel to the outside of the dwelling unit at street or the finished ground level.

24.2.2.3 Secondary Means of Escape. The secondary means of escape, other than an existing approved means of escape, shall be one of the means specified in 24.2.2.3.1 through 24.2.2.3.4.

24.2.2.3.1 It shall be a door, stairway, passage, or hall providing a way of unobstructed travel to the outside of the dwelling at street or the finished ground level that is independent of and remote from the primary means of escape.

24.2.2.3.2 It shall be a passage through an adjacent nonlockable space, independent of and remote from the primary means of escape, to any approved means of escape.

24.2.2.3.3* It shall be an outside window or door operable from the inside without the use of tools, keys, or special effort and shall provide a clear opening of not less than 5.7 ft^2 (0.53 m^2). The width shall be not less than 20 in. (510 mm), and the height shall be not less than 24 in. (610 mm). The bottom of the opening shall be not more than 44 in. (1120 mm) above the floor. Such means of escape shall be acceptable where one of the following criteria is met:

(1) The window shall be within 20 ft (6100 mm) of the finished ground level.

(2) The window shall be directly accessible to fire department rescue apparatus as approved by the authority having jurisdiction.
(3) The window or door shall open onto an exterior balcony.
(4) Windows having a sill height below the adjacent finished ground level shall be provided with a window well meeting all of the following criteria:
  (a) The window well shall have horizontal dimensions that allow the window to be fully opened.
  (b) The window well shall have an accessible net clear opening of not less than 9 ft^2 (0.82 m^2) with a length and width of not less than 36 in. (915 mm).
  (c) A window well with a vertical depth of more than 44 in. (1120 mm) shall be equipped with an approved permanently affixed ladder or with steps meeting both of the following criteria:
    i. The ladder or steps shall not encroach more than 6 in. (150 mm) into the required dimensions of the window well.
    ii. The ladder or steps shall not be obstructed by the window.

24.2.2.3.4 It shall be a bulkhead complying with 24.2.7 and meeting the minimum area requirements of 24.2.2.3.

24.2.2.3.5 Ladders or steps that comply with the requirements of 24.2.2.3.3(4)(c) shall be exempt from the requirements of 7.2.2.

24.2.2.4 Two Primary Means of Escape. In buildings, other than existing buildings and other than those protected throughout by an approved, supervised automatic sprinkler system in accordance with 24.3.5, every story more than 2000 ft^2 (185 m^2) in area within the dwelling unit shall be provided with two primary means of escape remotely located from each other.

24.2.3 Arrangement of Means of Escape. Any required path of travel in a means of escape from any room to the outside shall not pass through another room or apartment not under the immediate control of the occupant of the first room or through a bathroom or other space subject to locking.

24.2.4 Doors.

24.2.4.1 Doors in the path of travel of a means of escape, other than bathroom doors in accordance with 24.2.4.2 and doors serving a room not exceeding 70 ft^2 (6.5 m^2), shall be not less than 28 in. (710 mm) wide.

24.2.4.2 Bathroom doors and doors serving a room not exceeding 70 ft^2 (6.5 m^2) shall be not less than 24 in. (610 mm) wide.

24.2.4.3 Doors shall be not less than 6 ft 6 in. (1980 mm) in nominal height.

24.2.4.4 Every closet door latch shall be such that children can open the door from inside the closet.

24.2.4.5 Every bathroom door shall be designed to allow opening from the outside during an emergency when locked.

24.2.4.6 Doors shall be swinging or sliding.

24.2.4.7* No door in any means of escape shall be locked against egress when the building is occupied. All locking devices that impede or prohibit egress or that cannot be easily disengaged shall be prohibited.

24.2.4.8 Floor levels at doors in the primary means of escape shall comply with 7.2.1.3, unless otherwise permitted by any of the following:

(1) In existing buildings, where the door discharges to the outside or to an exterior balcony or exterior exit access, the floor level outside the door shall be permitted to be one step lower than the inside, but shall not be in excess of 8 in. (205 mm).
(2) In new buildings, where the door discharges to the outside or to an exterior exit access, an exterior landing with not more than a 7 in. (180 mm) drop below the door threshold and a minimum dimension of 36 in. (915 mm) or the width of the door leaf, whichever is smaller, shall be permitted.
(3) A door at the top of an interior stair shall be permitted to open directly onto a stair, provided that the door does not swing over the stair and the door serves an area with an occupant load of fewer than 50 persons.

24.2.4.9 Forces to open doors shall comply with 7.2.1.4.5.

24.2.4.10 Latching devices for doors shall comply with 7.2.1.5.10.

24.2.5 Stairs, Ramps, Guards, and Handrails.

24.2.5.1 Stairs, ramps, guards, and handrails shall be in accordance with 7.2.2 for stairs, 7.2.5 for ramps, and 7.2.2.4 for guards and handrails, as modified by 24.2.5.1.1 through 24.2.5.1.3.

24.2.5.1.1 The provisions of 7.2.2.5, 7.2.5.5, and 7.7.3 shall not apply to stairs and ramps.

24.2.5.1.2 If serving as a secondary means of escape, stairs complying with the fire escape requirements of Table 7.2.8.4(a) or Table 7.2.8.4(b) shall be permitted.

24.2.5.1.3 If serving as a secondary means of escape, ramps complying with the existing ramp requirements of Table 7.2.5.3(b) shall be permitted.

24.2.5.2 Interior stairways shall be provided with means capable of providing artificial light at the minimum level specified by 7.8.1.3 for exit stairs, measured at the center of treads and on landing surfaces within 24 in. (610 mm) of step nosings.

24.2.5.3 For interior stairways, manual lighting controls shall be reachable and operable without traversing any step of the stair.

24.2.5.4 The clear width of stairs, landings, ramps, balconies, and porches shall be not less than 36 in. (915 mm), measured in accordance with 7.3.2.

24.2.5.5 Spiral stairs and winders in accordance with 7.2.2.2.3 and 7.2.2.2.4 shall be permitted within a single dwelling unit.

24.2.5.6 No sleeping rooms or living areas shall be accessible only by a ladder, a stair ladder, an alternating tread device or folding stairs, or through a trap door.

24.2.6 Hallways.

24.2.6.1 The width of hallways, other than existing approved hallways, which shall be permitted to continue to be used, shall be not less than 36 in. (915 mm).

24.2.6.2 The height of hallways, other than existing approved hallways, which shall be permitted to continue to be used, shall be not less than 7 ft (2135 mm) nominal, with clearance below projections from the ceiling of not less than 6 ft 8 in. (2030 mm) nominal.

24.2.7 Bulkheads.

24.2.7.1 Bulkhead Enclosures. Where provided, bulkhead enclosures shall provide direct access to the basement from the exterior.

24.2.7.2 Bulkhead Enclosure Stairways. Stairways serving bulkhead enclosures that are not part of the required primary means of escape, and that provide access from the outside finished ground level to the basement, shall be exempt from the provisions of 24.2.5.1 when the maximum height from the basement finished floor level to the finished ground level adjacent to the stairway does not exceed 8 ft (2440 mm), and the finished ground level opening to the stairway is covered by a bulkhead enclosure with hinged doors or other approved means.

24.3 Protection.

24.3.1 Protection of Vertical Openings. (Reserved)

24.3.2 Protection from Hazards. (Reserved)

24.3.3 Interior Finish.

24.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

24.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C.

24.3.3.3 Interior Floor Finish. (Reserved)

24.3.3.4 Contents and Furnishings. Contents and furnishings shall not be required to comply with Section 10.3.

24.3.4 Detection, Alarm, and Communications Systems.

24.3.4.1 Smoke alarms or a smoke detection system shall be provided in accordance with either 24.3.4.1.1 or 24.3.4.1.2, as modified by 24.3.4.1.3.

24.3.4.1.1* Smoke alarms shall be installed in accordance with 9.6.2.10 in all of the following locations:

(1) All sleeping rooms
(2)*Outside of each separate sleeping area, in the immediate vicinity of the sleeping rooms
(3) On each level of the dwelling unit, including basements

24.3.4.1.2 Dwelling units shall be protected by an approved smoke detection system in accordance with Section 9.6 and equipped with an approved means of occupant notification.

24.3.4.1.3 In existing one- and two-family dwellings, approved smoke alarms powered by batteries shall be permitted.

24.3.4.2 Carbon Monoxide Alarms and Carbon Monoxide-Detection Systems.

24.3.4.2.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with Section 9.12 and 24.3.4.2 shall be provided in new one- and two-family dwellings where either of the following conditions exists:

(1) Dwelling units with communicating attached garages, unless otherwise exempted by 24.3.4.2.3
(2) Dwelling units containing fuel-burning appliances or fuel-burning fireplaces

24.3.4.2.2* Where required by 24.3.4.2.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate dwelling unit sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level of a dwelling unit, including basements, and excluding attics and crawl spaces

24.3.4.2.3 Carbon monoxide alarms and carbon monoxide detectors as specified in 24.3.4.2.1(1) shall not be required in the following locations:

(1) In garages
(2) Within dwelling units with communicating attached garages that are open parking structures as defined by the building code
(3) Within dwelling units with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

24.3.5* Extinguishment Requirements.

24.3.5.1 All new one- and two-family dwellings shall be protected throughout by an approved automatic sprinkler system in accordance with 24.3.5.2.

24.3.5.2 Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 9.7; in buildings of four or fewer stories in height above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, and with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall also be permitted.

24.4 Reserved.

24.5 Building Services.

24.5.1 Heating, Ventilating, and Air-Conditioning.

24.5.1.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

24.5.1.2 Unvented fuel-fired heaters shall not be used unless they are listed and approved.

24.5.2 Reserved.

Chapter 25 Reserved

Chapter 26 Lodging or Rooming Houses

26.1 General Requirements.

26.1.1 Application.

26.1.1.1* The requirements of this chapter shall apply to buildings that provide sleeping accommodations for 16 or fewer persons on either a transient or permanent basis, with or without meals, but without separate cooking facilities for individual occupants, except as provided in Chapter 24.

26.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

26.1.1.3 General. The provisions of Chapter 4, General, shall apply.

26.1.1.4 The requirements of this chapter shall apply to new buildings and to existing or modified buildings according to the provisions of 1.3.1 of this *Code*.

26.1.2 Classification of Occupancy. See 6.1.8 and 26.1.1.1.

26.1.3 Multiple Occupancies.

26.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

26.1.3.2 No lodging or rooming house shall have its sole means of egress pass through any nonresidential occupancy in the same building, unless otherwise permitted by 26.1.3.2.1 or 26.1.3.2.2.

26.1.3.2.1 In buildings that are protected by an automatic sprinkler system in accordance with Section 9.7, lodging or rooming houses shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that both of the following criteria are met:

(1) The lodging or rooming house shall comply with Chapter 26.
(2) The sole means of egress from the lodging or rooming house shall not pass through a high hazard contents area, as defined in 6.2.2.4.

26.1.3.2.2 In buildings that are not protected by an automatic sprinkler system in accordance with Section 9.7, lodging or rooming houses shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The sole means of egress from the lodging or rooming house to the exterior shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.
(2) The lodging or rooming house shall comply with Chapter 26.
(3) The sole means of egress from the lodging or rooming house shall not pass through a high hazard contents area, as defined in 6.2.2.4.

26.1.3.3 Lodging or rooming houses shall be permitted to be located above a nonresidential occupancy only where one of the following conditions exists:

(1) Where the lodging or rooming house and exits therefrom are separated from the nonresidential occupancy by construction having a minimum 1-hour fire resistance rating
(2) Where the nonresidential occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(3) Where the lodging or rooming house is located above a nonresidential occupancy, and the nonresidential occupancy is protected by an automatic fire detection system in accordance with Section 9.6

26.1.3.4 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

26.1.4 Definitions.

26.1.4.1 General. For definitions, see Chapter 3, Definitions.

26.1.4.2 Special Definitions. Special terms applicable to this chapter are defined in Chapter 3. Where necessary, other terms are defined in the text.

26.1.5 Classification of Hazard of Contents. The contents of residential occupancies shall be classified as ordinary hazard in accordance with 6.2.2.

26.1.6 Minimum Construction Requirements. (Reserved)

26.1.7 Occupant Load. See 26.1.1.1.

26.2 Means of Escape Requirements.

26.2.1 Number and Types of Means of Escape.

26.2.1.1 Primary Means of Escape.

26.2.1.1.1 Every sleeping room and living area shall have access to a primary means of escape complying with Chapter 24 and located to provide a safe path of travel to the outside.

26.2.1.1.2 Where the sleeping room is above or below the level of exit discharge, the primary means of escape shall be an interior stair in accordance with 26.2.2, an exterior stair, a horizontal exit in accordance with 7.2.4, or an existing fire escape stair in accordance with 7.2.8.

26.2.1.2 Secondary Means of Escape. In addition to the primary route, each sleeping room and living area shall have a second means of escape in accordance with 24.2.2, unless the sleeping room or living area has a door leading directly outside the building with access to the finished ground level or to a stairway that meets the requirements for exterior stairs in 26.2.1.1.2.

26.2.1.3 Two Primary Means of Escape. In other than existing buildings and those protected throughout by an approved, supervised automatic sprinkler system in accordance with 26.3.6, every story more than 2000 ft^2 (185 m^2) in area, or with travel distance to the primary means of escape more than 75 ft (23 m), shall be provided with two primary means of escape remotely located from each other.

26.2.2 Stairways.

26.2.2.1 Interior stairways, other than those in accordance with 26.2.2.2 or 26.2.2.3, shall comply with 7.2.2.5.3 and shall be enclosed by fire barriers having a minimum ½-hour fire resistance rating, with all openings protected with smoke-actuated automatic-closing or self-closing doors having a fire resistance comparable to that required for the enclosure.

26.2.2.2 Where an interior stair connects the street floor with the story next above or below only, but not with both, the interior stair shall be required to be enclosed only on the street floor.

26.2.2.3 Stairways shall be permitted to be unenclosed in accordance with 26.3.1.1.2 and 26.3.1.1.3.

26.2.2.4 Winders in accordance with 7.2.2.2.4 shall be permitted.

26.2.3 Doors.

26.2.3.1 Doors in a means of escape, other than bathroom doors in accordance with 26.2.3.2, and paths of travel in a means of escape shall be not less than 28 in. (710 mm) wide.

26.2.3.2 Bathroom doors shall be not less than 24 in. (610 mm) wide.

26.2.3.3 Every closet door latch shall be such that it can be readily opened from the inside in case of emergency.

26.2.3.4 Every bathroom door shall be designed to allow opening from the outside during an emergency when locked.

26.2.3.5 Door-locking arrangements shall comply with either 26.2.3.5.1 or 26.2.3.5.2.

26.2.3.5.1* No door in any means of escape shall be locked against egress when the building is occupied.

26.2.3.5.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted, provided that not more than one such device is located in any one escape path.

26.2.3.6 Doors serving a single dwelling unit shall be permitted to be provided with a lock in accordance with 7.2.1.5.7.

26.3 Protection.

26.3.1 Protection of Vertical Openings.

26.3.1.1 Vertical openings shall comply with 26.3.1.1.1, 26.3.1.1.2, or 26.3.1.1.3.

26.3.1.1.1 Vertical openings shall be protected so that no primary escape route is exposed to an unprotected vertical opening.

26.3.1.1.1.1 The vertical opening shall be considered protected if the opening is cut off and enclosed in a manner that provides a smoke- and fire-resisting capability of not less than ½ hour.

26.3.1.1.1.2 Any doors or openings shall have a smoke- and fire-resisting capability equivalent to that of the enclosure and shall be automatic-closing on detection of smoke or shall be self-closing.

26.3.1.1.2 In buildings three or fewer stories in height that are protected throughout by an approved automatic sprinkler system in accordance with 26.3.6, unprotected vertical openings shall be permitted, provided that a primary means of escape from each sleeping area is provided that does not pass through a portion of a lower floor, unless such portion is separated from all spaces on that floor by construction having a minimum ½-hour fire resistance rating.

26.3.1.1.3 Stair enclosures shall not be required in buildings two or fewer stories in height where both of the following conditions exist:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 26.3.6.1.
(2) The allowance of 24.2.2.1.2 to omit a secondary means of escape is not used.

26.3.1.2* Exterior stairs shall be protected against blockage caused by fire within the building.

26.3.2 Protection from Hazards. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

26.3.3 Interior Finish.

26.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

26.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C.

26.3.3.3 Interior Floor Finish.

26.3.3.3.1 Newly installed interior floor finish shall comply with Section 10.2.

26.3.3.3.2 Newly installed interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

26.3.4 Detection, Alarm, and Communications Systems.

26.3.4.1 General.

26.3.4.1.1 Lodging and rooming houses, other than those meeting 26.3.4.1.2, shall be provided with a fire alarm system in accordance with Section 9.6.

26.3.4.1.2 A fire alarm system in accordance with Section 9.6 shall not be required in existing lodging and rooming houses that have an existing smoke detection system meeting or exceeding the requirements of 26.3.4.5.1 where that detection system includes not less than one manual fire alarm box per floor arranged to initiate the smoke detection alarm.

26.3.4.2 Initiation. Initiation of the required fire alarm system shall be by manual means in accordance with 9.6.2, or by alarm initiation in accordance with 9.6.2.1(3) in buildings protected throughout by an approved automatic sprinkler system in accordance with 26.3.6.

26.3.4.3 Notification. Occupant notification shall be provided automatically in accordance with 9.6.3, as modified by 26.3.4.3.1 and 26.3.4.3.2.

26.3.4.3.1* Visible signals for the hearing impaired shall not be required where the proprietor resides in the building and there are five or fewer rooms for rent.

26.3.4.3.2 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

26.3.4.4 Detection. (Reserved)

26.3.4.5 Smoke Alarms.

26.3.4.5.1 Approved smoke alarms, other than existing smoke alarms meeting the requirements of 26.3.4.5.3, shall be installed in accordance with 9.6.2.10 in every sleeping room.

26.3.4.5.2 In other than existing buildings, the smoke alarms required by 26.3.4.5.1 shall be interconnected in accordance with 9.6.2.10.3.

26.3.4.5.3 Existing battery-powered smoke alarms, rather than house electric-powered smoke alarms, shall be permitted where the facility has demonstrated to the authority having jurisdiction that the testing, maintenance, and battery replacement programs will ensure reliability of power to the smoke alarms.

26.3.4.6 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

26.3.4.6.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with Section 9.12 and 26.3.4.6 shall be provided in new lodging or rooming houses where either of the following conditions exists:

(1) Lodging or rooming houses with communicating attached garages, unless otherwise exempted by 26.3.4.6.3
(2) Lodging or rooming houses containing fuel-burning appliances or fuel-burning fireplaces

26.3.4.6.2* Where required by 26.3.4.6.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level, including basements, and excluding attics and crawl spaces

26.3.4.6.3 Carbon monoxide alarms and carbon monoxide detectors as specified in 26.3.4.6.1(1) shall not be required in the following locations:

(1) In garages
(2) Within lodging or rooming houses with communicating attached garages that are open parking structures as defined by the building code

(3) Within lodging or rooming houses with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

26.3.5 Separation of Sleeping Rooms.

26.3.5.1 All sleeping rooms shall be separated from escape route corridors by smoke partitions in accordance with Section 8.4.

26.3.5.2 There shall be no louvers or operable transoms in corridor walls.

26.3.5.3 Air passages shall not penetrate corridor walls, unless they are properly installed heating and utility installations other than transfer grilles.

26.3.5.4 Transfer grilles shall be prohibited in corridor walls.

26.3.5.5 Doors shall be provided with latches or other mechanisms suitable for keeping the doors closed.

26.3.5.6 Doors shall not be arranged to prevent the occupant from closing the door.

26.3.5.7 In buildings other than those protected throughout by an approved automatic sprinkler system in accordance with 26.3.6, doors shall be self-closing or automatic-closing upon detection of smoke.

26.3.6 Extinguishment Requirements.

26.3.6.1 All new lodging or rooming houses shall be protected throughout by an approved automatic sprinkler system in accordance with 26.3.6.2.

26.3.6.2 Where an automatic sprinkler system is required or is used as an alternative method of protection, either for total or partial building coverage, the system shall be in accordance with Section 9.7 and 26.3.6.2.1 through 26.3.6.2.6.

26.3.6.2.1 Activation of the automatic sprinkler system shall actuate the fire alarm system in accordance with Section 9.6.

26.3.6.2.2 In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

26.3.6.2.3* Systems in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall be permitted where all of the following requirements are met:

(1) The lodging or rooming house shall not be part of a mixed occupancy.
(2) Entrance foyers shall be sprinklered.
(3) Lodging or rooming houses with sleeping accommodations for more than eight occupants shall be treated as two-family dwellings with regard to the water supply.

26.3.6.2.4 In buildings sprinklered in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, closets less than 12 ft^2 (1.1 m^2) in area in individual dwelling units shall not be required to be sprinklered.

26.3.6.2.5 In buildings sprinklered in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size.

26.3.6.2.6 In existing lodging or rooming houses, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2).

26.4 Reserved.

26.5 Building Services.

26.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

26.5.2 Heating, Ventilating, and Air-Conditioning.

26.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

26.5.2.2 Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, *National Fuel Gas Code*, shall not be used.

26.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

26.6 Reserved.

26.7 Operating Features.

26.7.1 Contents and Furnishings.

26.7.1.1 Contents and furnishings shall not be required to comply with Section 10.3.

26.7.1.2 Furnishings or decorations of an explosive or highly flammable character shall not be used.

26.7.1.3 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use.

Chapter 27 Reserved

Chapter 28 New Hotels and Dormitories

28.1 General Requirements.

28.1.1 Application.

28.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as hotel or dormitory occupancies. *(See 1.3.1.)*

28.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

28.1.1.3 General. The provisions of Chapter 4, General, shall apply.

28.1.1.4 Any dormitory divided into suites of rooms, with one or more bedrooms opening into a living room or study that has a door opening into a common corridor serving a number of suites, shall be classified as an apartment building.

28.1.1.5 The term *hotel*, wherever used in this *Code*, shall include a hotel, an inn, a club, a motel, a bed and breakfast, or any other structure meeting the definition of hotel.

28.1.2 Classification of Occupancy. See 6.1.8 and 28.1.4.2.

28.1.3 Multiple Occupancies.

28.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

28.1.3.2 No guest room or guest suite of a hotel or dormitory shall have its sole means of egress pass through any nonresidential occupancy in the same building, unless otherwise permitted by 28.1.3.2.1 or 28.1.3.2.2.

28.1.3.2.1 In buildings that are protected by an automatic sprinkler system in accordance with Section 9.7, guest rooms and guest suites of hotels and dormitories shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that both of the following criteria are met:

(1) The hotel or dormitory shall comply with Chapter 28.
(2) The sole means of egress from the guest room or guest suite of the hotel or dormitory shall not pass through a high-hazard contents area, as defined in 6.2.2.4.

28.1.3.2.2 In buildings that are not protected by an automatic sprinkler system in accordance with Section 9.7, guest rooms and guest suites of hotels and dormitories shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The sole means of egress from the guest room or guest suite of the hotel or dormitory to the exterior shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.
(2) The hotel or dormitory shall comply with Chapter 28.
(3) The sole means of egress from the guest room or guest suite of the hotel or dormitory shall not pass through a high-hazard contents area, as defined in 6.2.2.4.

28.1.3.3 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

28.1.4 Definitions.

28.1.4.1 General. For definitions, see Chapter 3, Definitions.

28.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Dormitory.** See 3.3.64.
(2) **Guest Room.** See 3.3.132.
(3) **Guest Suite.** See 3.3.273.1.
(4) **Hotel.** See 3.3.145.

28.1.5 Classification of Hazard of Contents.

28.1.5.1 The contents of residential occupancies shall be classified as ordinary hazard in accordance with 6.2.2.

28.1.5.2 For the design of automatic sprinkler systems, the classification of contents in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall apply.

28.1.6 Minimum Construction Requirements. (Reserved)

28.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

28.2 Means of Egress Requirements.

28.2.1 General.

28.2.1.1 Means of egress from guest rooms or guest suites to the outside of the building shall be in accordance with Chapter 7 and this chapter.

28.2.1.2 Means of escape within the guest room or guest suite shall comply with the provisions of Section 24.2 for one- and two-family dwellings.

28.2.1.3 For the purpose of application of the requirements of Chapter 24, the terms *guest room* and *guest suite* shall be synonymous with the terms *dwelling unit* or *living unit*.

28.2.2 Means of Egress Components.

28.2.2.1 General.

28.2.2.1.1 Components of means of egress shall be limited to the types described in 28.2.2.2 through 28.2.2.12.

28.2.2.1.2 In buildings, other than high-rise buildings, that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, exit enclosures shall have a minimum 1-hour fire resistance rating, and doors shall have a minimum 1-hour fire protection rating.

28.2.2.2 Doors.

28.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

28.2.2.2.2 Door-locking arrangements shall comply with 28.2.2.2.2.1, 28.2.2.2.2.2, 28.2.2.2.2.3, or 28.2.2.2.2.4.

28.2.2.2.2.1 No door in any means of egress shall be locked against egress when the building is occupied.

28.2.2.2.2.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

28.2.2.2.2.3 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

28.2.2.2.2.4 Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

28.2.2.2.3 Revolving doors complying with 7.2.1.10 shall be permitted.

28.2.2.3 Stairs. Stairs complying with 7.2.2 shall be permitted.

28.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

28.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

28.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

28.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

28.2.2.8 Reserved.

28.2.2.9 Reserved.

28.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

28.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

28.2.2.12 Areas of Refuge.

28.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted, as modified by 28.2.2.12.2.

28.2.2.12.2* In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, the two accessible rooms or spaces separated from each other by smoke-resistive partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

28.2.3 Capacity of Means of Egress.

28.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

28.2.3.2 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging onto the street floor.

28.2.3.3* Corridors, other than those within individual guest rooms or individual guest suites, shall be of sufficient width to accommodate the required occupant load and shall be not less than 44 in. (1120 mm).

28.2.4 Number of Means of Egress.

28.2.4.1 Means of egress shall comply with all of the following, except as otherwise permitted by 28.2.4.2 and 28.2.4.3:

(1) The number of means of egress shall be in accordance with Section 7.4.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

28.2.4.2 Exit access, as required by 28.2.4.1(3), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 28.2.5.

28.2.4.3 A single exit shall be permitted in buildings where the total number of stories does not exceed four, provided that all of the following conditions are met:

(1) There are four or fewer guest rooms or guest suites per story.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5.
(3) The exit stairway does not serve more than one-half of a story below the level of exit discharge.
(4) The travel distance from the entrance door of any guest room or guest suite to an exit does not exceed 35 ft (10.7 m).
(5) The exit stairway is completely enclosed or separated from the rest of the building by barriers having a minimum 1-hour fire resistance rating.
(6) All openings between the exit stairway enclosure and the building are protected with self-closing door assemblies having a minimum 1-hour fire protection rating.
(7) All corridors serving as access to exits have a minimum 1-hour fire resistance rating.
(8) Horizontal and vertical separation having a minimum ½-hour fire resistance rating is provided between guest rooms or guest suites.

28.2.5 Arrangement of Means of Egress.

28.2.5.1 Access to all required exits shall be in accordance with Section 7.5, as modified by 28.2.5.2.

28.2.5.2 The distance between exits addressed by 7.5.1.3 shall not apply to common nonlooped exit access corridors in buildings that have corridor doors from the guest room or guest suite that are arranged such that the exits are located in opposite directions from such doors.

28.2.5.3 In buildings not protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, common paths of travel shall not exceed 35 ft (10.7 m); travel within a guest room or guest suite shall not be included when calculating common path of travel.

28.2.5.4 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, common path of travel shall not exceed 50 ft (15 m); travel within a guest room or guest suite shall not be included when determining common path of travel.

28.2.5.5 In buildings not protected throughout by an approved, automatic sprinkler system in accordance with 28.3.5, dead-end corridors shall not exceed 35 ft (10.7 m).

28.2.5.6 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, dead-end corridors shall not exceed 50 ft (15 m).

28.2.5.7 Any guest room or any guest suite of rooms in excess of 2000 ft^2 (185 m^2) shall be provided with not less than two exit access doors remotely located from each other.

28.2.6 Travel Distance to Exits.

28.2.6.1 Travel distance within a guest room or guest suite to a corridor door shall not exceed 75 ft (23 m) in buildings not protected by an approved, supervised automatic sprinkler system in accordance with 28.3.5.

28.2.6.2 Travel distance within a guest room or guest suite to a corridor door shall not exceed 125 ft (38 m) in buildings protected by an approved, supervised automatic sprinkler system in accordance with 28.3.5.

28.2.6.3 Travel distance from the corridor door of any guest room or guest suite to the nearest exit shall comply with 28.2.6.3.1, 28.2.6.3.2, or 28.2.6.3.3.

28.2.6.3.1 Travel distance from the corridor door of any guest room or guest suite to the nearest exit, measured in accordance with Section 7.6, shall not exceed 100 ft (30 m).

28.2.6.3.2 Travel distance from the corridor door of any guest room or guest suite to the nearest exit, measured in accordance with Section 7.6, shall not exceed 200 ft (61 m) for exterior ways of exit access arranged in accordance with 7.5.3.

28.2.6.3.3 Travel distance from the corridor door of any guest room or guest suite to the nearest exit shall comply with 28.2.6.3.3.1 and 28.2.6.3.3.2.

28.2.6.3.3.1 Travel distance from the corridor door of any guest room or guest suite to the nearest exit shall be measured in accordance with Section 7.6 and shall not exceed 200 ft (61 m) where the exit access and any portion of the building that is tributary to the exit access are protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5.

28.2.6.3.3.2 Where the building is not protected throughout by an approved, supervised automatic sprinkler system, the 200 ft (61 m) travel distance shall be permitted within any portion of the building that is protected by an approved, supervised automatic sprinkler system, provided that the sprinklered portion of the building is separated from any nonsprinklered portion by fire barriers having a fire resistance rating as follows:

(1) Minimum 1-hour fire resistance rating for buildings three or fewer stories in height
(2) Minimum 2-hour fire resistance rating for buildings four or more stories in height

28.2.7 Discharge from Exits.

28.2.7.1 Exit discharge shall comply with Section 7.7.

28.2.7.2* Any required exit stair that is located so that it is necessary to pass through the lobby or other open space to reach the outside of the building shall be continuously enclosed down to a level of exit discharge or to a mezzanine within a lobby at a level of exit discharge.

28.2.7.3 The distance of travel from the termination of the exit enclosure to an exterior door leading to a public way shall not exceed 100 ft (30 m).

28.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

28.2.9 Emergency Lighting.

28.2.9.1 Emergency lighting in accordance with Section 7.9 shall be provided.

28.2.9.2 The requirement of 28.2.9.1 shall not apply where each guest room or guest suite has an exit direct to the outside of the building at street or the finished ground level.

28.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

28.2.11 Special Means of Egress Features.

28.2.11.1 Reserved.

28.2.11.2 Lockups. Lockups in hotel and dormitory occupancies shall comply with the requirements of 22.4.5.

28.2.11.3 Normally Unoccupied Building Service Equipment Support Areas. The use of Section 7.13 shall be prohibited.

28.3 Protection.

28.3.1 Protection of Vertical Openings.

28.3.1.1 Vertical openings shall comply with 28.3.1.1.1 through 28.3.1.2.

28.3.1.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6.

28.3.1.1.2 Vertical openings in accordance with 8.6.9.1 shall be permitted.

28.3.1.1.3 In buildings, other than high-rise buildings, that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, the walls enclosing vertical openings shall have a minimum 1-hour fire resistance rating, and doors shall have a minimum 1-hour fire protection rating.

28.3.1.2 No floor below the level of exit discharge used only for storage, heating equipment, or purposes other than residential occupancy shall have unprotected openings to floors used for residential purposes.

28.3.2 Protection from Hazards.

28.3.2.1 General. All rooms containing high-pressure boilers, refrigerating machinery, transformers, or other service equipment subject to possible explosion shall not be located directly under or directly adjacent to exits and shall be effectively cut off from other parts of the building as specified in Section 8.7.

28.3.2.2 Hazardous Areas.

28.3.2.2.1 Any hazardous area shall be protected in accordance with Section 8.7.

28.3.2.2.2 The areas described in Table 28.3.2.2.2 shall be protected as indicated.

28.3.2.2.3 Where sprinkler protection without fire-rated separation is used, areas shall be separated from other spaces by smoke partitions complying with Section 8.4.

Table 28.3.2.2.2 Hazardous Area Protection

Hazardous Area Description	Separation/Protection[a]
Boiler and fuel-fired heater rooms serving more than a single guest room or guest suite	1 hour and sprinklers
Employee locker rooms	1 hour or sprinklers
Gift or retail shops	1 hour or sprinklers
Bulk laundries	1 hour and sprinklers
Guest laundries ≤100 ft^2 (≤9.3 m^2) outside of guest rooms or guest suites	1 hour or sprinklers[b]
Guest laundries >100 ft^2 (>9.3 m^2) outside of guest rooms or guest suites	1 hour and sprinklers
Maintenance shops	1 hour and sprinklers
Storage rooms[c]	1 hour or sprinklers
Trash collection rooms	1 hour and sprinklers

[a]Minimum fire resistance rating.
[b]Where sprinklers are provided, the separation specified in 8.7.1.2 and 28.3.2.2.3 is not required.
[c]Where storage areas not exceeding 24 ft^2 (2.2 m^2) are directly accessible from the guest room or guest suite, no separation or protection is required.

28.3.3 Interior Finish.

28.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

28.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted as follows:

(1) Exit enclosures — Class A
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C

28.3.3.3 Interior Floor Finish.

28.3.3.3.1 Interior floor finish shall comply with Section 10.2.

28.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 28.3.6.1 shall be not less than Class II.

28.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

28.3.4 Detection, Alarm, and Communications Systems.

28.3.4.1 General. A fire alarm system in accordance with Section 9.6, except as modified by 28.3.4.2 through 28.3.4.6, shall be provided.

28.3.4.2 Initiation. The required fire alarm system shall be initiated by each of the following:

(1) Manual means in accordance with 9.6.2
(2) Manual fire alarm box located at the hotel desk or other convenient central control point under continuous supervision by responsible employees
(3) Required automatic sprinkler system
(4) Required automatic detection system other than sleeping room smoke detectors

28.3.4.3 Notification.

28.3.4.3.1* Occupant notification shall be provided automatically in accordance with 9.6.3.

28.3.4.3.2 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

28.3.4.3.3* Guest rooms and guest suites specifically required and equipped to accommodate hearing-impaired individuals shall be provided with a visible notification appliance.

28.3.4.3.4 In occupiable areas, other than guest rooms and guest suites, visible notification appliances shall be provided.

28.3.4.3.5 Annunciation and annunciation zoning in accordance with 9.6.7 shall be provided in buildings three or more stories in height or having more than 50 guest rooms or guest suites. Annunciation shall be provided at a location readily accessible from the primary point of entry for emergency response personnel.

28.3.4.3.6 Emergency forces notification shall be provided in accordance with 9.6.4.

28.3.4.4 Detection. A corridor smoke detection system in accordance with Section 9.6 shall be provided in buildings other than those protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5.3.

28.3.4.5* Smoke Alarms. Smoke alarms shall be installed in accordance with 9.6.2.10 in every guest room and every living area and sleeping room within a guest suite.

28.3.4.6 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

28.3.4.6.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with Section 9.8 and 28.3.4.6 shall be provided in new hotels and dormitories where either of the following conditions exists:

(1) Guest rooms or guest suites with communicating attached garages, unless otherwise exempted by 28.3.4.6.3
(2) Guest rooms or guest suites containing a permanently installed fuel-burning appliance or fuel-burning fireplace

28.3.4.6.2 Where required by 28.3.4.6.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate guest room or guest suite sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level of a guest room and guest suite

28.3.4.6.3 Carbon monoxide alarms and carbon monoxide detectors as specified in 28.3.4.6.1(1) shall not be required in the following locations:

(1) In garages
(2) Within guest rooms or guest suites with communicating attached garages that are open parking structures as defined by the building code
(3) Within guest rooms or guest suites with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

28.3.4.6.4 Where fuel-burning appliances or fuel-burning fireplaces are installed outside guest rooms or guest suites, carbon monoxide alarms or carbon monoxide detectors shall be installed in accordance with the manufacturer's published instructions in the locations specified as follows:

(1) On the ceilings of rooms containing permanently installed fuel-burning appliances or fuel-burning fireplaces
(2) Centrally located within occupiable spaces served by the first supply air register from a permanently installed, fuel-burning HVAC system
(3) Centrally located within occupiable spaces adjacent to a communicating attached garage

28.3.5 Extinguishment Requirements.

28.3.5.1 All buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5.3.

28.3.5.2 Reserved.

28.3.5.3 Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 9.7, as modified by 28.3.5.4. In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

28.3.5.4 The provisions for draft stops and closely spaced sprinklers in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required for openings complying with 8.6.9.1 where the opening is within the guest room or guest suite.

28.3.5.5 Reserved.

28.3.5.6 Listed quick-response or listed residential sprinklers shall be used throughout guest rooms and guest room suites.

28.3.5.7 Open parking structures that comply with NFPA 88A, *Standard for Parking Structures*, and are contiguous with hotels or dormitories shall be exempt from the sprinkler requirements of 28.3.5.1.

28.3.5.8 In buildings other than those protected throughout with an approved, supervised automatic sprinkler system in accordance with 28.3.5.3, portable fire extinguishers shall be provided as specified in Section 9.9 in hazardous areas addressed by 28.3.2.2.

28.3.6 Corridors.

28.3.6.1 Walls.

28.3.6.1.1 Exit access corridor walls shall comply with 28.3.6.1.2 or 28.3.6.1.3.

28.3.6.1.2 In buildings not complying with 28.3.6.1.3, exit access corridor walls shall consist of fire barriers in accordance with Section 8.3 that have not less than a 1-hour fire resistance rating.

28.3.6.1.3 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5, corridor walls shall have a minimum ½-hour fire resistance rating.

28.3.6.2 Doors.

28.3.6.2.1 Doors that open onto exit access corridors shall have not less than a 20-minute fire protection rating in accordance with Section 8.3.

28.3.6.2.2 Reserved.

28.3.6.2.3 Doors that open onto exit access corridors shall be self-closing and self-latching.

28.3.6.3 Unprotected Openings.

28.3.6.3.1 Unprotected openings, other than those from spaces complying with 28.3.6.3.2, shall be prohibited in exit access corridor walls and doors.

28.3.6.3.2 Spaces shall be permitted to be unlimited in area and open to the corridor, provided that all of the following criteria are met:

(1) The space is not used for guest rooms or guest suites or hazardous areas.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 28.3.5.
(3) The space does not obstruct access to required exits.

28.3.6.4 Transoms, Louvers, or Transfer Grilles. Transoms, louvers, or transfer grilles shall be prohibited in walls or doors of exit access corridors.

28.3.7 Subdivision of Building Spaces. Buildings shall be subdivided in accordance with 28.3.7.1 or 28.3.7.2.

28.3.7.1 In buildings not protected throughout by an approved, supervised automatic sprinkler system, each hotel guest room, including guest suites, and dormitory room shall be separated from other guest rooms or dormitory rooms by walls and floors constructed as fire barriers having a minimum 1-hour fire resistance rating.

28.3.7.2 In buildings protected throughout by an approved, supervised automatic sprinkler system, each hotel guest room, including guest suites, and dormitory room shall be separated from other guest rooms or dormitory rooms by walls and floors constructed as fire barriers having a minimum ½-hour fire resistance rating.

28.3.7.3 Doors in the barriers required by 28.3.7.1 and 28.3.7.2 shall have a fire protection rating of not less than 20 minutes and shall not be required to be self-closing.

28.3.8 Special Protection Features. (Reserved)

28.4 Special Provisions.

28.4.1 High-Rise Buildings.

28.4.1.1 High-rise buildings shall comply with Section 11.8.

28.4.1.2* Emergency action plans in accordance with Section 4.8 shall be provided and shall include all of the following:

(1) Egress procedures
(2) Methods
(3) Preferred evacuation routes for each event, including appropriate use of elevators

28.4.2 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

28.5 Building Services.

28.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

28.5.2 Heating, Ventilating, and Air-Conditioning.

28.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2, except as otherwise required in this chapter.

28.5.2.2 Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, *National Fuel Gas Code*, shall not be used.

28.5.3 Elevators, Escalators, and Conveyors.

28.5.3.1 Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

28.5.3.2* In high-rise buildings, one elevator shall be provided with a protected power supply and shall be available for use by the fire department in case of emergency.

28.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

28.6 Reserved.

28.7 Operating Features.

28.7.1 Hotel Emergency Organization.

28.7.1.1* Employees of hotels shall be instructed and drilled in the duties they are to perform in the event of fire, panic, or other emergency.

28.7.1.2* Drills of the emergency organization shall be held at quarterly intervals and shall cover such points as the operation and maintenance of the available first aid fire appliances, the testing of devices to alert guests, and a study of instructions for emergency duties.

28.7.2 Emergency Duties. Upon discovery of a fire, employees shall carry out all of the following duties:

(1) Activation of the facility fire protection signaling system, if provided
(2) Notification of the public fire department
(3) Other action as previously instructed

28.7.3 Drills in Dormitories. Emergency egress and relocation drills in accordance with Section 4.7 shall be held with sufficient frequency to familiarize occupants with all types of hazards and to establish conduct of the drill as a matter of routine. Drills shall be conducted during peak occupancy periods and shall include suitable procedures to ensure that all persons subject to the drill participate.

28.7.4 Emergency Instructions for Residents or Guests.

28.7.4.1* A floor diagram reflecting the actual floor arrangement, exit locations, and room identification shall be posted in a location and manner acceptable to the authority having jurisdiction on, or immediately adjacent to, every guest room door in hotels and in every resident room in dormitories.

28.7.4.2* Fire safety information shall be provided to allow guests to make the decision to evacuate to the outside, to evacuate to an area of refuge, to remain in place, or to employ any combination of the three options.

28.7.5 Emergency Action Plans. Emergency action plans in accordance with Section 4.8 shall be provided.

28.7.6 Contents and Furnishings.

28.7.6.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*

28.7.6.2 Upholstered Furniture and Mattresses.

28.7.6.2.1 Newly introduced upholstered furniture shall meet the criteria specified in 10.3.2.1 and 10.3.3.

28.7.6.2.2 Newly introduced mattresses shall meet the criteria specified in 10.3.2.2 and 10.3.4.

28.7.6.3 Furnishings or decorations of an explosive or highly flammable character shall not be used.

28.7.6.4 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use.

28.7.7 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 29 Existing Hotels and Dormitories

29.1 General Requirements.

29.1.1 Application.

29.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as hotel or dormitory occupancies, unless meeting the requirement of 29.1.1.4.

29.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

29.1.1.3 General. The provisions of Chapter 4, General, shall apply.

29.1.1.4 Any dormitory divided into suites of rooms, with one or more bedrooms opening into a living room or study that has a door opening into a common corridor serving a number of suites, shall be classified as an apartment building.

29.1.1.5 The term *hotel*, wherever used in this *Code*, shall include a hotel, an inn, a club, a motel, a bed and breakfast, or any other structure meeting the definition of hotel.

29.1.2 Classification of Occupancy. See 6.1.8 and 29.1.4.2.

29.1.3 Multiple Occupancies.

29.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

29.1.3.2 No guest room or guest suite of a hotel or dormitory shall have its sole means of egress pass through any nonresidential occupancy in the same building, unless otherwise permitted by 29.1.3.2.1 or 29.1.3.2.2.

29.1.3.2.1 In buildings that are protected by an automatic sprinkler system in accordance with Section 9.7, guest rooms and guest suites of hotels and dormitories shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that both of the following criteria are met:

(1) The hotel or dormitory shall comply with Chapter 29.
(2) The sole means of egress from a guest room or guest suite of the hotel or dormitory shall not pass through a high-hazard contents area, as defined in 6.2.2.4.

29.1.3.2.2 In buildings that are not protected by an automatic sprinkler system in accordance with Section 9.7, guest rooms and guest suites of hotels and dormitories shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The sole means of egress from the guest room or guest suite of the hotel or dormitory to the exterior shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.
(2) The hotel or dormitory shall comply with Chapter 29.
(3) The sole means of egress from the guest room or guest suite of the hotel or dormitory shall not pass through a high-hazard contents area, as defined in 6.2.2.4.

29.1.3.3 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

29.1.4 Definitions.

29.1.4.1 General. For definitions, see Chapter 3, Definitions.

29.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Dormitory.** See 3.3.64.
(2) **Guest Room.** See 3.3.132.
(3) **Guest Suite.** See 3.3.273.1.
(4) **Hotel.** See 3.3.145.

29.1.5 Classification of Hazard of Contents.

29.1.5.1 The contents of residential occupancies shall be classified as ordinary hazard in accordance with 6.2.2.

29.1.5.2 For the design of automatic sprinkler systems, the classification of contents in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall apply.

29.1.6 Minimum Construction Requirements. (Reserved)

29.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

29.2 Means of Egress Requirements.

29.2.1 General.

29.2.1.1 Means of egress from guest rooms or guest suites to the outside of the building shall be in accordance with Chapter 7 and this chapter.

29.2.1.2 Means of escape within the guest room or guest suite shall comply with the provisions of Section 24.2 for one- and two-family dwellings.

29.2.1.3 For the purpose of application of the requirements of Chapter 24, the terms *guest room* and *guest suite* shall be synonymous with the terms *dwelling unit* or *living unit*.

29.2.2 Means of Egress Components.

29.2.2.1 General.

29.2.2.1.1 Components of means of egress shall be limited to the types described in 29.2.2.2 through 29.2.2.12.

29.2.2.1.2 In buildings, other than high-rise buildings, that are protected throughout by an approved automatic sprinkler system in accordance with 29.3.5, exit enclosures shall have a minimum 1-hour fire resistance rating, and doors shall have a minimum 1-hour fire protection rating.

29.2.2.2 Doors.

29.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

29.2.2.2.2 Door-locking arrangements shall comply with 29.2.2.2.2.1, 29.2.2.2.2.2, 29.2.2.2.2.3, or 29.2.2.2.2.4.

29.2.2.2.2.1 No door in any means of egress shall be locked against egress when the building is occupied.

29.2.2.2.2.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

29.2.2.2.2.3 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

29.2.2.2.2.4 Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

29.2.2.2.3 Revolving doors complying with 7.2.1.10 shall be permitted.

29.2.2.3 Stairs. Stairs complying with 7.2.2 shall be permitted.

29.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

29.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

29.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

29.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

29.2.2.8* Escalators. Escalators previously approved as a component in a means of egress shall be permitted to continue to be considered in compliance.

29.2.2.9 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted.

29.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

29.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

29.2.2.12 Areas of Refuge.

29.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted, as modified by 28.2.2.12.2.

29.2.2.12.2* In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 29.3.5, the two accessible rooms or spaces separated from each other by smoke-resistive partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

29.2.3 Capacity of Means of Egress.

29.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

29.2.3.2 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging onto the street floor.

29.2.4 Number of Means of Egress.

29.2.4.1 Means of egress shall comply with all of the following, except as otherwise permitted by 29.2.4.2 and 29.2.4.3:

(1) The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.
(2) Not less than two separate exits shall be accessible from every part of every story, including stories below the level of exit discharge and stories occupied for public purposes.

29.2.4.2 Exit access, as required by 29.2.4.1(2), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 29.2.5.

29.2.4.3 A single exit shall be permitted in buildings where the total number of stories does not exceed four, provided that all of the following conditions are met:

(1) There are four or fewer guest rooms or guest suites per story.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 29.3.5.
(3) The exit stairway does not serve more than one-half of a story below the level of exit discharge.
(4) The travel distance from the entrance door of any guest room or guest suite to an exit does not exceed 35 ft (10.7 m).
(5) The exit stairway is completely enclosed or separated from the rest of the building by barriers having a minimum 1-hour fire resistance rating.
(6) All openings between the exit stairway enclosure and the building are protected with self-closing door assemblies having a minimum 1-hour fire protection rating.
(7) All corridors serving as access to exits have a minimum 1-hour fire resistance rating.
(8) Horizontal and vertical separation having a minimum ½-hour fire resistance rating is provided between guest rooms or guest suites.

29.2.5 Arrangement of Means of Egress.

29.2.5.1 Access to all required exits shall be in accordance with Section 7.5.

29.2.5.2 Reserved.

29.2.5.3 In buildings not protected throughout by an approved, supervised automatic sprinkler system in accordance with 29.3.5, common paths of travel shall not exceed 35 ft (10.7 m); travel within a guest room or guest suite shall not be included when calculating common path of travel.

29.2.5.4 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 29.3.5, common path of travel shall not exceed 50 ft (15 m); travel within a guest room or guest suite shall not be included when determining common path of travel.

29.2.5.5 Dead-end corridors shall not exceed 50 ft (15 m).

29.2.6 Travel Distance to Exits.

29.2.6.1 Travel distance within a guest room or guest suite to a corridor door shall not exceed 75 ft (23 m) in buildings not protected by an approved, supervised automatic sprinkler system in accordance with 29.3.5.

29.2.6.2 Travel distance within a guest room or guest suite to a corridor door shall not exceed 125 ft (38 m) in buildings protected by an approved, supervised automatic sprinkler system in accordance with 29.3.5.

29.2.6.3 Travel distance from the corridor door of any guest room or guest suite to the nearest exit shall comply with 29.2.6.3.1, 29.2.6.3.2, or 29.2.6.3.3.

29.2.6.3.1 Travel distance from the corridor door of any guest room or guest suite to the nearest exit, measured in accordance with Section 7.6, shall not exceed 100 ft (30 m).

29.2.6.3.2 Travel distance from the corridor door of any guest room or guest suite to the nearest exit, measured in accordance with Section 7.6, shall not exceed 200 ft (61 m) for exterior ways of exit access arranged in accordance with 7.5.3.

29.2.6.3.3 Travel distance from the corridor door of any guest room or guest suite to the nearest exit shall comply with 29.2.6.3.3.1 and 29.2.6.3.3.2.

29.2.6.3.3.1 Travel distance from the corridor door of any guest room or guest suite to the nearest exit shall be measured in accordance with Section 7.6 and shall not exceed 200 ft (61 m) where the exit access and any portion of the building that is tributary to the exit access are protected throughout by an approved, supervised automatic sprinkler system in accordance with 29.3.5.

29.2.6.3.3.2 Where the building is not protected throughout by an approved, supervised automatic sprinkler system, the 200 ft (61 m) travel distance shall be permitted within any portion of the building that is protected by an approved, supervised automatic sprinkler system, provided that the sprinklered portion of the building is separated from any nonsprinklered portion by fire barriers having a fire resistance rating as follows:

(1) Minimum 1-hour fire resistance rating for buildings three or fewer stories in height
(2) Minimum 2-hour fire resistance rating for buildings four or more stories in height

29.2.7 Discharge from Exits.

29.2.7.1 Exit discharge shall comply with Section 7.7.

29.2.7.2* Any required exit stair that is located so that it is necessary to pass through the lobby or other open space to reach the outside of the building shall be continuously enclosed down to a level of exit discharge or to a mezzanine within a lobby at a level of exit discharge.

29.2.7.3 The distance of travel from the termination of the exit enclosure to an exterior door leading to a public way shall not exceed 150 ft (46 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with 29.3.5 and shall not exceed 100 ft (30 m) in all other buildings.

29.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

29.2.9 Emergency Lighting.

29.2.9.1 Emergency lighting in accordance with Section 7.9 shall be provided in all buildings with more than 25 rooms.

29.2.9.2 The requirement of 29.2.9.1 shall not apply where each guest room or guest suite has an exit direct to the outside of the building at street or the finished ground level.

29.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

29.2.11 Special Means of Egress Features.

29.2.11.1 Reserved.

29.2.11.2 Lockups. Lockups in hotel and dormitory occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

29.2.11.3 Normally Unoccupied Building Service Equipment Support Areas. The use of Section 7.13 shall be prohibited.

29.3 Protection.

29.3.1 Protection of Vertical Openings.

29.3.1.1 Vertical openings shall comply with 29.3.1.1.1 through 29.3.1.2.

29.3.1.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6.

29.3.1.1.2 Vertical openings in accordance with 8.6.9.1 shall be permitted.

29.3.1.1.3 In buildings, other than high-rise buildings, that are protected throughout by an approved automatic sprinkler system in accordance with 29.3.5, and in which exits and required ways of travel thereto are adequately safeguarded against fire and smoke within the building, or where every individual room has direct access to an exterior exit without passing through any public corridor, the protection of vertical openings that are not part of required exits shall not be required where approved by the authority having jurisdiction and where such openings do not endanger required means of egress.

29.3.1.1.4 In buildings two or fewer stories in height, unprotected openings shall be permitted by the authority having jurisdiction to continue to be used where the building is protected throughout by an approved automatic sprinkler system in accordance with 29.3.5.

29.3.1.2 No floor below the level of exit discharge used only for storage, heating equipment, or purposes other than residential occupancy shall have unprotected openings to floors used for residential purposes.

29.3.2 Protection from Hazards.

29.3.2.1 General. All rooms containing high-pressure boilers, refrigerating machinery, transformers, or other service equipment subject to possible explosion shall not be located directly under or directly adjacent to exits and shall be effectively cut off from other parts of the building as specified in Section 8.7.

29.3.2.2 Hazardous Areas.

29.3.2.2.1 Any hazardous area shall be protected in accordance with Section 8.7.

29.3.2.2.2 The areas described in Table 29.3.2.2.2 shall be protected as indicated.

29.3.2.2.3 Where sprinkler protection without fire-rated separation is used, areas shall be separated from other spaces by smoke partitions complying with Section 8.4.

29.3.3 Interior Finish.

29.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

29.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted as follows:

(1) Exit enclosures — Class A or Class B
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C

29.3.3.3 Interior Floor Finish. In nonsprinklered buildings, newly installed interior floor finish in exits and exit access corridors shall be not less than Class II in accordance with 10.2.7.

29.3.4 Detection, Alarm, and Communications Systems.

29.3.4.1 General. A fire alarm system in accordance with Section 9.6, except as modified by 29.3.4.2 through 29.3.4.5, shall be provided in buildings, other than those where each guest room has exterior exit access in accordance with 7.5.3 and the building is three or fewer stories in height.

Table 29.3.2.2.2 Hazardous Area Protection

Hazardous Area Description	Separation/Protection[a]
Boiler and fuel-fired heater rooms serving more than a single guest room or guest suite	1 hour or sprinklers
Employee locker rooms	1 hour or sprinklers
Gift or retail shops >100 ft^2 (>9.3 m^2)	1 hour or sprinklers[b]
Bulk laundries	1 hour or sprinklers
Guest laundries >100 ft^2 (>9.3 m^2) outside of guest rooms or guest suites	1 hour or sprinklers[b]
Maintenance shops	1 hour and sprinklers
Rooms or spaces used for storage of combustible supplies and equipment in quantities deemed hazardous by the authority having jurisdiction[c]	1 hour or sprinklers
Trash collection rooms	1 hour and sprinklers

[a]Minimum fire resistance rating.
[b]Where sprinklers are provided, the separation specified in 8.7.1.2 and 29.3.2.2.3 shall not be required.
[c]Where storage areas not exceeding 24 ft^2 (2.2 m^2) are directly accessible from the guest room or guest suite, no separation or protection is required.

29.3.4.2 Initiation. The required fire alarm system shall be initiated by each of the following:

(1) Manual means in accordance with 9.6.2, unless there are other effective means to activate the fire alarm system, such as complete automatic sprinkler or automatic detection systems, with manual fire alarm box in accordance with 29.3.4.2(2) required
(2) Manual fire alarm box located at the hotel desk or other convenient central control point under continuous supervision by responsible employees
(3) Required automatic sprinkler system
(4) Required automatic detection system other than sleeping room smoke detectors

29.3.4.3 Notification.

29.3.4.3.1 Occupant notification shall be provided automatically in accordance with 9.6.3.

29.3.4.3.2 Positive alarm sequence in accordance with 9.6.3.4, and a presignal system in accordance with 9.6.3.3, shall be permitted.

29.3.4.3.3 Reserved.

29.3.4.3.4 Reserved.

29.3.4.3.5 Reserved.

29.3.4.3.6* Where the existing fire alarm system does not provide for automatic emergency forces notification in accordance with 9.6.4, provisions shall be made for the immediate notification of the public fire department by telephone or other means in case of fire, and, where there is no public fire department, notification shall be made to the private fire brigade.

29.3.4.3.7 Where a new fire alarm system is installed or the existing fire alarm system is replaced, emergency forces notification shall be provided in accordance with 9.6.4.

29.3.4.4 Detection. (Reserved)

29.3.4.5* Smoke Alarms. An approved single-station smoke alarm shall be installed in accordance with 9.6.2.10 in every guest room and every living area and sleeping room within a guest suite.

29.3.4.5.1 The smoke alarms shall not be required to be interconnected.

29.3.4.5.2 Single-station smoke alarms without a secondary (standby) power source shall be permitted.

29.3.5 Extinguishment Requirements.

29.3.5.1 All high-rise buildings, other than those where each guest room or guest suite has exterior exit access in accordance with 7.5.3, shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 29.3.5.3.

29.3.5.2 Reserved.

29.3.5.3* Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be in accordance with Section 9.7, as modified by 29.3.5.4 and 29.3.5.5. In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

29.3.5.4 The provisions for draft stops and closely spaced sprinklers in NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required for openings complying with 8.6.9.1 where the opening is within the guest room or guest suite.

29.3.5.5 In guest rooms and in guest room suites, sprinkler installations shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2).

29.3.5.6 Reserved.

29.3.5.7 Reserved.

29.3.5.8 In buildings other than those protected throughout with an approved, supervised automatic sprinkler system in accordance with 29.3.5.3, portable fire extinguishers shall be provided as specified in Section 9.9 in hazardous areas addressed by 29.3.2.2.

29.3.6 Corridors.

29.3.6.1 Walls.

29.3.6.1.1 Exit access corridor walls shall comply with either 29.3.6.1.2 or 29.3.6.1.3.

29.3.6.1.2 In buildings not complying with 29.3.6.1.3, exit access corridor walls shall consist of fire barriers in accordance with 8.2.3 having a minimum ½-hour fire resistance rating.

29.3.6.1.3 In buildings protected throughout by an approved automatic sprinkler system in accordance with 29.3.5, no fire resistance rating shall be required, but the walls and all openings therein shall resist the passage of smoke.

29.3.6.2 Doors.

29.3.6.2.1 Doors that open onto exit access corridors, other than those complying with 8.3.4 or in buildings meeting the requirements of 29.3.6.2.2, shall have a minimum 20-minute fire protection rating in accordance with Section 8.3.

29.3.6.2.2 Where automatic sprinkler protection is provided in the corridor in accordance with 31.3.5.8 through 31.3.5.9, doors shall not be required to have a fire protection rating but shall resist the passage of smoke and be equipped with latches to keep doors tightly closed.

29.3.6.2.3 Doors that open onto exit access corridors shall be self-closing and self-latching.

29.3.6.3 Unprotected Openings.

29.3.6.3.1 Unprotected openings, other than those from spaces complying with 29.3.6.3.2, shall be prohibited in exit access corridor walls and doors.

29.3.6.3.2 Spaces shall be permitted to be unlimited in area and open to the corridor, provided that all of the following criteria are met:

(1) The space is not used for guest rooms or guest suites or hazardous areas.
(2) The space is protected throughout by an approved automatic sprinkler system in accordance with 29.3.5.
(3) The space does not obstruct access to required exits.

29.3.6.4 Transoms, Louvers, or Transfer Grilles.

29.3.6.4.1 Transoms, louvers, or transfer grilles shall be prohibited in walls or doors of exit access corridors, unless meeting the requirements of 29.3.6.4.2, 29.3.6.4.3, or 29.3.6.4.4.

29.3.6.4.2 Existing transoms shall be permitted but shall be fixed in the closed position and shall be covered or otherwise protected to provide a fire resistance rating not less than that of the wall in which they are installed.

29.3.6.4.3 The requirement of 29.3.6.4.1 shall not apply where a corridor smoke detection system is provided that, when sensing smoke, sounds the building alarm and shuts down return or exhaust fans that draw air into the corridor from the guest rooms. The transfer grille or louver shall be located in the lower one-third of the wall or door height.

29.3.6.4.4 The requirement of 29.3.6.4.1 shall not apply to buildings protected throughout by an approved automatic sprinkler system complying with 29.3.5 or buildings with corridor sprinkler protection in accordance with 31.3.5.8 through 31.3.5.9. The transfer grille or louver shall be located in the lower one-third of the wall or door height.

29.3.7 Subdivision of Building Spaces. In buildings other than those meeting the requirements of 29.3.7.1, 29.3.7.2, or 29.3.7.3, every guest room floor shall be divided into not less than two smoke compartments of approximately the same size by smoke partitions in accordance with Section 8.4.

29.3.7.1 Smoke partitions shall not be required in buildings protected throughout by an approved automatic sprinkler system in accordance with 29.3.5 or a corridor sprinkler system conforming to 31.3.5.8 through 31.3.5.9.

29.3.7.2 Smoke partitions shall not be required where each guest room is provided with exterior ways of exit access arranged in accordance with 7.5.3.

29.3.7.3 Smoke partitions shall not be required where the aggregate corridor length on each floor is not more than 150 ft (46 m).

29.3.7.4 Additional smoke partitions shall be provided so that the travel distance from a guest room corridor door to a smoke partition shall not exceed 150 ft (46 m).

29.3.8 Special Protection Features. (Reserved)

29.4 Special Provisions.

29.4.1 High-Rise Buildings.

29.4.1.1 High-rise buildings shall comply with 29.3.5.1.

29.4.1.2* Emergency action plans in accordance with Section 4.8 shall be provided and shall include all of the following:

(1) Egress procedures
(2) Methods
(3) Preferred evacuation routes for each event, including appropriate use of elevators

29.4.2 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

29.5 Building Services.

29.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

29.5.2 Heating, Ventilating, and Air-Conditioning.

29.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2, except as otherwise required in this chapter.

29.5.2.2 Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, *National Fuel Gas Code*, shall not be used.

29.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

29.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

29.6 Reserved.

29.7 Operating Features.

29.7.1 Hotel Emergency Organization.

29.7.1.1* Employees of hotels shall be instructed and drilled in the duties they are to perform in the event of fire, panic, or other emergency.

29.7.1.2* Drills of the emergency organization shall be held at quarterly intervals and shall cover such points as the operation and maintenance of the available first aid fire appliances, the testing of devices to alert guests, and a study of instructions for emergency duties.

29.7.2 Emergency Duties. Upon discovery of a fire, employees shall carry out all of the following duties:

(1) Activation of the facility fire protection signaling system, if provided
(2) Notification of the public fire department
(3) Other action as previously instructed

29.7.3 Drills in Dormitories. Emergency egress and relocation drills in accordance with Section 4.7 shall be held with sufficient frequency to familiarize occupants with all types of hazards and to establish conduct of the drill as a matter of routine. Drills shall be conducted during peak occupancy periods and shall include suitable procedures to ensure that all persons subject to the drill participate.

29.7.4 Emergency Instructions for Residents or Guests.

29.7.4.1* A floor diagram reflecting the actual floor arrangement, exit locations, and room identification shall be posted in a location and manner acceptable to the authority having jurisdiction on, or immediately adjacent to, every guest room door in hotels and in every resident room in dormitories.

29.7.4.2* Fire safety information shall be provided to allow guests to make the decision to evacuate to the outside, to evacuate to an area of refuge, to remain in place, or to employ any combination of the three options.

29.7.5 Emergency Action Plans. Emergency action plans in accordance with Section 4.8 shall be provided.

29.7.6 Contents and Furnishings.

29.7.6.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations shall meet the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*

29.7.6.2 Upholstered Furniture and Mattresses.

29.7.6.2.1 Newly introduced upholstered furniture shall meet the criteria specified in 10.3.2.1 and 10.3.3.

29.7.6.2.2 Newly introduced mattresses shall meet the criteria specified in 10.3.2.2 and 10.3.4.

29.7.6.3 Furnishings or decorations of an explosive or highly flammable character shall not be used.

29.7.6.4 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use.

29.7.7 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15

Chapter 30 New Apartment Buildings

30.1 General Requirements.

30.1.1 Application.

30.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as apartment occupancies. *(See 1.3.1.)*

30.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

30.1.1.3 General. The provisions of Chapter 4, General, shall apply.

30.1.1.4 The term *apartment building*, wherever used in this *Code*, shall include an apartment house, a tenement, a garden apartment, or any other structure meeting the definition of apartment building.

30.1.2 Classification of Occupancy. See 6.1.8 and 30.1.4.2.

30.1.3 Multiple Occupancies.

30.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

30.1.3.2 No dwelling unit of an apartment building shall have its sole means of egress pass through any nonresidential occupancy in the same building, unless otherwise permitted by 30.1.3.2.1 or 30.1.3.2.2.

30.1.3.2.1 In buildings that are protected by an automatic sprinkler system in accordance with Section 9.7, dwelling units of an apartment building shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that both of the following criteria are met:

(1) The dwelling unit of the apartment building shall comply with Chapter 30.
(2) The sole means of egress from the dwelling unit of the apartment building shall not pass through a high hazard contents area, as defined in 6.2.2.4.

30.1.3.2.2 In buildings that are not protected by an automatic sprinkler system in accordance with Section 9.7, dwelling units of an apartment building shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The sole means of egress from the dwelling unit of the apartment building to the exterior shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.
(2) The dwelling unit of the apartment building shall comply with Chapter 30.
(3) The sole means of egress from the dwelling unit of the apartment building shall not pass through a high hazard contents area, as defined in 6.2.2.4.

30.1.3.3 Multiple dwelling units shall be permitted to be located above a nonresidential occupancy only where one of the following conditions exists:

(1) Where the dwelling units of the residential occupancy and exits therefrom are separated from the nonresidential occupancy by construction having a minimum 1-hour fire resistance rating
(2) Where the nonresidential occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7

30.1.3.4 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

30.1.4 Definitions.

30.1.4.1 General. For definitions, see Chapter 3, Definitions.

30.1.4.2 Special Definitions.

30.1.4.2.1 General. Special terms applicable to this chapter are defined in Chapter 3. Where necessary, other terms are defined in the text.

30.1.4.2.2 Apartment Building. See 3.3.36.3.

30.1.5 Classification of Hazard of Contents. The contents of residential occupancies shall be classified as ordinary hazard in accordance with 6.2.2.

30.1.6 Minimum Construction Requirements. (Reserved)

30.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

30.2 Means of Egress Requirements.

30.2.1 General.

30.2.1.1 Means of egress from dwelling units to the outside of the building shall be in accordance with Chapter 7 and this chapter.

30.2.1.2 Means of escape within the dwelling unit shall comply with the provisions of Section 24.2 for one- and two-family dwellings.

30.2.2 Means of Egress Components.

30.2.2.1 General.

30.2.2.1.1 Components of means of egress shall be limited to the types described in 30.2.2.2 through 30.2.2.12.

30.2.2.1.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5, exit enclosures shall have a minimum 1-hour fire resistance rating, and doors shall have a minimum 1-hour fire protection rating.

30.2.2.2 Doors.

30.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

30.2.2.2.2 Door-locking arrangements shall comply with 30.2.2.2.2.1, 30.2.2.2.2.2, 30.2.2.2.2.3, or 30.2.2.2.2.4.

30.2.2.2.2.1* No door in any means of egress shall be locked against egress when the building is occupied.

30.2.2.2.2.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

30.2.2.2.2.3 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

30.2.2.2.2.4 Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

30.2.2.2.3 Revolving doors complying with 7.2.1.10 shall be permitted.

30.2.2.2.4 Apartment occupancies shall be exempt from the re-entry provisions of 7.2.1.5.8 where the exit enclosure serves directly only one dwelling unit per floor, and such exit is a smokeproof enclosure in accordance with 7.2.3.

30.2.2.3 Stairs.

30.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

30.2.2.3.2 Reserved.

30.2.2.3.3 Spiral stairs complying with 7.2.2.2.3 shall be permitted within each dwelling unit.

30.2.2.3.4 Winders complying with 7.2.2.2.4 shall be permitted within each dwelling unit.

30.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

30.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

30.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

30.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

30.2.2.8 Reserved.

30.2.2.9 Reserved.

30.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

30.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

30.2.2.12 Areas of Refuge.

30.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted, as modified by 30.2.2.12.2.

30.2.2.12.2* In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5, the two accessible rooms or spaces separated from each other by smoke-resistive partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

30.2.3 Capacity of Means of Egress.

30.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

30.2.3.2 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging onto the street floor.

30.2.3.3 Corridors with a required capacity of more than 50 persons, as defined in Section 7.3, shall be of sufficient width to accommodate the required occupant load but have a width of not less than 44 in. (1120 mm).

30.2.3.4 Corridors with a required capacity of not more than 50 persons, as defined in Section 7.3, shall be not less than 36 in. (915 mm) in width.

30.2.4 Number of Means of Egress.

30.2.4.1 The number of means of egress shall comply with Section 7.4.

30.2.4.2 The minimum number of exits shall comply with 30.2.4.3, 30.2.4.4, or 30.2.4.6.

30.2.4.3 Every dwelling unit shall have access to at least two separate exits remotely located from each other as required by 7.5.1.

30.2.4.4 Dwelling units shall be permitted to have access to a single exit, provided that one of the following conditions is met:

(1) The dwelling unit has an exit door opening directly to the street or yard at the finished ground level.
(2) The dwelling unit has direct access to an outside stair that complies with 7.2.2 and serves a maximum of two units, both of which are located on the same story.
(3) The dwelling unit has direct access to an interior stair that serves only that unit and is separated from all other portions of the building by fire barriers having a minimum 1-hour fire resistance rating, with no opening therein.

30.2.4.5 Reserved.

30.2.4.6 A single exit shall be permitted in buildings where the total number of stories does not exceed four, provided that all of the following conditions are met:

(1) There are four or fewer dwelling units per story.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5.

(3) The exit stairway does not serve more than one-half story below the level of exit discharge.
(4) The travel distance from the entrance door of any dwelling unit to an exit does not exceed 35 ft (10.7 m).
(5) The exit stairway is completely enclosed or separated from the rest of the building by barriers having a minimum 1-hour fire resistance rating.
(6) All openings between the exit stairway enclosure and the building are protected with self-closing door assemblies having a minimum 1-hour fire protection rating.
(7) All corridors serving as access to exits have a minimum 1-hour fire resistance rating.
(8) Horizontal and vertical separation having a minimum ½-hour fire resistance rating is provided between dwelling units.

30.2.5 Arrangement of Means of Egress.

30.2.5.1 Access to all required exits shall be in accordance with Section 7.5, as modified by 30.2.5.2.

30.2.5.2 The distance between exits addressed by 7.5.1.3 shall not apply to nonlooped exit access corridors in buildings that have corridor doors from the dwelling units that are arranged such that the exits are located in opposite directions from such doors.

30.2.5.3 Common path of travel shall comply with 30.2.5.3.1 or 30.2.5.3.2.

30.2.5.3.1 No common path of travel shall exceed 35 ft (10.7 m) in buildings not protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5. Travel within a dwelling unit shall not be included when calculating common path of travel.

30.2.5.3.2 No common path of travel shall exceed 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5. Travel within a dwelling unit shall not be included when determining common path of travel.

30.2.5.4 Dead-end corridors shall be limited in accordance with either 30.2.5.4.1 or 30.2.5.4.2.

30.2.5.4.1 Dead-end corridors shall not exceed 35 ft (10.7 m) in buildings not protected throughout by an approved automatic sprinkler system in accordance with 30.3.5.

30.2.5.4.2 Dead-end corridors shall not exceed 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5.

30.2.6 Travel Distance to Exits. Travel distance shall be measured in accordance with Section 7.6.

30.2.6.1 Travel distance within a dwelling unit (apartment) to a corridor door shall not exceed 75 ft (23 m) in buildings not protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5.

30.2.6.2 Travel distance within a dwelling unit (apartment) to a corridor door shall not exceed 125 ft (38 m) in buildings protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5.

30.2.6.3 The travel distance from a dwelling unit (apartment) entrance door to the nearest exit shall be limited in accordance with 30.2.6.3.1, 30.2.6.3.2, or 30.2.6.3.3.

30.2.6.3.1 The travel distance from a dwelling unit (apartment) entrance door to the nearest exit shall not exceed 100 ft (30 m).

30.2.6.3.2 In buildings protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5, the travel distance from a dwelling unit (apartment) entrance door to the nearest exit shall not exceed 200 ft (61 m).

30.2.6.3.3 The travel distance from a dwelling unit (apartment) entrance door to the nearest exit shall not exceed 200 ft (61 m) for exterior ways of exit access arranged in accordance with 7.5.3.

30.2.6.4 The travel distance, from areas other than those within living units, to an exit, shall not exceed 200 ft (61 m), or 250 ft (76 m) in buildings protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5.5.

30.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

30.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

30.2.9 Emergency Lighting. Emergency lighting in accordance with Section 7.9 shall be provided in all buildings four or more stories in height, or with more than 12 dwelling units, unless every dwelling unit has a direct exit to the outside of the building at the finished ground level.

30.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10 in all buildings requiring more than one exit.

30.2.11 Special Means of Egress Features.

30.2.11.1 Reserved.

30.2.11.2 Lockups. Lockups in apartment buildings shall comply with the requirements of 22.4.5.

30.2.11.3 Normally Unoccupied Building Service Equipment Support Areas. The use of Section 7.13 shall be prohibited.

30.3 Protection.

30.3.1 Protection of Vertical Openings.

30.3.1.1 Vertical openings shall comply with 30.3.1.1.1 through 30.3.1.3.

30.3.1.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6.

30.3.1.1.2 Where the provisions of 8.6.6 are used, the requirements of 30.3.5.8 shall be met.

30.3.1.1.3 Vertical openings in accordance with 8.6.9.1 shall be permitted.

30.3.1.1.4 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5, walls enclosing vertical openings shall have a minimum 1-hour fire resistance rating, and the doors shall have a minimum 1-hour fire protection rating.

30.3.1.2 No floor below the level of exit discharge used only for storage, heating equipment, or purposes other than residential occupancy and open to the public shall have unprotected openings to floors used for residential purposes.

30.3.1.3 Within any individual dwelling unit, unless protected by an approved automatic sprinkler system in accordance with 30.3.5, vertical openings more than one story above or below the entrance floor level of the dwelling unit shall not be permitted.

30.3.2 Protection from Hazards.

30.3.2.1 Hazardous Areas. Any hazardous area shall be protected in accordance with Section 8.7.

30.3.2.1.1 The areas described in Table 30.3.2.1.1 shall be protected as indicated.

Table 30.3.2.1.1 Hazardous Area Protection

Hazardous Area Description	Separation/Protection†
Boiler and fuel-fired heater rooms serving more than a single dwelling unit	1 hour and sprinklers
Employee locker rooms	1 hour or sprinklers
Gift or retail shops	1 hour or sprinklers
Bulk laundries	1 hour and sprinklers
Laundries ≤100 ft^2 (≤9.3 m^2) outside of dwelling units	1 hour or sprinklers‡
Laundries >100 ft^2 (>9.3 m^2) outside of dwelling units	1 hour and sprinklers
Maintenance shops	1 hour and sprinklers
Storage rooms outside of dwelling units	1 hour or sprinklers
Trash collection rooms	1 hour and sprinklers

†Minimum fire resistance rating.
‡Where sprinklers are provided, the separation specified in 8.7.1.2 and 30.3.2.1.2 is not required.

30.3.2.1.2 Where sprinkler protection without fire-rated separation is used, areas shall be separated from other spaces by smoke partitions complying with Section 8.4.

30.3.3 Interior Finish.

30.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

30.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted as follows:

(1) Exit enclosures — Class A
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C

30.3.3.3 Interior Floor Finish.

30.3.3.3.1 Interior floor finish shall comply with Section 10.2.

30.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 30.3.6 shall be not less than Class II.

30.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

30.3.4 Detection, Alarm, and Communications Systems.

30.3.4.1 General.

30.3.4.1.1 Apartment buildings four or more stories in height or with more than 11 dwelling units, other than those meeting the requirements of 30.3.4.1.2, shall be provided with a fire alarm system in accordance with Section 9.6, except as modified by 30.3.4.2 through 30.3.4.5.

30.3.4.1.2 A fire alarm system shall not be required in buildings where each dwelling unit is separated from other contiguous dwelling units by fire barriers *(see Section 8.3)* having a minimum 1-hour fire resistance rating, and where each dwelling unit has either its own independent exit or its own independent stairway or ramp discharging at the finished ground level.

30.3.4.2 Initiation.

30.3.4.2.1 Initiation of the required fire alarm system shall be by manual means in accordance with 9.6.2, unless the building complies with 30.3.4.2.2.

30.3.4.2.2 Initiation of the required fire alarm system by manual means shall not be required in buildings four or fewer stories in height, containing not more than 16 dwelling units, and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5.1.

30.3.4.2.3 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5, required fire alarm systems shall be initiated upon operation of the automatic sprinkler system.

30.3.4.3 Notification.

30.3.4.3.1 Occupant notification shall be provided automatically in accordance with Section 9.6, and both of the following shall also apply:

(1) Visible signals shall be installed in units designed for the hearing impaired.
(2) Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

30.3.4.3.2 Annunciation, and annunciation zoning, in accordance with 9.6.7 shall be provided, unless the building complies with either 30.3.4.3.3 or 30.3.4.3.4. Annunciation shall be provided at a location readily accessible from the primary point of entry for emergency response personnel.

30.3.4.3.3 Annunciation, and annunciation zoning, shall not be required in buildings two or fewer stories in height and having not more than 50 dwelling units.

30.3.4.3.4 Annunciation, and annunciation zoning, shall not be required in buildings four or fewer stories in height containing not more than 16 dwelling units and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5.1.

30.3.4.3.5 Emergency forces notification shall be accomplished in accordance with 9.6.4.

30.3.4.4 Detection. (Reserved)

30.3.4.5* Smoke Alarms. Smoke alarms shall be installed in accordance with 9.6.2.10 in every sleeping area, outside every sleeping area in the immediate vicinity of the bedrooms, and on all levels of the dwelling unit, including basements.

30.3.4.6 Carbon Monoxide Alarms and Carbon Monoxide Detection Systems.

30.3.4.6.1 Carbon monoxide alarms or carbon monoxide detectors in accordance with Section 9.12 and 30.3.4.6 shall be provided in new apartment buildings where either of the following conditions exists:

(1) Dwelling units with communicating attached garages, unless otherwise exempted by 30.3.4.6.3
(2) Dwelling units containing a permanently installed fuel-burning appliance or fuel-burning fireplace

30.3.4.6.2 Where required by 30.3.4.6.1, carbon monoxide alarms or carbon monoxide detectors shall be installed in the following locations:

(1) Outside of each separate dwelling unit sleeping area in the immediate vicinity of the sleeping rooms
(2) On every occupiable level of a dwelling unit

30.3.4.6.3 Carbon monoxide alarms and carbon monoxide detectors as specified in 30.3.4.6.1(1) shall not be required in the following locations:

(1) In garages
(2) Within dwelling units with communicating attached garages that are open parking structures as defined by the building code
(3) Within dwelling units with communicating attached garages that are mechanically ventilated in accordance with the mechanical code

30.3.4.6.4 Where fuel-burning appliances or fuel-burning fireplaces are installed outside dwelling units, carbon monoxide alarms or carbon monoxide detectors shall be installed in accordance with the manufacturer's published instructions in the locations specified as follows:

(1) On the ceilings of rooms containing permanently installed fuel-burning appliances or fuel-burning fireplaces
(2) Centrally located within occupiable spaces served by the first supply air register from a permanently installed, fuel-burning HVAC system
(3) Centrally located within occupiable spaces adjacent to a communicating attached garage

30.3.5 Extinguishment Requirements.

30.3.5.1 All buildings shall be protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 30.3.5.2.

30.3.5.2 Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be installed in accordance with Section 9.7, as modified by 30.3.5.3 and 30.3.5.4. In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

30.3.5.3* In buildings sprinklered in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, closets less than 12 ft^2 (1.1 m^2) in area in individual dwelling units shall not be required to be sprinklered. Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size.

30.3.5.4* In buildings sprinklered in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, bathrooms not greater than 55 ft^2 (5.1 m^2) in individual dwelling units shall not be required to be sprinklered.

30.3.5.5 The draft stop and closely spaced sprinkler requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required for convenience openings complying with 8.6.9.1 where the convenience opening is within the dwelling unit.

30.3.5.6 Listed quick-response or listed residential sprinklers shall be used throughout all dwelling units.

30.3.5.7 Open parking structures complying with NFPA 88A, *Standard for Parking Structures*, that are contiguous with apartment buildings shall be exempt from the sprinkler requirements of 30.3.5.1.

30.3.5.8 Buildings with unprotected openings in accordance with 8.6.6 shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5.

30.3.5.9 Reserved.

30.3.5.10 Reserved.

30.3.5.11 Reserved.

30.3.5.12 Reserved.

30.3.5.13 Portable fire extinguishers in accordance with Section 9.9 shall be provided in hazardous areas addressed by 30.3.2.1, unless the building is protected throughout with an approved, supervised automatic sprinkler system in accordance with 30.3.5.2.

30.3.6 Corridors.

30.3.6.1 Walls. Exit access corridor walls shall comply with 30.3.6.1.1 or 30.3.6.1.2.

30.3.6.1.1 In buildings not complying with 30.3.6.1.2, exit access corridor walls shall consist of fire barriers in accordance with Section 8.3 that have not less than a 1-hour fire resistance rating.

30.3.6.1.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5.2, corridor walls shall have a minimum ½-hour fire resistance rating.

30.3.6.2 Doors.

30.3.6.2.1 Doors that open onto exit access corridors shall have not less than a 20-minute fire protection rating in accordance with Section 8.3.

30.3.6.2.2 Reserved.

30.3.6.2.3 Doors that open onto exit access corridors shall be self-closing and self-latching.

30.3.6.3 Unprotected Openings.

30.3.6.3.1 Unprotected openings, other than those from spaces complying with 30.3.6.3.2, shall be prohibited in exit access corridor walls and doors.

30.3.6.3.2 Spaces shall be permitted to be unlimited in area and open to the corridor, provided that the following criteria are met:

(1) The space is not used for guest rooms or guest suites or hazardous areas.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 30.3.5.
(3) The space does not obstruct access to required exits.

30.3.6.4 Transoms, Louvers, or Transfer Grilles. Transoms, louvers, or transfer grilles shall be prohibited in walls or doors of exit access corridors.

30.3.7 Subdivisions of Building Spaces. Buildings shall be subdivided in accordance with 30.3.7.1 or 30.3.7.2.

30.3.7.1 In buildings not meeting the requirement of 30.3.7.2, dwelling units shall be separated from each other by walls and floors constructed as fire barriers having a minimum 1-hour fire resistance rating.

30.3.7.2 In buildings protected throughout by an approved, supervised automatic sprinkler system, dwelling units shall be separated from each other by walls and floors constructed as fire barriers having a minimum ½-hour fire resistance rating.

30.3.8 Special Protection Features. (Reserved)

30.4 Special Provisions.

30.4.1 High-Rise Buildings.

30.4.1.1 High-rise buildings shall comply with Section 11.8. The provisions of 30.3.5.3 and 30.3.4.5 shall be permitted.

30.4.1.2* Emergency action plans in accordance with Section 4.8 shall be provided and shall include all of the following:

(1) Egress procedures
(2) Methods
(3) Preferred evacuation routes for each event, including appropriate use of elevators

30.4.2 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

30.5 Building Services.

30.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

30.5.2 Heating, Ventilating, and Air-Conditioning.

30.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

30.5.2.2 Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, *National Fuel Gas Code*, shall not be used.

30.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

30.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

30.6 Reserved.

30.7 Operating Features.

30.7.1 Emergency Instructions for Residents of Apartment Buildings. Emergency instructions shall be provided annually to each dwelling unit to indicate the location of alarms, egress paths, and actions to be taken, both in response to a fire in the dwelling unit and in response to the sounding of the alarm system.

30.7.2 Contents and Furnishings.

30.7.2.1 Contents and furnishings shall not be required to comply with Section 10.3.

30.7.2.2 Furnishings or decorations of an explosive or highly flammable character shall not be used outside of dwelling units.

30.7.2.3 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use.

30.7.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 31 Existing Apartment Buildings

31.1* General Requirements.

31.1.1 Application.

31.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as apartment occupancies. In addition, the building shall meet the requirements of one of the following options:

(1) Option 1, buildings without fire suppression or detection systems
(2) Option 2, buildings provided with a complete approved automatic fire detection and notification system in accordance with 31.3.4.4
(3) Option 3, buildings provided with approved automatic sprinkler protection in selected areas, as described in 31.3.5.8
(4) Option 4, buildings protected throughout by an approved automatic sprinkler system

31.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

31.1.1.3 General. The provisions of Chapter 4, General, shall apply.

31.1.1.4 The term *apartment building*, wherever used in this *Code*, shall include an apartment house, a tenement, a garden apartment, or any other structure meeting the definition of apartment building.

31.1.2 Classification of Occupancy. See 6.1.8 and 31.1.4.2.

31.1.3 Multiple Occupancies.

31.1.3.1 Multiple occupancies shall be in accordance with 6.1.14.

31.1.3.2 No dwelling unit of an apartment building shall have its sole means of egress pass through any nonresidential occupancy in the same building, unless otherwise permitted by 31.1.3.2.1 or 31.1.3.2.2.

31.1.3.2.1 In buildings that are protected by an automatic sprinkler system in accordance with Section 9.7, dwelling units of an apartment building shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The dwelling unit of the apartment building shall comply with Chapter 31.
(2) The sole means of egress from the dwelling unit of the apartment building shall not pass through a high hazard contents area, as defined in 6.2.2.4.

31.1.3.2.2 In buildings that are not protected by an automatic sprinkler system in accordance with Section 9.7, dwelling units of an apartment building shall be permitted to have their sole means of egress pass through a nonresidential occupancy in the same building, provided that all of the following criteria are met:

(1) The sole means of egress from the dwelling unit of the apartment building to the exterior shall be separated from the remainder of the building by fire barriers having a minimum 1-hour fire resistance rating.
(2) The dwelling unit of the apartment building shall comply with Chapter 31.

(3) The sole means of egress from the dwelling unit of the apartment building shall not pass through a high hazard contents area, as defined in 6.2.2.4.

31.1.3.3 Multiple dwelling units shall be permitted to be located above a nonresidential occupancy only where one of the following conditions exists:

(1) Where the dwelling units of the residential occupancy and exits therefrom are separated from the nonresidential occupancy by construction having a minimum 1-hour fire resistance rating
(2) Where the nonresidential occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7
(3) Where not more than two dwelling units are located above a nonresidential occupancy that is protected by an automatic fire detection system in accordance with Section 9.6

31.1.3.4 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis.

31.1.4 Definitions.

31.1.4.1 General. For definitions, see Chapter 3, Definitions.

31.1.4.2 Special Definitions.

31.1.4.2.1 General. Special terms applicable to this chapter are defined in Chapter 3. Where necessary, other terms are defined in the text.

31.1.4.2.2 Apartment Building. See 3.3.36.3.

31.1.5 Classification of Hazard of Contents. The contents of residential occupancies shall be classified as ordinary hazard in accordance with 6.2.2.

31.1.6 Minimum Construction Requirements. (Reserved)

31.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

31.2 Means of Egress Requirements.

31.2.1 General.

31.2.1.1 Means of egress from dwelling units to the outside of the building shall be in accordance with Chapter 7 and this chapter.

31.2.1.2 Means of escape within the dwelling unit shall comply with the provisions of Section 24.2 for one- and two-family dwellings.

31.2.2 Means of Egress Components.

31.2.2.1 General.

31.2.2.1.1 Components of means of egress shall be limited to the types described in 31.2.2.2 through 31.2.2.12.

31.2.2.1.2 In buildings using Option 4, exit enclosures shall have a minimum 1-hour fire resistance rating, and doors shall have a minimum 1-hour fire protection rating.

31.2.2.1.3 In non-high-rise buildings using Option 2, Option 3, or Option 4, exit stair doors shall be permitted to be 1¾ in. (44 mm) thick, solid-bonded wood-core doors that are self-closing and self-latching and in wood frames not less than ¾ in. (19 mm) thick.

31.2.2.2 Doors.

31.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

31.2.2.2.2 Door-locking arrangements shall comply with 30.2.2.2.2.1, 30.2.2.2.2.2, 30.2.2.2.2.3, or 31.2.2.2.2.4.

31.2.2.2.2.1 No door in any means of egress shall be locked against egress when the building is occupied.

31.2.2.2.2.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

31.2.2.2.2.3 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

31.2.2.2.2.4 Elevator lobby exit access door locking in accordance with 7.2.1.6.3 shall be permitted.

31.2.2.2.3 Revolving doors complying with 7.2.1.10 shall be permitted.

31.2.2.2.4 Apartment occupancies protected throughout by an approved, supervised automatic sprinkler system shall be exempt from the re-entry provisions of 7.2.1.5.8 where the exit enclosure serves directly only one dwelling unit per floor, and such exit is a smokeproof enclosure in accordance with 7.2.3.

31.2.2.3 Stairs.

31.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

31.2.2.3.2 Within any individual dwelling unit, unless protected by an approved automatic sprinkler system in accordance with 31.3.5, stairs more than one story above or below the entrance floor level of the dwelling unit shall not be permitted.

31.2.2.3.3 Spiral stairs complying with 7.2.2.2.3 shall be permitted within a single dwelling unit.

31.2.2.3.4 Winders complying with 7.2.2.2.4 shall be permitted.

31.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted. *(See also 31.2.11.1.)*

31.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

31.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

31.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

31.2.2.8* Escalators. Escalators previously approved as a component in the means of egress shall be permitted to continue to be considered as in compliance.

31.2.2.9 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted.

31.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

31.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

31.2.2.12 Areas of Refuge.

31.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted, as modified by 31.2.2.12.2.

31.2.2.12.2* In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 31.3.5, the two accessible rooms or spaces separated from each other by smoke-resistive partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

31.2.3 Capacity of Means of Egress.

31.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

31.2.3.2 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging onto the street floor.

31.2.4 Number of Means of Egress.

31.2.4.1 The number of means of egress shall comply with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.

31.2.4.2 The minimum number of exits shall comply with 31.2.4.3, 31.2.4.4, 31.2.4.5, 31.2.4.6, or 31.2.4.7.

31.2.4.3 Every dwelling unit shall have access to not less than two separate exits remotely located from each other as required by 7.5.1.

31.2.4.4 Dwelling units shall be permitted to have access to a single exit, provided that one of the following conditions is met:

(1) The dwelling unit has an exit door opening directly to the street or yard at the finished ground level.
(2) The dwelling unit has direct access to an outside stair that complies with 7.2.2 and serves not more than two units, both located on the same story.
(3) The dwelling unit has direct access to an interior stair that serves only that unit and is separated from all other portions of the building by fire barriers having a minimum 1-hour fire resistance rating, with no opening therein.

31.2.4.5 A single exit shall be permitted in buildings where the total number of stories does not exceed four, provided that all of the following conditions are met:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 31.3.5.
(2) The exit stairway does not serve more than one-half of a story below the level of exit discharge.
(3) The travel distance from the entrance door of any dwelling unit to an exit does not exceed 35 ft (10.7 m).
(4) The exit stairway is completely enclosed or separated from the rest of the building by barriers having a minimum 1-hour fire resistance rating.
(5) All openings between the exit stairway enclosure and the building are protected with self-closing doors having a minimum 1-hour fire protection rating.
(6) All corridors serving as access to exits have a minimum ½-hour fire resistance rating.
(7) Horizontal and vertical separation having a minimum ½-hour fire resistance rating is provided between dwelling units.

31.2.4.6* A single exit shall be permitted in buildings not exceeding three stories in height, provided that all of the following conditions are met:

(1) The exit stairway does not serve more than one-half of a story below the level of exit discharge.
(2) The travel distance from the entrance door of any dwelling unit to an exit does not exceed 35 ft (10.7 m).
(3) The exit stairway is completely enclosed or separated from the rest of the building by barriers having a minimum 1-hour fire resistance rating.
(4) All openings between the exit stairway enclosure and the building are protected with self-closing doors having a minimum 1-hour fire protection rating.
(5) All corridors serving as access to exits have a minimum ½-hour fire resistance rating.
(6) Horizontal and vertical separation having a minimum ½-hour fire resistance rating is provided between dwelling units.

31.2.4.7 A building of any height with not more than four dwelling units per floor, with a smokeproof enclosure in accordance with the requirements of 7.2.3 or outside stair as the exit, where such exit is immediately accessible to all dwelling units served thereby, shall be permitted to have a single exit. The term *immediately accessible* means that the travel distance from the entrance door of any dwelling unit to an exit shall not exceed 20 ft (6100 mm).

31.2.5 Arrangement of Means of Egress.

31.2.5.1 Access to all required exits shall be in accordance with Section 7.5.

31.2.5.2 Reserved.

31.2.5.3 Common path of travel shall comply with 31.2.5.3.1 or 31.2.5.3.2.

31.2.5.3.1 No common path of travel shall exceed 35 ft (10.7 m) in buildings not protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 31.3.5. Travel within a dwelling unit shall not be included when calculating common path of travel.

31.2.5.3.2 No common path of travel shall exceed 50 ft (15 m) in buildings protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 31.3.5. Travel within a dwelling unit shall not be included when calculating common path of travel.

31.2.5.4 Dead-end corridors shall not exceed 50 ft (15 m).

31.2.6 Travel Distance to Exits. Travel distance shall be measured in accordance with Section 7.6.

31.2.6.1 Travel distance within a dwelling unit (apartment) to a corridor door shall not exceed the following limits:

(1) For buildings using Option 1 or Option 3, 75 ft (23 m)
(2) For buildings using Option 2 or Option 4, 125 ft (38 m)

31.2.6.2 The travel distance from a dwelling unit (apartment) entrance door to the nearest exit shall not exceed the following limits, as modified by 31.2.6.3:

(1) For buildings using Option 1, 100 ft (30 m)
(2) For buildings using Option 2 or Option 3, 150 ft (46 m)
(3) For buildings using Option 4, 200 ft (61 m)

31.2.6.3 Travel distance to exits shall not exceed 200 ft (61 m) for exterior ways of exit access arranged in accordance with 7.5.3.

31.2.6.4 The travel distance, from areas other than those within living units, to an exit shall not exceed 200 ft (61 m), or 250 ft (76 m) in buildings protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 31.3.5.

31.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

31.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

31.2.9 Emergency Lighting. Emergency lighting in accordance with Section 7.9 shall be provided in all buildings four or more stories in height or with more than 12 dwelling units, unless every dwelling unit has a direct exit to the outside of the building at grade level.

31.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10 in all buildings requiring more than one exit.

31.2.11 Special Means of Egress Features.

31.2.11.1* High-Rise Buildings. In high-rise buildings using Option 1, Option 2, or Option 3, smokeproof enclosures shall be provided in accordance with 7.2.3.

31.2.11.2 Lockups. Lockups in apartment buildings, other than approved existing lockups, shall comply with the requirements of 23.4.5.

31.2.11.3 Normally Unoccupied Building Service Equipment Support Areas. The use of Section 7.13 shall be prohibited.

31.3 Protection.

31.3.1 Protection of Vertical Openings.

31.3.1.1 Vertical openings shall comply with 31.3.1.1.1 through 31.3.1.2.

31.3.1.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6.

31.3.1.1.2 Reserved.

31.3.1.1.3 Vertical openings in accordance with 8.6.9.1 shall be permitted.

31.3.1.1.4 In buildings protected throughout by an approved automatic sprinkler system in accordance with 31.3.5, and in which exits and required ways of travel thereto are adequately safeguarded against fire and smoke within the building, or where every individual room has direct access to an exterior exit without passing through any public corridor, the protection of vertical openings that are not part of required exits shall not be required.

31.3.1.2 No floor below the level of exit discharge used only for storage, heating equipment, or purposes other than residential occupancy and open to the public shall have unprotected openings to floors used for residential purposes.

31.3.2 Protection from Hazards.

31.3.2.1 Hazardous Areas. Any hazardous area shall be protected in accordance with Section 8.7.

31.3.2.1.1 The areas described in Table 31.3.2.1.1 shall be protected as indicated.

31.3.2.1.2 Where sprinkler protection without fire-rated separation is used, areas shall be separated from other spaces by smoke partitions complying with Section 8.4.

31.3.3 Interior Finish.

31.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

31.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be permitted as follows:

(1) Exit enclosures — Class A or Class B
(2) Lobbies and corridors — Class A or Class B
(3) Other spaces — Class A, Class B, or Class C

Table 31.3.2.1.1 Hazardous Area Protection

Hazardous Area Description	Separation/Protection†
Boiler and fuel-fired heater rooms serving more than a single dwelling unit	1 hour or sprinklers
Employee locker rooms	1 hour or sprinklers
Gift or retail shops >100 ft^2 (>9.3 m^2)	1 hour or sprinklers‡
Bulk laundries	1 hour or sprinklers
Laundries >100 ft^2 (>9.3 m^2) outside of dwelling units	1 hour or sprinklers‡
Maintenance shops	1 hour or sprinklers
Rooms or spaces used for storage of combustible supplies and equipment in quantities deemed hazardous by the authority having jurisdiction	1 hour or sprinklers
Trash collection rooms	1 hour or sprinklers

†Minimum fire resistance rating.
‡Where sprinklers are provided, the separation specified in 8.7.1.2 and 31.3.2.1.2 is not required.

31.3.3.3 Interior Floor Finish. In buildings utilizing Option 1 or Option 2, newly installed interior floor finish in exits and exit access corridors shall be not less than Class II in accordance with 10.2.7.

31.3.4 Detection, Alarm, and Communications Systems.

31.3.4.1 General.

31.3.4.1.1 Apartment buildings four or more stories in height or with more than 11 dwelling units, other than those meeting the requirements of 31.3.4.1.2, shall be provided with a fire alarm system in accordance with Section 9.6, except as modified by 31.3.4.2 through 31.3.4.5.

31.3.4.1.2 A fire alarm system shall not be required where each dwelling unit is separated from other contiguous dwelling units by fire barriers *(see Section 8.3)* having a minimum ½-hour fire resistance rating, and where each dwelling unit has either its own independent exit or its own independent stairway or ramp discharging at the finished ground level.

31.3.4.2 Initiation.

31.3.4.2.1 Initiation of the required fire alarm system shall be by manual means in accordance with 9.6.2, unless the building complies with 31.3.4.2.2.

31.3.4.2.2 Initiation of the required fire alarm system by manual means shall not be required in buildings four or fewer stories in height, containing not more than 16 dwelling units, and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 31.3.5.2.

31.3.4.2.3 In buildings using Option 2, the required fire alarm system shall be initiated by the automatic fire detection system in addition to the manual initiation means of 31.3.4.2.1.

31.3.4.2.4 In buildings using Option 3, the required fire alarm system shall be initiated upon operation of the automatic sprinkler system in addition to the manual initiation means of 31.3.4.2.1.

31.3.4.2.5 In buildings using Option 4, the required fire alarm system shall be initiated upon operation of the automatic sprinkler system in addition to the manual initiation means of 31.3.4.2.1.

31.3.4.3 Notification.

31.3.4.3.1 Occupant notification shall be provided automatically in accordance with Section 9.6, and all of the following shall also apply:

(1) Visible signals shall be installed in units designed for the hearing impaired.
(2) Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.
(3) Existing approved presignal systems shall be permitted in accordance with 9.6.3.3.

31.3.4.3.2 An annunciator panel, whose location shall be approved by the authority having jurisdiction, connected with the required fire alarm system shall be provided, unless the building meets the requirements of 31.3.4.3.3 or 31.3.4.3.4.

31.3.4.3.3 Annunciation shall not be required in buildings two or fewer stories in height and having not more than 50 rooms.

31.3.4.3.4 Annunciation shall not be required in buildings four or fewer stories in height containing not more than 16 dwelling units and protected throughout by an approved, supervised automatic sprinkler system installed in accordance with 31.3.5.2.

31.3.4.3.5 Emergency forces notification shall be accomplished in accordance with 9.6.4.

31.3.4.4 Detection.

31.3.4.4.1* In buildings using Option 2, a complete automatic fire detection system in accordance with 9.6.1.3 and 31.3.4.4.2 shall be required.

31.3.4.4.2 Automatic fire detection devices shall be installed as follows:

(1) Smoke detectors shall be installed in all common areas and work spaces outside the living unit, such as exit stairs, egress corridors, lobbies, storage rooms, equipment rooms, and other tenantless spaces in environments that are suitable for proper smoke detector operation.
(2) Heat detectors shall be located within each room of the living unit.

31.3.4.5 Smoke Alarms.

31.3.4.5.1* In buildings other than those equipped throughout with an existing, complete automatic smoke detection system, smoke alarms shall be installed in accordance with 9.6.2.10, as modified by 31.3.4.5.2, outside every sleeping area in the immediate vicinity of the bedrooms and on all levels of the dwelling unit, including basements.

31.3.4.5.2 Smoke alarms required by 31.3.4.5.1 shall not be required to be provided with a secondary (standby) power source.

31.3.4.5.3 In buildings other than those equipped throughout with an existing, complete automatic smoke detection system or a complete, supervised automatic sprinkler system in accordance with 31.3.5, smoke alarms shall be installed in every sleeping area in accordance with 9.6.2.10, as modified by 31.3.4.5.4.

31.3.4.5.4 Smoke alarms required by 31.3.4.5.3 shall be permitted to be battery powered.

31.3.5 Extinguishment Requirements.

31.3.5.1 Reserved.

31.3.5.2* Where an automatic sprinkler system is installed, either for total or partial building coverage, the system shall be installed in accordance with Section 9.7, as modified by 31.3.5.3 and 31.3.5.4. In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

31.3.5.3 In individual dwelling units, sprinkler installation shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2). Closets that contain equipment such as washers, dryers, furnaces, or water heaters shall be sprinklered, regardless of size.

31.3.5.4* In buildings sprinklered in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, bathrooms not greater than 55 ft^2 (5.1 m^2) in individual dwelling units shall not be required to be sprinklered.

31.3.5.5 The draft stop and closely spaced sprinkler requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required for convenience openings complying with 8.6.9.1 where the convenience opening is within the dwelling unit.

31.3.5.6 Reserved.

31.3.5.7 Reserved.

31.3.5.8 Reserved.

31.3.5.9 Buildings using Option 3 shall be provided with automatic sprinkler protection installed in accordance with 31.3.5.9.1 through 31.3.5.9.4.

31.3.5.9.1 Automatic sprinklers shall be installed in the corridor, along the corridor ceiling, utilizing the maximum spacing requirements of the standards referenced by Section 9.7.

31.3.5.9.2 An automatic sprinkler shall be installed within every dwelling unit that has a door opening to the corridor, with such sprinkler positioned over the center of the door, unless the door to the dwelling unit has not less than a 20-minute fire protection rating and is self-closing.

31.3.5.9.3 The workmanship and materials of the sprinkler installation specified in 31.3.5.8 shall meet the requirements of Section 9.7.

31.3.5.9.4 Where Option 3 is being used to permit the use of 1¾ in. (44 mm) thick, solid-bonded wood-core doors in accordance with 31.2.2.1.3, sprinklers shall be provided within the exit enclosures in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*.

31.3.5.10 Buildings using Option 4 shall be protected throughout by an approved automatic sprinkler system in accordance with 31.3.5.2 and meeting the requirements of Section 9.7 for supervision for buildings seven or more stories in height.

31.3.5.11* Where sprinklers are being used as an option to any requirement in this *Code*, the sprinklers shall be installed throughout the space in accordance with the requirements of that option.

31.3.5.12 High-Rise Building Sprinklers.

31.3.5.12.1 All high-rise buildings, other than those meeting 31.3.5.12.2 or 31.3.5.12.3, shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 31.3.5.2.

31.3.5.12.2 An automatic sprinkler system shall not be required where every dwelling unit has exterior exit access in accordance with 7.5.3.

31.3.5.12.3* An automatic sprinkler system shall not be required in buildings having an approved, engineered life safety system in accordance with 31.3.5.12.4.

31.3.5.12.4 Where required by 31.3.5.12.3, an engineered life safety system shall be developed by a registered professional engineer experienced in fire and life safety system design, shall be approved by the authority having jurisdiction, and shall include any or all of the following:

(1) Partial automatic sprinkler protection
(2) Smoke detection systems
(3) Smoke control systems
(4) Compartmentation
(5) Other approved systems

31.3.5.13 Portable fire extinguishers in accordance with Section 9.9 shall be provided in hazardous areas addressed by 31.3.2.1, unless the building is protected throughout with an approved, supervised automatic sprinkler system in accordance with 31.3.5.2.

31.3.6 Corridors.

31.3.6.1* Walls. Exit access corridor walls shall consist of fire barriers in accordance with Section 8.3 having a minimum ½-hour fire resistance rating.

31.3.6.2 Doors.

31.3.6.2.1 Doors that open onto exit access corridors, other than those complying with 8.3.4 or in buildings meeting the requirement of 31.3.6.2.2, shall have not less than a 20-minute fire protection rating in accordance with Section 8.3.

31.3.6.2.2 In buildings using Option 3 or Option 4, doors shall be constructed to resist the passage of smoke.

31.3.6.2.3 Doors that open onto exit access corridors shall be self-closing and self-latching.

31.3.6.3 Unprotected Openings.

31.3.6.3.1 Unprotected openings, other than those from spaces complying with 31.3.6.3.2, shall be prohibited in exit access corridor walls and doors.

31.3.6.3.2 Spaces shall be permitted to be unlimited in area and open to the corridor, provided that all of the following criteria are met:

(1) The space is not used for guest rooms or guest suites or hazardous areas.
(2) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 31.3.5.2.
(3) The space does not obstruct access to required exits.

31.3.6.4 Transoms, Louvers, or Transfer Grilles. Transoms, louvers, or transfer grilles shall be prohibited in walls or doors of exit access corridors.

31.3.7 Subdivision of Building Spaces — Smoke Partitions. In buildings other than those meeting the requirements of 31.3.7.1, 31.3.7.2, 31.3.7.3, 31.3.7.4, or 31.3.7.5, both of the following criteria shall be met:

(1) Smoke partitions in accordance with Section 8.4 shall be provided in exit access corridors to establish not less than two compartments of approximately equal size.
(2) The length of each smoke compartment, measured along the corridor, shall not exceed 200 ft (61 m).

31.3.7.1 Smoke partitions shall not be required in buildings using Option 4.

31.3.7.2 Smoke partitions shall not be required in buildings having exterior exit access in accordance with 7.5.3 that provides access to two exits.

31.3.7.3 Smoke partitions shall not be required in buildings complying with 31.2.4.4, 31.2.4.5, 31.2.4.6, or 31.2.4.7.

31.3.7.4 Smoke partitions shall not be required in buildings with exits not more than 50 ft (15 m) apart.

31.3.7.5 Smoke partitions shall not be required where each dwelling unit has direct access to the exterior at the finished ground level.

31.3.8 Special Protection Features. (Reserved)

31.4 Special Provisions.

31.4.1 High-Rise Buildings.

31.4.1.1 High-rise buildings shall comply with 31.2.11.1 and 31.3.5.11.

31.4.1.2* Emergency action plans in accordance with Section 4.8 shall be provided and shall include all of the following:

(1) Egress procedures
(2) Methods
(3) Preferred evacuation routes for each event, including appropriate use of elevators

31.4.2 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

31.5 Building Services.

31.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

31.5.2 Heating, Ventilating, and Air-Conditioning.

31.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

31.5.2.2 Unvented fuel-fired heaters, other than gas space heaters in compliance with NFPA 54, *National Fuel Gas Code*, shall not be used.

31.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

31.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

31.6 Reserved.

31.7 Operating Features.

31.7.1 Emergency Instructions for Residents of Apartment Buildings. Emergency instructions shall be provided annually to each dwelling unit to indicate the location of alarms, egress paths, and actions to be taken, both in response to a fire in the dwelling unit and in response to the sounding of the alarm system.

31.7.2 Contents and Furnishings.

31.7.2.1 Contents and furnishings shall not be required to comply with Section 10.3.

31.7.2.2 Furnishings or decorations of an explosive or highly flammable character shall not be used outside of dwelling units.

31.7.2.3 Fire-retardant coatings shall be maintained to retain the effectiveness of the treatment under service conditions encountered in actual use.

31.7.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 32 New Residential Board and Care Occupancies

32.1 General Requirements.

32.1.1 Application.

32.1.1.1 General. The requirements of this chapter shall apply to new buildings or portions thereof used as residential board and care occupancies. *(See 1.3.1.)*

32.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

32.1.1.3 General. The provisions of Chapter 4, General, shall apply.

32.1.1.4 Reserved.

32.1.1.5 Chapter Sections. This chapter is divided into five sections as follows:

(1) Section 32.1 — General Requirements
(2) Section 32.2 — Small Facilities (that is, sleeping accommodations for not more than 16 residents)
(3) Section 32.3 — Large Facilities (that is, sleeping accommodations for more than 16 residents)
(4) Section 32.4 — Suitability of an Apartment Building to House a Board and Care Occupancy *(Sections 32.5 and 32.6 are reserved.)*
(5) Section 32.7 — Operating Features

32.1.1.6 Conversion. For the purposes of this chapter, exceptions for conversions shall apply only for a change of occupancy from an existing residential or health care occupancy to a residential board and care occupancy.

32.1.2 Classification of Occupancy. See 6.1.9 and 32.1.3.

32.1.3 Multiple Occupancies.

32.1.3.1 Multiple occupancies shall comply with 6.1.14 and 32.1.3 in buildings other than those meeting the requirement of 32.1.3.2.

32.1.3.2 The requirement of 32.1.3.1 shall not apply to apartment buildings housing residential board and care occupancies in conformance with Section 32.4. In such facilities, any safeguards required by Section 32.4 that are more restrictive than those for other housed occupancies shall apply only to the extent prescribed by Section 32.4.

32.1.3.3 No board and care occupancy shall have its sole means of egress or means of escape pass through any nonresidential or non-health care occupancy in the same building.

32.1.3.4 No board and care occupancy shall be located above a nonresidential or non-health care occupancy, unless the board and care occupancy and exits therefrom are separated from the nonresidential or non-health care occupancy by construction having a minimum 2-hour fire resistance rating.

32.1.4 Definitions.

32.1.4.1 General. For definitions, see Chapter 3, Definitions.

32.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Personal Care.** See 3.3.208.
(2) **Point of Safety.** See 3.3.213.
(3) **Residential Board and Care Occupancy.** See 3.3.190.12.
(4) **Residential Board and Care Resident.** See 3.3.233.
(5) **Staff (Residential Board and Care).** See 3.3.263.
(6) **Thermal Barrier.** See 3.3.31.3.

32.1.5 Acceptability of Means of Egress or Escape. No means of escape or means of egress shall be considered as complying with the minimum criteria for acceptance, unless emergency evacuation drills are regularly conducted using that route in accordance with the requirements of 32.7.3.

32.1.6* Fire Resistance–Rated Assemblies. Fire resistance–rated assemblies shall comply with Section 8.3.

32.1.7 Reserved.

32.1.8 Reserved.

32.2 Small Facilities.

32.2.1 General.

32.2.1.1 Scope.

32.2.1.1.1 Section 32.2 shall apply to residential board and care occupancies providing sleeping accommodations for not more than 16 residents.

32.2.1.1.2 Where sleeping accommodations for more than 16 residents are provided, the occupancy shall be classified as a large facility in accordance with Section 32.3.

32.2.1.2 Reserved.

32.2.1.3 Minimum Construction Requirements. (Reserved)

32.2.1.4 Multiple-Level Buildings. For purposes of applying requirements of this chapter that utilize the term *level of exit discharge*, including determination of stories in height as addressed in 4.6.3, the level of exit discharge shall be permitted to be the combination of floor levels as addressed in 32.2.1.4.1, 32.2.1.4.2, or 32.2.1.4.3.

32.2.1.4.1 One floor level located not more than three stair risers above the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

32.2.1.4.2 One floor level located not more than three stair risers below the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

32.2.1.4.3 Where one floor level is located above the level of exit discharge, another floor level is located below the level of exit discharge, and not more than a total of three stair risers separate the upper level from the lower level, the two floor levels shall be permitted to be considered part of the level of exit discharge.

32.2.1.4.4 The provisions of 32.2.1.4.1, 32.2.1.4.2, and 32.2.1.4.3 shall not be used in combination with each other.

32.2.2 Means of Escape. Designated means of escape shall be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or emergency.

32.2.2.1 Reserved.

32.2.2.2 Primary Means of Escape.

32.2.2.2.1 Every sleeping room and living area shall have access to a primary means of escape located to provide a safe path of travel to the outside at street level or the finished ground level.

32.2.2.2.2 Where sleeping rooms or living areas are above or below the level of exit discharge, the primary means of escape shall be an interior stair in accordance with 32.2.2.4, an exterior stair, a horizontal exit, or a fire escape stair.

32.2.2.3 Secondary Means of Escape.

32.2.2.3.1 Sleeping rooms, other than those complying with 32.2.2.3.2 or 32.2.2.3.3, and living areas in facilities without a sprinkler system installed in accordance with 32.2.3.5 shall have a second means of escape consisting of one of the following:

(1) Door, stairway, passage, or hall providing a way of unobstructed travel to the outside of the dwelling at street or the finished ground level that is independent of, and remotely located from, the primary means of escape
(2) Passage through an adjacent nonlockable space independent of, and remotely located from, the primary means of escape to any approved means of escape
(3)*Outside window or door operable from the inside, without the use of tools, keys, or special effort, that provides a clear opening of not less than 5.7 ft^2 (0.53 m^2), with the width not less than 20 in. (510 mm), the height not less than 24 in. (610 mm), and the bottom of the opening not more than 44 in. (1120 mm) above the floor, with such means of escape acceptable, provided that one of the following criteria is met:
   (a) The window is within 20 ft (6100 mm) of the finished ground level.
   (b) The window is directly accessible to fire department rescue apparatus, as approved by the AHJ.
   (c) The window or door opens onto an exterior balcony.
(4) Windows having a sill height below the adjacent finished ground level that are provided with a window well meeting the following criteria:
   (a) The window well has horizontal dimensions that allow the window to be fully opened.
   (b) The window well has an accessible net clear opening of not less than 9 ft^2 (0.84 m^2), with a length and width of not less than 36 in. (915 mm).
   (c) A window well with a vertical depth of more than 44 in. (1120 mm) is equipped with an approved permanently affixed ladder or with steps meeting the following criteria:
      i. The ladder or steps do not encroach more than 6 in. (150 mm) into the required dimensions of the window well.
      ii. The ladder or steps are not obstructed by the window.

32.2.2.3.2 Sleeping rooms that have a door leading directly to the outside of the building with access to the finished ground level or to an exterior stairway meeting the requirements of 32.2.2.6.3 shall be considered as meeting all the requirements for a second means of escape.

32.2.2.3.3 Sleeping rooms shall not be required to have a secondary means of escape where the clinical needs of the residents require special security measures, provided all of the following are met:

(1) The building is protected throughout by an approved automatic sprinkler system in accordance with 32.3.3.5.
(2) A fire alarm system is provided in accordance with 32.3.3.4.1 through 32.3.3.4.3 and 32.3.3.4.6.
(3) Smoke detectors are provided in accordance with 32.3.3.4.8.

32.2.2.4 Interior Stairs Used for Primary Means of Escape. Interior stairs shall be protected in accordance with 32.2.2.4.1 through 32.2.2.4.4, unless they meet the requirement of 32.2.2.4.5, 32.2.2.4.6, or 32.2.2.4.7.

32.2.2.4.1 Interior stairs shall be enclosed with fire barriers in accordance with Section 8.3 having a minimum ½-hour resistance rating.

32.2.2.4.2 Stairs shall comply with 7.2.2.5.3.

32.2.2.4.3 The entire primary means of escape shall be arranged so that occupants are not required to pass through a portion of a story above or a story below, unless that route is separated from all spaces on that story by construction having a minimum ½-hour fire resistance rating.

32.2.2.4.4 In buildings of construction other than Type II(000), Type III(200), or Type V(000), the supporting construction shall be protected to afford the required fire resistance rating of the supported wall.

32.2.2.4.5 Stairs that connect a story at street level to only one other story shall be permitted to be open to the story that is not at street level.

32.2.2.4.6 In buildings three or fewer stories in height and protected by an approved automatic sprinkler system in accordance with 32.2.3.5, stair enclosures shall not be required, provided that there still remains a primary means of escape from each sleeping area that does not require occupants to pass through a portion of a lower floor, unless that route is separated from all spaces on that floor by construction having a minimum ½-hour fire resistance rating.

32.2.2.4.7 Stairs serving a maximum of two stories in buildings protected with an approved automatic sprinkler system in accordance with 32.2.3.5 shall be permitted to be unenclosed.

32.2.2.5 Doors.

32.2.2.5.1 Doors, other than those meeting the requirements of 32.2.2.5.1.1 and 32.2.2.5.1.2, and paths of travel to a means of escape shall be not less than 32 in. (810 mm) wide.

32.2.2.5.1.1 Bathroom doors shall be not less than 24 in. (610 mm) wide.

32.2.2.5.1.2 In conversions *(see 32.1.1.6)*, 28 in. (710 mm) doors shall be permitted.

32.2.2.5.2 Doors shall be swinging or sliding.

32.2.2.5.3 Every closet door latch shall be readily opened from the inside.

32.2.2.5.4 Every bathroom door shall be designed to allow opening from the outside during an emergency when locked.

32.2.2.5.5 No door in any means of escape, other than those meeting the requirement of 32.2.2.5.5.1, 32.2.2.5.5.2, or 32.2.2.5.5.3, shall be locked against egress when the building is occupied.

32.2.2.5.5.1 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted on exterior doors only.

32.2.2.5.5.2 Access-controlled egress door assemblies complying with 7.2.1.6.2 shall be permitted.

32.2.2.5.5.3 Door-locking arrangements shall be permitted where the clinical needs of residents require specialized security measures or where residents pose a security threat, provided all of the following conditions are met:

(1) Staff can readily unlock doors at all times in accordance with 32.2.2.5.5.4.
(2) The building is protected by an approved automatic sprinkler system in accordance with 32.2.3.5.
(3) The provision of 32.2.3.5.2 for conversions is not be permitted to be used.

32.2.2.5.5.4 Doors located in the means of egress and permitted to be locked in accordance with 32.2.2.5.5.3 shall comply with all of the following:

(1) Provisions shall be made for the rapid removal of occupants by means of one of the following:
    (a) Remote control of locks from within the locked building
    (b) Keying of all locks to keys carried by staff at all times
    (c) Other such reliable means available to staff at all times
(2) Only one locking device shall be permitted on each door.

32.2.2.5.6 Forces to open doors shall comply with 7.2.1.4.5.

32.2.2.5.7 Door-latching devices shall comply with 7.2.1.5.10.

32.2.2.5.8 Floor levels at doors shall comply with 7.2.1.3.

32.2.2.6 Stairs.

32.2.2.6.1 Stairs shall comply with 7.2.2, unless otherwise specified in this chapter.

32.2.2.6.2 Existing winders complying with 7.2.2.2.4 shall be permitted to remain only in conversions.

32.2.2.6.3* Exterior stairs shall be protected against blockage caused by fire within the building.

32.2.3 Protection.

32.2.3.1 Protection of Vertical Openings.

32.2.3.1.1 Reserved.

32.2.3.1.2 Vertical openings, other than those meeting the requirement of 32.2.3.1.4, shall be separated by smoke partitions in accordance with Section 8.4 having a minimum ½-hour fire resistance rating.

32.2.3.1.3 Reserved.

32.2.3.1.4 Stairs shall be permitted to be open where complying with 32.2.2.4.6 or 32.2.2.4.7.

32.2.3.2 Hazardous Areas.

32.2.3.2.1* Any space where there is storage or activity having fuel conditions exceeding those of a one- or two-family dwelling and that possesses the potential for a fully involved fire shall be protected in accordance with 32.2.3.2.4 and 32.2.3.2.5.

32.2.3.2.2 Spaces requiring protection in accordance with 32.2.3.2.1 shall include, but shall not be limited to, areas for cartoned storage, food or household maintenance items in wholesale or institutional-type quantities and concentrations, or mass storage of residents' belongings.

32.2.3.2.3 Reserved.

32.2.3.2.4 Any hazardous area that is on the same floor as, and is in or abuts, a primary means of escape or a sleeping room shall be protected by one of the following means:

(1) Protection shall be an enclosure having a minimum 1-hour fire resistance rating, in accordance with 8.2.3, and an automatic fire detection system connected to the fire alarm system provided in 32.2.3.4.1.
(2) Protection shall be automatic sprinkler protection, in accordance with 32.2.3.5, and a smoke partition, in accordance with Section 8.4, located between the hazardous area and the sleeping area or primary escape route, with any doors in such separation self-closing or automatic-closing in accordance with 7.2.1.8.

32.2.3.2.5 Other hazardous areas shall be protected by one of the following:

(1) Enclosure having a minimum ½-hour fire resistance rating, with a self-closing or automatic-closing door in accordance with 7.2.1.8 that is equivalent to minimum 1¾ in. (44 mm) thick, solid-bonded wood-core construction, and protected by an automatic fire detection system connected to the fire alarm system provided in 32.2.3.4.1
(2) Automatic sprinkler protection in accordance with 32.2.3.5, regardless of enclosure

32.2.3.3 Interior Finish.

32.2.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

32.2.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C.

32.2.3.3.3 Interior Floor Finish.

32.2.3.3.3.1 Interior floor finish shall comply with Section 10.2.

32.2.3.3.3.2 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

32.2.3.4 Detection, Alarm, and Communications Systems.

32.2.3.4.1 General. A manual fire alarm system shall be provided in accordance with Section 9.6.

32.2.3.4.2 Occupant Notification. Occupant notification shall be provided automatically, without delay, in accordance with 9.6.3.

32.2.3.4.3 Smoke Alarms.

32.2.3.4.3.1 Approved smoke alarms shall be provided in accordance with 9.6.2.10.

32.2.3.4.3.2 Smoke alarms shall be installed on all levels, including basements but excluding crawl spaces and unfinished attics.

32.2.3.4.3.3 Additional smoke alarms shall be installed in all living areas, as defined in 3.3.21.5.

32.2.3.4.3.4 Each sleeping room shall be provided with an approved smoke alarm in accordance with 9.6.2.10.

32.2.3.5* Extinguishment Requirements.

32.2.3.5.1* All facilities, other than those meeting the requirement of 32.2.3.5.2, shall be protected throughout by an approved automatic sprinkler system, installed in accordance with 32.2.3.5.3, using quick-response or residential sprinklers.

32.2.3.5.2* In conversions, sprinklers shall not be required in small board and care homes serving eight or fewer residents when all occupants have the ability as a group to move reliably to a point of safety within 3 minutes.

32.2.3.5.3 Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

(1) The system shall be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and shall initiate the fire alarm system in accordance with 32.2.3.4.1.
(2) The adequacy of the water supply shall be documented to the authority having jurisdiction.

32.2.3.5.3.1 In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted. All habitable areas, closets, roofed porches, roofed decks, and roofed balconies shall be sprinklered.

32.2.3.5.3.2* An automatic sprinkler system with a 30-minute water supply, and complying with all of the following requirements and with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall be permitted:

(1) All habitable areas, closets, roofed porches, roofed decks, and roofed balconies shall be sprinklered.
(2) Facilities with more than eight residents shall be treated as two-family dwellings with regard to water supply.

32.2.3.5.4 Automatic sprinkler systems installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be provided with electrical supervision in accordance with 9.7.2.

32.2.3.5.5 Automatic sprinkler systems installed in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall be provided with valve supervision by one of the following methods:

(1) Single listed control valve that shuts off both domestic and sprinkler systems and separate shutoff for the domestic system only
(2) Electrical supervision in accordance with 9.7.2
(3) Valve closure that causes the sounding of an audible signal in the facility

32.2.3.5.6 Sprinkler piping serving not more than six sprinklers for any isolated hazardous area shall be permitted to be installed in accordance with 9.7.1.2 and shall meet all of the following requirements:

(1) In new installations, where more than two sprinklers are installed in a single area, waterflow detection shall be provided to initiate the fire alarm system required by 32.2.3.4.1.
(2) The duration of water supplies shall be as required by 32.2.3.5.3.2.

32.2.3.5.7 Attics shall be protected in accordance with 32.2.3.5.7.1 or 32.2.3.5.7.2.

32.2.3.5.7.1 Where an automatic sprinkler system is required by 32.2.3.5, attics used for living purposes, storage, or fuel-fired equipment shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 9.7.1.1.

32.2.3.5.7.2 Where an automatic sprinkler system is required by 32.2.3.5, attics not used for living purposes, storage, or fuel-fired equipment shall meet one of the following criteria:

(1) Attics shall be protected throughout by a heat detection system arranged to activate the building fire alarm system in accordance with Section 9.6.
(2) Attics shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 9.7.1.1.
(3) Attics shall be of noncombustible or limited-combustible construction.
(4) Attics shall be constructed of fire-retardant-treated wood in accordance with NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*.

32.2.3.5.8 Systems installed in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall be inspected, tested, and maintained in accordance with 32.2.3.5.8.1 through 32.2.3.5.8.15, which reference specific sections of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. The frequency of the inspection, test, or maintenance shall be in accordance with this *Code*, whereas the purpose and procedure shall be from NFPA 25.

32.2.3.5.8.1 Control valves shall be inspected monthly in accordance with 13.3.2 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.2 Gages shall be inspected monthly in accordance with 13.2.7.1 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.3 Alarm devices shall be inspected quarterly in accordance with 5.2.6 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.4 Alarm devices shall be tested semiannually in accordance with 5.3.3 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.5 Valve supervisory switches shall be tested semiannually in accordance with 13.3.3.5 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.6 Visible sprinklers shall be inspected annually in accordance with 5.2.1 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.7 Visible pipe shall be inspected annually in accordance with 5.2.2 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

32.2.3.5.8.8 Visible pipe hangers shall be inspected annually in accordance with 5.2.3 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

32.2.3.5.8.9 Buildings shall be inspected annually prior to the onset of freezing weather to ensure that there is adequate heat wherever water-filled piping is run in accordance with 5.2.5 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

32.2.3.5.8.10 A representative sample of fast-response sprinklers shall be tested once the sprinklers in the system are 20 years old in accordance with 5.3.1.1.1.2 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.* If the sample fails the test, all of the sprinklers represented by that sample shall be replaced. If the sprinklers pass the test, the test shall be repeated every 10 years thereafter.

32.2.3.5.8.11 A representative sample of dry-pendent sprinklers shall be tested once the sprinklers in the system are 10 years old in accordance with 5.3.1.1.1.5 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.* If the sample fails the test, all of the sprinklers represented by that sample shall be replaced. If the sprinklers pass the test, the test shall be repeated every 10 years thereafter.

32.2.3.5.8.12 Antifreeze solutions shall be tested annually in accordance with 5.3.4 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

32.2.3.5.8.13 Control valves shall be operated through their full range and returned to normal annually in accordance with 13.3.3.1 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

32.2.3.5.8.14 Operating stems of OS&Y valves shall be lubricated annually in accordance with 13.3.4 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

32.2.3.5.8.15 Dry-pipe systems that extend into the unheated portions of the building shall be inspected, tested, and maintained in accordance with 13.4.4 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

32.2.3.6 Construction of Corridor Walls.

32.2.3.6.1 Corridor walls, other than those meeting the provisions of 32.2.3.6.2, shall meet all of the following requirements:

(1) Walls separating sleeping rooms shall have a minimum ½-hour fire resistance rating. The minimum ½-hour fire resistance rating shall be considered to be achieved if the partitioning is finished on both sides with lath and plaster or materials providing a 15-minute thermal barrier.
(2) Sleeping room doors shall be substantial doors, such as those of 1¾ in. (44 mm) thick, solid-bonded wood-core construction or of other construction of equal or greater stability and fire integrity.
(3) Any vision panels shall be fixed fire window assemblies in accordance with 8.3.4 or shall be wired glass not exceeding 9 ft^2 (0.84 m^2) each in area and installed in approved frames.

32.2.3.6.2 The requirements of 32.2.3.6.1 shall not apply to corridor walls that are smoke partitions in accordance with Section 8.4 where the facility is protected in accordance with 32.2.3.5, and all of the following shall also apply:

(1) In such instances, there shall be no limitation on the type or size of glass panels.
(2) Door closing shall comply with 32.2.3.6.4.

32.2.3.6.3 No louvers, operable transoms, or other air passages shall penetrate the wall, except properly installed heating and utility installations other than transfer grilles, which shall be prohibited.

32.2.3.6.4 Doors shall meet all of the following requirements:

(1) Doors shall be provided with latches or other mechanisms suitable for keeping the doors closed.
(2) No doors shall be arranged to prevent the occupant from closing the door.
(3) Doors shall be self-closing or automatic-closing in accordance with 7.2.1.8 in buildings other than those protected throughout by an approved automatic sprinkler system in accordance with 32.2.3.5.

32.2.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

32.2.5 Building Services.

32.2.5.1 Utilities. Utilities shall comply with Section 9.1.

32.2.5.2 Heating, Ventilating, and Air-Conditioning.

32.2.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with 9.2.1 and 9.2.2, unless otherwise required in this chapter.

32.2.5.2.2 No stove or combustion heater shall be located to block escape in case of fire caused by the malfunction of the stove or heater.

32.2.5.2.3 Unvented fuel-fired heaters shall not be used in any residential board and care facility.

32.2.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with Section 9.4.

32.3 Large Facilities.

32.3.1 General.

32.3.1.1 Scope.

32.3.1.1.1 Section 32.3 shall apply to residential board and care occupancies providing sleeping accommodations for more than 16 residents.

32.3.1.1.2 Facilities having sleeping accommodations for not more than 16 residents shall comply with Section 32.2.

32.3.1.2 Reserved.

32.3.1.3 Minimum Construction Requirements. Large board and care facilities shall be limited to the building construction types specified in Table 32.3.1.3 *(see 8.2.1)*, based on the number of stories in height as defined in 4.6.3.

32.3.1.4 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

Table 32.3.1.3 Construction Type Limitations

Construction Type	Sprinklered[a]	Stories in Height[b]				
		1	2	3	4–12	>12
I (442)[c, d]	Yes	X	X	X	X	X
	No	NP	NP	NP	NP	NP
I (332)[c, d]	Yes	X	X	X	X	X
	No	NP	NP	NP	NP	NP
II (222)[c, d]	Yes	X	X	X	X	NP
	No	NP	NP	NP	NP	NP
II (111)[c, d]	Yes	X	X	X	NP	NP
	No	NP	NP	NP	NP	NP
II (000)	Yes	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP
III (211)	Yes	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP
III (200)	Yes	X	NP	NP	NP	NP
	No	NP	NP	NP	NP	NP
IV (2HH)	Yes	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP
V (111)	Yes	X	X	NP	NP	NP
	No	NP	NP	NP	NP	NP
V (000)	Yes	X	NP	NP	NP	NP
	No	NP	NP	NP	NP	NP

X: Permitted. NP: Not permitted.

[a]Building protected throughout by an approved automatic sprinkler system installed in accordance with 9.7.1.1(1), and provided with quick-response or residential sprinklers throughout. (*See 32.3.3.5.*)

[b]See 4.6.3.

[c]Any building of Type I, Type II(222), or Type II(111) construction is permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:

(1) The roof covering meets Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings,* or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings.*

(2) The roof is separated from all occupied portions of the building by a noncombustible floor assembly having not less than a 2-hour fire resistance rating that includes not less than 2½ in. (63 mm) of concrete or gypsum fill.

(3) The structural elements supporting the 2-hour fire resistance–rated floor assembly specified in item (2) are required to have only the fire resistance rating required of the building.

[d]Any building of Type I, Type II(222), or Type II(111) construction is permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:

(1) The roof covering meets Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings,* or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings.*

(2) The roof/ceiling assembly is constructed with fire-retardant-treated wood meeting the requirements of NFPA 220, *Standard on Types of Building Construction.*

(3) The roof/ceiling assembly has the required fire resistance rating for the type of construction.

32.3.2 Means of Egress.

32.3.2.1 General.

32.3.2.1.1 Means of egress from resident rooms and resident dwelling units to the outside of the building shall be in accordance with Chapter 7 and this chapter.

32.3.2.1.2 Means of escape within the resident room or resident dwelling unit shall comply with Section 24.2 for one- and two-family dwellings.

32.3.2.2 Means of Egress Components.

32.3.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 32.3.2.2.2 through 32.3.2.2.10.

32.3.2.2.2 Doors. Doors in means of egress shall meet all of the following criteria:

(1) Doors complying with 7.2.1 shall be permitted.
(2) Doors within individual rooms and suites of rooms shall be permitted to be swinging or sliding.
(3) No door, other than those meeting the requirement of 32.3.2.2.2(4), 32.3.2.2.2(5), or 32.3.2.2.2(6), shall be equipped with a lock or latch that requires the use of a tool or key from the egress side.
(4) Delayed-egress locks in accordance with 7.2.1.6.1 shall be permitted.
(5) Access-controlled egress door assemblies in accordance with 7.2.1.6.2 shall be permitted.
(6) Door-locking arrangements shall be permitted where the clinical needs of residents require specialized security measures or where residents pose a security threat, provided both of the following conditions are met:
    (a) Staff can readily unlock doors at all times in accordance with 32.3.2.2.2(7)
    (b) The building is protected by an approved automatic sprinkler system in accordance with 32.3.3.5
(7) Doors located in the means of egress that are permitted to be locked under other provisions of Chapter 32, other than those meeting the requirement of 32.3.2.2.2(4) or 32.3.2.2.2(5), shall have adequate provisions made for the rapid removal of occupants by means such as remote control of locks, keying of all locks to keys carried by staff at all times, or other such reliable means available to staff at all times.
(8) Only one such locking device, as described in 32.3.2.2.2(7), shall be permitted on each door.

32.3.2.2.3 Stairs. Stairs complying with 7.2.2 shall be permitted.

32.3.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

32.3.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

32.3.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

32.3.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

32.3.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

32.3.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

32.3.2.2.10 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

32.3.2.3 Capacity of Means of Egress.

32.3.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

32.3.2.3.2 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging onto the street floor.

32.3.2.3.3 The width of corridors shall be sufficient for the occupant load served but shall be not less than 60 in. (1525 mm).

32.3.2.4 Number of Means of Egress.

32.3.2.4.1 Means of egress shall comply with the following, except as otherwise permitted by 32.3.2.4.2:

(1) The number of means of egress shall be in accordance with Section 7.4.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

32.3.2.4.2 Exit access, as required by 32.3.2.4.1(3), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 32.3.2.5.2.

32.3.2.5 Arrangement of Means of Egress.

32.3.2.5.1 Access to all required exits shall be in accordance with Section 7.5.

32.3.2.5.2 Common paths of travel shall not exceed 75 ft (23 m).

32.3.2.5.3 Reserved.

32.3.2.5.4 Dead-end corridors shall not exceed 30 ft (9.1 m).

32.3.2.5.5 Any room, or any suite of rooms, exceeding 2000 ft^2 (185 m^2) shall be provided with not less than two exit access doors located remotely from each other.

32.3.2.6 Travel Distance to Exits. Travel distance from any point in a room to the nearest exit, measured in accordance with Section 7.6, shall not exceed 250 ft (76 m).

32.3.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

32.3.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

32.3.2.9 Emergency Lighting. Emergency lighting in accordance with Section 7.9 shall be provided, unless each sleeping room has a direct exit to the outside at the finished ground level.

32.3.2.10 Marking of Means of Egress. Means of egress shall be marked in accordance with Section 7.10.

32.3.2.11 Special Means of Egress Features.

32.3.2.11.1 Reserved.

32.3.2.11.2 Lockups. Lockups in residential board and care occupancies shall comply with the requirements of 22.4.5.

32.3.3 Protection.

32.3.3.1 Protection of Vertical Openings.

32.3.3.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6.

32.3.3.1.2 Unenclosed vertical openings in accordance with 8.6.9.1 shall be permitted.

32.3.3.1.3 No floor below the level of exit discharge used only for storage, heating equipment, or purposes other than residential occupancy shall have unprotected openings to floors used for residential occupancy.

32.3.3.2 Protection from Hazards.

32.3.3.2.1 Hazardous areas shall be protected in accordance with Section 8.7.

32.3.3.2.2 The areas described in Table 32.3.3.2.2 shall be protected as indicated.

Table 32.3.3.2.2 Hazardous Area Protection

Hazardous Area Description	Separation/Protection†
Boiler and fuel-fired heater rooms	1 hour
Central/bulk laundries larger than 100 ft^2 (9.3 m^2)	1 hour
Paint shops employing hazardous substances and materials in quantities less than those that would be classified as a severe hazard	1 hour
Physical plant maintenance shops	1 hour
Soiled linen rooms	1 hour
Storage rooms larger than 50 ft^2 (4.6 m^2), but not exceeding 100 ft^2 (9.3 m^2), storing combustible material	Smoke partition
Storage rooms larger than 100 ft^2 (9.3 m^2) storing combustible material	1 hour
Trash collection rooms	1 hour

†Minimum fire resistance rating.

32.3.3.3* Interior Finish.

32.3.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

32.3.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be in accordance with the following:

(1) Exit enclosures — Class A
(2) Lobbies and corridors — Class B
(3) Rooms and enclosed spaces — Class B

32.3.3.3.3 Interior Floor Finish.

32.3.3.3.3.1 Interior floor finish shall comply with Section 10.2.

32.3.3.3.3.2 Interior floor finish in exit enclosures and exit access corridors and spaces not separated from them by walls complying with 32.3.3.6 shall be not less than Class II.

32.3.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

32.3.3.4 Detection, Alarm, and Communications Systems.

32.3.3.4.1 General. A fire alarm system shall be provided in accordance with Section 9.6.

32.3.3.4.2 Initiation. The required fire alarm system shall be initiated by each of the following:

(1) Manual means in accordance with 9.6.2
(2) Manual fire alarm box located at a convenient central control point under continuous supervision of responsible employees
(3) Required automatic sprinkler system
(4) Required detection system

32.3.3.4.3 Annunciator Panel. An annunciator panel, connected to the fire alarm system, shall be provided at a location readily accessible from the primary point of entry for emergency response personnel.

32.3.3.4.4 Occupant Notification. Occupant notification shall be provided automatically, without delay, in accordance with 9.6.3.

32.3.3.4.5 High-Rise Buildings. High-rise buildings shall be provided with an approved emergency voice communication/alarm system in accordance with 11.8.4.

32.3.3.4.6* Emergency Forces Notification. Emergency forces notification shall meet the following requirements:

(1) Emergency forces notification shall be accomplished in accordance with 9.6.4.
(2) Smoke detection devices or smoke detection systems shall be permitted to initiate a positive alarm sequence in accordance with 9.6.3.4 for not more than 120 seconds.

32.3.3.4.7 Smoke Alarms. Approved smoke alarms shall be installed in accordance with 9.6.2.10 inside every sleeping room, outside every sleeping area in the immediate vicinity of the bedrooms, and on all levels within a resident unit.

32.3.3.4.8 Smoke Detection Systems.

32.3.3.4.8.1 Corridors and spaces open to the corridors, other than those meeting the requirement of 32.3.3.4.8.3, shall be provided with smoke detectors that comply with *NFPA 72, National Fire Alarm and Signaling Code*, and are arranged to initiate an alarm that is audible in all sleeping areas.

32.3.3.4.8.2 Reserved.

32.3.3.4.8.3 Smoke detection systems shall not be required in unenclosed corridors, passageways, balconies, colonnades, or other arrangements with one or more sides along the long dimension fully or extensively open to the exterior at all times.

32.3.3.5 Extinguishment Requirements.

32.3.3.5.1 General. All buildings shall be protected throughout by an approved automatic sprinkler system installed in accordance with 9.7.1.1(1) and provided with quick-response or residential sprinklers throughout.

32.3.3.5.2 Reserved.

32.3.3.5.3 Reserved.

32.3.3.5.4 Reserved.

32.3.3.5.5 Supervision. Automatic sprinkler systems shall be provided with electrical supervision in accordance with 9.7.2.

32.3.3.5.6 Reserved.

32.3.3.5.7 Portable Fire Extinguishers. Portable fire extinguishers shall be provided in accordance with Section 9.9.

32.3.3.6* Corridors and Separation of Sleeping Rooms.

32.3.3.6.1 Access shall be provided from every resident use area to at least one means of egress that is separated from all sleeping rooms by walls complying with 32.3.3.6.3 through 32.3.3.6.6.

32.3.3.6.2 Sleeping rooms shall be separated from corridors, living areas, and kitchens by walls complying with 32.3.3.6.3 through 32.3.3.6.6.

32.3.3.6.3 Walls required by 32.3.3.6.1 or 32.3.3.6.2 shall be smoke partitions in accordance with Section 8.4 having a minimum ½-hour fire resistance rating.

32.3.3.6.4 Doors protecting corridor openings shall not be required to have a fire protection rating, but shall be constructed to resist the passage of smoke.

32.3.3.6.5 Door-closing devices shall not be required on doors in corridor wall openings, other than those serving exit enclosures, smoke barriers, enclosures of vertical openings, and hazardous areas.

32.3.3.6.6 No louvers, transfer grilles, operable transoms, or other air passages, other than properly installed heating and utility installations, shall penetrate the walls or doors specified in 32.3.3.6.

32.3.3.7 Subdivision of Building Spaces. Buildings shall be subdivided by smoke barriers in accordance with 32.3.3.7.1 through 32.3.3.7.21.

32.3.3.7.1 Every story shall be divided into not less than two smoke compartments, unless it meets the requirement of 32.3.3.7.4, 32.3.3.7.5, 32.3.3.7.6, or 32.3.3.7.7.

32.3.3.7.2 Each smoke compartment shall have an area not exceeding 22,500 ft^2 (2100 m^2).

32.3.3.7.3 The travel distance from any point to reach a door in the required smoke barrier shall be limited to a distance of 200 ft (61 m).

32.3.3.7.4 Smoke barriers shall not be required on stories that do not contain a board and care occupancy located above the board and care occupancy.

32.3.3.7.5 Smoke barriers shall not be required in areas that do not contain a board and care occupancy and that are separated from the board and care occupancy by a fire barrier complying with Section 8.3.

32.3.3.7.6 Smoke barriers shall not be required on stories that do not contain a board and care occupancy and that are more than one story below the board and care occupancy.

32.3.3.7.7 Smoke barriers shall not be required in open parking structures protected throughout by an approved, supervised automatic sprinkler system in accordance with 32.3.3.5.

32.3.3.7.8 Smoke barriers shall be constructed in accordance with Section 8.5 and shall have a minimum 1-hour fire resistance rating, unless they meet the requirement of 32.3.3.7.9 or 32.3.3.7.10.

32.3.3.7.9 Where an atrium is used, smoke barriers shall be permitted to terminate at an atrium wall constructed in accordance with 8.6.7(1)(c), in which case not less than two separate smoke compartments shall be provided on each floor.

32.3.3.7.10* Dampers shall not be required in duct penetrations of smoke barriers in fully ducted heating, ventilating, and air-conditioning systems.

32.3.3.7.11 Not less than 15 net ft^2 (1.4 net m^2) per resident shall be provided within the aggregate area of corridors, lounge or dining areas, and other low hazard areas on each side of the smoke barrier.

32.3.3.7.12 On stories not housing residents, not less than 6 net ft^2 (0.56 net m^2) per occupant shall be provided on each side of the smoke barrier for the total number of occupants in adjoining compartments.

32.3.3.7.13* Doors in smoke barriers shall be substantial doors, such as 1¾ in. (44 mm) thick, solid-bonded wood-core doors, or shall be of construction that resists fire for a minimum of 20 minutes.

32.3.3.7.14 Nonrated factory- or field-applied protective plates extending not more than 48 in. (1220 mm) above the bottom of the door shall be permitted.

32.3.3.7.15 Cross-corridor openings in smoke barriers shall be protected by a pair of swinging doors or a special-purpose horizontally sliding accordion or folding door assemblies complying with 7.2.1.14.

32.3.3.7.16 Swinging doors shall be arranged so that each door swings in a direction opposite from the other.

32.3.3.7.17* Doors in smoke barriers shall comply with 8.5.4 and shall be self-closing or automatic-closing in accordance with 7.2.1.8.

32.3.3.7.18* Vision panels consisting of fire-rated glazing or wired glass panels in approved frames shall be provided in each cross-corridor swinging door and in each cross-corridor horizontal-sliding door in a smoke barrier.

32.3.3.7.19 Rabbets, bevels, or astragals shall be required at the meeting edges, and stops shall be required at the head and sides of door frames in smoke barriers.

32.3.3.7.20 Positive latching hardware shall not be required.

32.3.3.7.21 Center mullions shall be prohibited.

32.3.3.8 Cooking Facilities.

32.3.3.8.1 Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 32.3.3.8.2, 32.3.3.8.3, or 32.3.3.8.4.

32.3.3.8.2* Where residential cooking equipment is used for food warming or limited cooking, the equipment shall not be required to be protected in accordance with 9.2.3, and the presence of the equipment shall not require the area to be protected as a hazardous area.

32.3.3.8.3* Compliance with 9.2.3 shall not be required where all of the following conditions are met:

(1) Residential or commercial cooking equipment in a single kitchen per smoke compartment is used to prepare meals for 30 or fewer persons.
(2) The portion of the board and care facility served by the cooking facility is limited to 30 beds and is separated from other portions of the board and care facility by a smoke barrier constructed in accordance with 32.3.3.7.8 and with 32.3.3.7.13 through 32.3.3.7.21.

(3) The cooktop or range is equipped with a range hood of a width at least equal to the width of the cooking surface, with grease baffles or other grease-collecting and clean-out capability.
(4)*The hood systems have a minimum airflow of 500 cfm (14,000 L/min).
(5) The hood systems that are not ducted to the exterior additionally have a charcoal filter to remove smoke and odor.
(6) The cooktop or range complies with all of the following:
  (a) The cooktop or range is protected with a fire suppression system listed in accordance with ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment*, or is tested and meets all requirements of UL 300A, *Extinguishing System Units for Residential Range Top Cooking Surfaces*, in accordance with the applicable testing document's scope.
  (b) A manual release of the extinguishing system is provided in accordance with Section 10.5 of NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.
  (c) An interlock is provided to turn off all sources of fuel and electrical power to the cooktop or range when the suppression system is activated.
(7)*The use of solid fuel for cooking is prohibited.
(8)*Deep-fat frying is prohibited.
(9) Portable fire extinguishers in accordance with NFPA 96 are located in all kitchen areas.
(10)*A switch meeting all of the following is provided:
  (a) A locked switch, or a switch located in a restricted location, is provided within the cooking facility that deactivates the cooktop or range.
  (b) The switch is used to deactivate the cooktop or range whenever the kitchen is not under staff supervision.
  (c) The switch is on a timer, not exceeding a 120-minute capacity, that automatically deactivates the cooktop or range, independent of staff action.
(11) Procedures for the use, inspection, testing, and maintenance of the cooking equipment are in accordance with Chapter 11 of NFPA 96, and the manufacturer's instructions are followed.
(12)*No fewer than two ac-powered photoelectric smoke alarms, interconnected in accordance with 9.6.2.10.3 and equipped with a silence feature, are located not closer than 20 ft (6.1 m) and not farther than 25 ft (7.6 m) from the cooktop or range.
(13) The smoke alarms required by 32.3.3.8.3(12) are permitted to be located outside the kitchen area where such placement is necessary for compliance with the 20 ft (6.1 m) minimum distance criterion.
(14) A single system smoke detector is permitted to be installed in lieu of the smoke alarms required in 32.3.3.8.3(12), provided the following criteria are met:
  (a) The detector is located not closer than 20 ft (6.1 m) and not farther than 25 ft (7.6 m) from the cooktop or range.
  (b) The detector is permitted to initiate a local audible alarm signal only.
  (c) The detector is not required to initiate a building-wide occupant notification signal.
  (d) The detector is not required to notify emergency forces.
  (e) The local audible signal initiated by the detector is permitted to be silenced and reset by a button on the detector or by a switch installed within 10 ft (3.0 m) of the system smoke detector.
  (f) System smoke detectors that are required by other sections of the chapter to be installed in corridors or spaces open to the corridor are not used to meet the requirements of 32.3.3.8.3(12) and are located not closer than 25 ft (7.6 m) to the cooktop or range.

32.3.3.8.4* Within a smoke compartment, residential or commercial cooking equipment that is used to prepare meals for 30 or fewer persons shall be permitted, provided that the cooking facility complies with all of the following conditions:

(1) The space containing the cooking equipment is not a sleeping room.
(2) The space containing the cooking equipment is separated from the corridor by partitions complying with 32.3.3.6.2 through 32.3.3.6.5.
(3) The requirements of 32.3.3.8.3(1) through (10) are met.

32.3.3.8.5* Where cooking facilities are protected in accordance with 9.2.3, the presence of the cooking equipment shall not cause the room or space housing the equipment to be classified as a hazardous area with respect to the requirements of 32.3.3.2, and the room or space shall not be permitted to be open to the corridor.

32.3.3.9 Standpipes.

32.3.3.9.1 General. Where required, standpipe and hose systems shall be installed and maintained in accordance with Section 9.10.

32.3.3.9.2 In High-Rise Buildings. Class I standpipe systems shall be installed throughout all high-rise buildings.

32.3.3.9.3 Roof Outlets. Roof outlets shall not be required on roofs having a slope of 3 in 12 or greater.

32.3.4 Special Provisions.

32.3.4.1 High-Rise Buildings. High-rise buildings shall comply with Section 11.8.

32.3.4.2 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

32.3.5 Reserved.

32.3.6 Building Services.

32.3.6.1 Utilities. Utilities shall comply with Section 9.1.

32.3.6.2 Heating, Ventilating, and Air-Conditioning.

32.3.6.2.1 Heating, ventilating, and air-conditioning equipment shall comply with Section 9.2.

32.3.6.2.2 No stove or combustion heater shall be located such that it blocks escape in case of fire caused by the malfunction of the stove or heater.

32.3.6.2.3 Unvented fuel-fired heaters shall not be used in any board and care occupancy.

32.3.6.3 Elevators, Dumbwaiters, and Vertical Conveyors.

32.3.6.3.1 Elevators, dumbwaiters, and vertical conveyors shall comply with Section 9.4.

32.3.6.3.2* In high-rise buildings, one elevator shall be provided with a protected power supply and shall be available for use by the fire department in case of emergency.

32.3.6.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with Section 9.5.

32.4* Suitability of an Apartment Building to House a Board and Care Occupancy.

32.4.1 General.

32.4.1.1 Scope.

32.4.1.1.1 Section 32.4 shall apply to apartment buildings that have one or more individual apartments used as a board and care occupancy. *(See 32.1.3.2.)*

32.4.1.1.2 The provisions of Section 32.4 shall be used to determine the suitability of apartment buildings, other than those complying with 32.4.1.1.4, to house a residential board and care facility.

32.4.1.1.3 The suitability of apartment buildings not used for board and care occupancies shall be determined in accordance with Chapter 30.

32.4.1.1.4 If a new board and care occupancy is created in an existing apartment building, the suitability of such a building for apartments not used for board and care occupancies shall be determined in accordance with Chapter 31.

32.4.1.2 Requirements for Individual Apartments. Requirements for individual apartments used as residential board and care occupancies shall be as specified in Section 32.2. Egress from the apartment into the common building corridor shall be considered acceptable egress from the board and care facility.

32.4.1.3* Additional Requirements. Apartment buildings housing board and care facilities shall comply with the requirements of Chapter 30 and the additional requirements of Section 32.4, unless the authority having jurisdiction has determined that equivalent safety for housing a residential board and care facility is provided in accordance with Section 1.4.

32.4.1.4 Minimum Construction Requirements.

32.4.1.4.1 In addition to the requirements of Chapter 30, apartment buildings, other than those complying with 32.4.1.4.2, housing residential board and care facilities shall meet the construction requirements of 32.3.1.3.

32.4.1.4.2 If a new board and care occupancy is created in an existing apartment building, the construction requirements of 19.1.6 shall apply.

32.4.2 Means of Egress.

32.4.2.1 The requirements of Section 30.2 shall apply only to the parts of means of egress serving the apartment(s) used as a residential board and care occupancy, as modified by 32.4.2.2.

32.4.2.2 If a new board and care occupancy is created in an existing apartment building, the requirements of Section 31.2 shall apply to the parts of the means of egress serving the apartment(s) used as a residential board and care occupancy.

32.4.3 Protection.

32.4.3.1 Interior Finish.

32.4.3.1.1 The requirements of 30.3.3 shall apply only to the parts of means of egress serving the apartment(s) used as a residential board and care occupancy, as modified by 32.4.3.1.2.

32.4.3.1.2 If a new board and care occupancy is created in an existing apartment building, the requirements of 31.3.3 shall apply to the parts of the means of egress serving the apartment(s) used as a residential board and care occupancy.

32.4.3.2 Construction of Corridor Walls.

32.4.3.2.1 The requirements of 30.3.6 shall apply only to corridors serving the residential board and care facility, including that portion of the corridor wall separating the residential board and care facility from the common corridor, as modified by 32.4.3.2.2.

32.4.3.2.2 If a new board and care occupancy is created in an existing apartment building, the requirements of 31.3.6 shall apply to the corridor serving the residential board and care facility.

32.4.3.3 Subdivision of Building Spaces. (Reserved)

32.5 Reserved.

32.6 Reserved.

32.7 Operating Features.

32.7.1 Emergency Action Plan.

32.7.1.1 The administration of every residential board and care facility shall have, in effect and available to all supervisory personnel, written copies of a plan for protecting all persons in the event of fire, for keeping persons in place, for evacuating persons to areas of refuge, and for evacuating persons from the building when necessary.

32.7.1.2 The emergency action plan shall include special staff response, including the fire protection procedures needed to ensure the safety of any resident, and shall be amended or revised whenever any resident with unusual needs is admitted to the home.

32.7.1.3 All employees shall be periodically instructed and kept informed with respect to their duties and responsibilities under the plan, and such instruction shall be reviewed by the staff not less than every 2 months.

32.7.1.4 A copy of the plan shall be readily available at all times within the facility.

32.7.2 Resident Training.

32.7.2.1 All residents participating in the emergency action plans shall be trained in the proper actions to be taken in the event of fire.

32.7.2.2 The training required by 32.7.2.1 shall include actions to be taken if the primary escape route is blocked.

32.7.2.3 If a resident is given rehabilitation or habilitation training, training in fire prevention and the actions to be taken in the event of a fire shall be a part of the training program.

32.7.2.4 Residents shall be trained to assist each other in case of fire to the extent that their physical and mental abilities permit them to do so without additional personal risk.

32.7.3 Emergency Egress and Relocation Drills. Emergency egress and relocation drills shall be conducted in accordance with 32.7.3.1 through 32.7.3.6.

32.7.3.1 Emergency egress and relocation drills shall be conducted not less than six times per year on a bimonthly basis, with not less than two drills conducted during the night when residents are sleeping, as modified by 32.7.3.5 and 32.7.3.6.

32.7.3.2 The emergency drills shall be permitted to be announced to the residents in advance.

32.7.3.3* The drills shall involve the actual evacuation of all residents to an assembly point, as specified in the emergency action plan, and shall provide residents with experience in egressing through all exits and means of escape required by the *Code*.

32.7.3.4 Exits and means of escape not used in any drill shall not be credited in meeting the requirements of this *Code* for board and care facilities.

32.7.3.5 Actual exiting from windows shall not be required to comply with 32.7.3; opening the window and signaling for help shall be an acceptable alternative.

32.7.3.6 Residents who cannot meaningfully assist in their own evacuation or who have special health problems shall not be required to actively participate in the drill. Section 18.7 shall apply in such instances.

32.7.4 Smoking.

32.7.4.1* Smoking regulations shall be adopted by the administration of board and care occupancies.

32.7.4.2 Where smoking is permitted, noncombustible safety-type ashtrays or receptacles shall be provided in convenient locations.

32.7.5* Furnishings, Mattresses, and Decorations.

32.7.5.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations shall comply with 32.7.5.1.1 and 32.7.5.1.2.

32.7.5.1.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations in board and care facilities shall be in accordance with the provisions of 10.3.1, unless otherwise permitted by 32.7.5.1.2.

32.7.5.1.2 In other than common areas, new draperies, curtains, and other similar loosely hanging furnishings and decorations shall not be required to comply with 32.7.5.1.1 where the building is protected throughout by an approved automatic sprinkler system installed in accordance with 32.2.3.5 for small facilities or 32.3.3.5 for large facilities.

32.7.5.2* New upholstered furniture within board and care facilities shall comply with 32.7.5.2.1 or 32.7.5.2.2.

32.7.5.2.1 New upholstered furniture shall be tested in accordance with the provisions of 10.3.2.1(1) and 10.3.3.

32.7.5.2.2 Upholstered furniture belonging to residents in sleeping rooms shall not be required to be tested, provided that a smoke alarm is installed in such rooms; battery-powered single-station smoke alarms shall be permitted in such rooms.

32.7.5.3* Newly introduced mattresses within board and care facilities shall comply with 32.7.5.3.1 or 32.7.5.3.2.

32.7.5.3.1 Newly introduced mattresses shall be tested in accordance with the provisions of 10.3.2.2 and 10.3.4.

32.7.5.3.2 Mattresses belonging to residents in sleeping rooms shall not be required to be tested, provided that a smoke alarm is installed in such rooms; battery-powered single-station smoke alarms shall be permitted in such rooms.

32.7.6 Staff. Staff shall be on duty and in the facility at all times when residents requiring evacuation assistance are present.

32.7.7 Inspection of Door Openings. Door assemblies for which the door leaf is required to swing in the direction of egress travel shall be inspected and tested not less than annually in accordance with 7.2.1.15.

Chapter 33 Existing Residential Board and Care Occupancies

33.1 General Requirements.

33.1.1* Application.

33.1.1.1 General. The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as residential board and care occupancies.

33.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

33.1.1.3 General. The provisions of Chapter 4, General, shall apply.

33.1.1.4* Chapter 32 Compliance. Any facility meeting the requirements of Chapter 32 shall not be required to meet those of Chapter 33.

33.1.1.5 Chapter Sections. This chapter is divided into five sections as follows:

(1) Section 33.1 — General Requirements
(2) Section 33.2 — Small Facilities (that is, sleeping accommodations for not more than 16 residents)
(3) Section 33.3 — Large Facilities (that is, sleeping accommodations for more than 16 residents)
(4) Section 33.4 — Suitability of an Apartment Building to House a Board and Care Occupancy *(Sections 33.5 and 33.6 are reserved.)*
(5) Section 33.7 — Operating Features

33.1.1.6 Conversion. For the purposes of this chapter, exceptions for conversions shall apply only for a change of occupancy from an existing residential or health care occupancy to a residential board and care occupancy.

33.1.2 Classification of Occupancy. See 6.1.9 and 33.1.3.

33.1.3 Multiple Occupancies.

33.1.3.1 Multiple occupancies shall comply with 6.1.14 in buildings other than those meeting the requirement of 33.1.3.2.

33.1.3.2 The requirement of 33.1.3.1 shall not apply to apartment buildings housing residential board and care occupancies in conformance with Section 33.4. In such facilities, any safeguards required by Section 33.4 that are more restrictive than those for other housed occupancies shall apply only to the extent prescribed by Section 33.4.

33.1.3.3 No board and care occupancy shall have its sole means of egress or means of escape pass through any nonresidential or non-health care occupancy in the same building.

33.1.3.4 No board and care occupancy shall be located above a nonresidential or non-health care occupancy, unless one of the following conditions is met:

(1) The board and care occupancy and exits therefrom are separated from the nonresidential or non-health care occupancy by construction having a minimum 2-hour fire resistance rating.

(2) The nonresidential or non-health care occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7 and is separated therefrom by construction having a minimum 1-hour fire resistance rating.

33.1.4 Definitions.

33.1.4.1 General. For definitions, see Chapter 3, Definitions.

33.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Evacuation Capability.** See 3.3.78.
(2) **Impractical Evacuation Capability.** See 3.3.78.1.
(3) **Personal Care.** See 3.3.208.
(4) **Point of Safety.** See 3.3.213.
(5) **Prompt Evacuation Capability.** See 3.3.78.2.
(6) **Residential Board and Care Occupancy.** See 3.3.190.12.
(7) **Residential Board and Care Resident.** See 3.3.233.
(8) **Slow Evacuation Capability.** See 3.3.78.3.
(9) **Staff (Residential Board and Care).** See 3.3.263.
(10) **Thermal Barrier.** See 3.3.31.3.

33.1.5 Acceptability of Means of Egress or Escape. No means of escape or means of egress shall be considered as complying with the minimum criteria for acceptance, unless emergency evacuation drills are regularly conducted using that route in accordance with the requirements of 33.7.3.

33.1.6* Fire Resistance–Rated Assemblies. Fire resistance–rated assemblies shall comply with Section 8.3.

33.1.7 Changes in Facility Size. A change in facility size from small to large shall be considered a change in occupancy subclassification and shall require compliance with the provisions applicable to new construction.

33.1.8* Changes in Group Evacuation Capability. A change in evacuation capability to a slower level shall be permitted where the facility conforms to one of the following requirements:

(1) The requirements of Chapter 32 applicable to new board and care facilities.
(2) The requirements of Chapter 33 applicable to existing board and care facilities for the new evacuation capability, provided that the building is protected throughout by an approved, supervised automatic sprinkler system complying with 32.3.3.5.

33.2 Small Facilities.

33.2.1 General.

33.2.1.1 Scope.

33.2.1.1.1 Section 33.2 shall apply to residential board and care occupancies providing sleeping accommodations for not more than 16 residents.

33.2.1.1.2 Where there are sleeping accommodations for more than 16 residents, the occupancy shall be classified as a large facility in accordance with Section 33.3.

33.2.1.2 Requirements Based on Evacuation Capability.

33.2.1.2.1 Small facilities, other than those meeting the requirement of 33.2.1.2.1.1 or 33.2.1.2.1.2, shall comply with the requirements of Section 33.2, as indicated for the appropriate evacuation capability; the ability of all occupants, residents, staff, and family members shall be considered in determining evacuation capability.

33.2.1.2.1.1* Facilities where the authority having jurisdiction has determined equivalent safety is provided in accordance with Section 1.4 shall not be required to comply with Section 33.2.

33.2.1.2.1.2 Facilities that were previously approved as complying with the requirements for a large facility having the same evacuation capability shall not be required to comply with Section 33.2.

33.2.1.2.2 Facility management shall furnish to the authority having jurisdiction, upon request, an evacuation capability determination using a procedure acceptable to the authority having jurisdiction; where such documentation is not furnished, the evacuation capability shall be classified as impractical.

33.2.1.3 Minimum Construction Requirements.

33.2.1.3.1 Prompt Evacuation Capability. (No special requirements.)

33.2.1.3.2 Slow Evacuation Capability.

33.2.1.3.2.1 The facility shall be housed in a building where the interior is fully sheathed with lath and plaster or other material providing a minimum 15-minute thermal barrier, as modified by 33.2.1.3.2.3 through 33.2.1.3.2.7, including all portions of bearing walls, bearing partitions, floor construction, and roofs.

33.2.1.3.2.2 All columns, beams, girders, and trusses shall be encased or otherwise protected with construction having a minimum ½-hour fire resistance rating.

33.2.1.3.2.3 Exposed steel or wood columns, girders, and beams (but not joists) located in the basement shall be permitted.

33.2.1.3.2.4 Buildings of Type I, Type II(222), Type II(111), Type III(211), Type IV, or Type V(111) construction shall not be required to meet the requirements of 33.2.1.3.2. *(See 8.2.1.)*

33.2.1.3.2.5 Areas protected by approved automatic sprinkler systems in accordance with 33.2.3.5 shall not be required to meet the requirements of 33.2.1.3.2.

33.2.1.3.2.6 Unfinished, unused, and essentially inaccessible loft, attic, or crawl spaces shall not be required to meet the requirements of 33.2.1.3.2.

33.2.1.3.2.7 Where the facility has demonstrated to the authority having jurisdiction that the group is capable of evacuating the building in 8 minutes or less, or where the group achieves an E-score of 3 or less using the board and care occupancies evacuation capability determination methodology of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, the requirements of 33.2.1.3.2 shall not apply.

33.2.1.3.3 Impractical Evacuation Capability. Nonsprinklered buildings shall be of any construction type in accordance with 8.2.1, other than Type II(000), Type III(200), or Type V(000) construction. Buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 33.2.3.5 shall be permitted to be of any type of construction.

33.2.1.4 Multiple-Level Buildings. For purposes of applying requirements of this chapter that utilize the term level of exit discharge, including determination of stories in height as addressed in 4.6.3, the level of exit discharge shall be permitted to be the combination of floor levels as addressed in 33.2.1.4.1, 33.2.1.4.2, or 33.2.1.4.3.

33.2.1.4.1 One floor level located not more than three stair risers above the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

33.2.1.4.2 One floor level located not more than three stair risers below the level of exit discharge shall be permitted to be considered part of the level of exit discharge.

33.2.1.4.3 Where one floor level is located above the level of exit discharge, another floor level is located below the level of exit discharge, and not more than a total of three stair risers separate the upper level from the lower level, the two floor levels shall be permitted to be considered part of the level of exit discharge.

33.2.1.4.4 The provisions of 33.2.1.4.1, 33.2.1.4.2, and 33.2.1.4.3 shall not be used in combination with each other.

33.2.2 Means of Escape. Designated means of escape shall be continuously maintained free of all obstructions or impediments to full instant use in the case of fire or emergency.

33.2.2.1 Number of Means of Escape.

33.2.2.1.1 Each normally occupied story of the facility shall have not less than two remotely located means of escape that do not involve using windows, unless the facility meets the requirement of 33.2.2.1.4 or 33.2.2.1.5.

33.2.2.1.2 Not less than one of the means of escape required by 33.2.2.1.1 shall be in accordance with 33.2.2.2.

33.2.2.1.3 The provisions of Chapter 7 shall not apply to means of escape, unless specifically referenced in this chapter.

33.2.2.1.4 In prompt evacuation capability facilities, one means of escape shall be permitted to involve windows complying with 33.2.2.3.1(3).

33.2.2.1.5 A second means of escape from each story shall not be required where the entire building is protected throughout by an approved automatic sprinkler system complying with 33.2.3.5 and the facility has two means of escape; this provision shall not be permitted to be used in conjunction with 33.2.2.3.3.

33.2.2.2 Primary Means of Escape.

33.2.2.2.1 Every sleeping room and living area shall have access to a primary means of escape located to provide a safe path of travel to the outside at street level or the finished ground level.

33.2.2.2.2 Where sleeping rooms or living areas are above or below the level of exit discharge, the primary means of escape shall be an interior stair in accordance with 33.2.2.4, an exterior stair, a horizontal exit, or a fire escape stair.

33.2.2.2.3 In slow and impractical evacuation capability facilities, the primary means of escape for each sleeping room shall not be exposed to living areas and kitchens, unless the building is protected by an approved automatic sprinkler system in accordance with 33.2.3.5 utilizing quick-response or residential sprinklers throughout.

33.2.2.2.4 Standard-response sprinklers shall be permitted for use in hazardous areas in accordance with 33.2.3.2.

33.2.2.3 Secondary Means of Escape.

33.2.2.3.1 In addition to the primary route, each sleeping room shall have a second means of escape consisting of one of the following, unless the provisions of 33.2.2.3.2, 33.2.2.3.3, or 33.2.2.3.4 are met:

(1) Door, stairway, passage, or hall providing a way of unobstructed travel to the outside of the dwelling at street or the finished ground level that is independent of, and remotely located from, the primary means of escape
(2) Passage through an adjacent nonlockable space independent of, and remotely located from, the primary means of escape to any approved means of escape
(3)*Outside window or door operable from the inside, without the use of tools, keys, or special effort, that provides a clear opening of not less than 5.7 ft^2 (0.53 m^2), with the width not less than 20 in. (510 mm), the height not less than 24 in. (610 mm), and the bottom of the opening not more than 44 in. (1120 mm) above the floor, with such means of escape acceptable, provided that one of the following criteria is met:
   (a) The window is within 20 ft (6100 mm) of the finished ground level.
   (b) The window is directly accessible to fire department rescue apparatus, as approved by the authority having jurisdiction.
   (c) The window or door opens onto an exterior balcony.
(4) Windows having a sill height below the adjacent finished ground level that are provided with a window well meeting the following criteria:
   (a) The window well has horizontal dimensions that allow the window to be fully opened.
   (b) The window well has an accessible net clear opening of not less than 9 ft^2 (0.84 m^2), with a length and width of not less than 36 in. (915 mm).
   (c) A window well with a vertical depth of more than 44 in. (1120 mm) is equipped with an approved permanently affixed ladder or with steps meeting the following criteria:
      i. The ladder or steps do not encroach more than 6 in. (150 mm) into the required dimensions of the window well.
      ii. The ladder or steps are not obstructed by the window.

33.2.2.3.2 Sleeping rooms that have a door leading directly to the outside of the building with access to the finished ground level or to a stairway that meets the requirements of exterior stairs in 33.2.2.2.2 shall be considered as meeting all the requirements for a second means of escape.

33.2.2.3.3 A second means of escape from each sleeping room shall not be required where the facility is protected throughout by an approved automatic sprinkler system in accordance with 33.2.3.5.

33.2.2.3.4 Existing approved means of escape shall be permitted to continue to be used.

33.2.2.4 Interior Stairs Used for Primary Means of Escape. Interior stairs used for primary means of escape shall comply with 33.2.2.4.1 through 33.2.2.4.9.

33.2.2.4.1 Interior stairs shall be enclosed with fire barriers in accordance with Section 8.3 having a minimum ½-hour fire resistance rating and shall comply with 7.2.2.5.3.

33.2.2.4.2 Reserved.

33.2.2.4.3 The entire primary means of escape shall be arranged so that it is not necessary for occupants to pass through a portion of a lower story, unless that route is separated from all spaces on that story by construction having a minimum ½-hour fire resistance rating.

33.2.2.4.4 In buildings of construction other than Type II(000), Type III(200), or Type V(000), the supporting construction shall be protected to afford the required fire resistance rating of the supported wall.

33.2.2.4.5 Stairs that connect a story at street level to only one other story shall be permitted to be open to the story that is not at street level.

33.2.2.4.6 Stair enclosures shall not be required in buildings three or fewer stories in height that house prompt or slow evacuation capability facilities, provided that both of the following criteria are met:

(1) The building is protected by an approved automatic sprinkler system in accordance with 33.2.3.5 that uses quick-response or residential sprinklers.
(2) A primary means of escape from each sleeping area exists that does not pass through a portion of a lower floor, unless that route is separated from all spaces on that floor by construction having a minimum ½-hour fire resistance rating.

33.2.2.4.7 Stair enclosures shall not be required in buildings that are two or fewer stories in height, that house prompt evacuation capability facilities with not more than eight residents, and that are protected by an approved automatic sprinkler system in accordance with 33.2.3.5 that uses quick-response or residential sprinklers.

33.2.2.4.8 The provisions of 33.2.2.3.3, 33.2.3.4.3.6, or 33.2.3.4.3.7 shall not be used in conjunction with 33.2.2.4.7.

33.2.2.4.9 Stairs shall be permitted to be open at the topmost story only where all of the following criteria are met:

(1) The building is three or fewer stories in height.
(2) The building houses prompt or slow evacuation capability facilities.
(3) The building is protected by an approved automatic sprinkler system in accordance with 33.2.3.5.
(4) The entire primary means of escape of which the stairs are a part is separated from all portions of lower stories.

33.2.2.5 Doors.

33.2.2.5.1 Doors, other than bathroom doors addressed in 33.2.2.5.1.1, and paths of travel to a means of escape shall be not less than 28 in. (710 mm) wide.

33.2.2.5.1.1 Bathroom doors shall be not less than 24 in. (610 mm) wide.

33.2.2.5.1.2 Reserved.

33.2.2.5.2 Doors shall be swinging or sliding.

33.2.2.5.3 Every closet door latch shall be readily opened from the inside.

33.2.2.5.4 Every bathroom door shall be designed to allow opening from the outside during an emergency when locked.

33.2.2.5.5 No door in any means of escape, other than those meeting the requirement of 33.2.2.5.5.1, 33.2.2.5.5.2, or 33.2.2.5.5.3, shall be locked against egress when the building is occupied.

33.2.2.5.5.1 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted on exterior doors only.

33.2.2.5.5.2 Access-controlled egress door assemblies complying with 7.2.1.6.2 shall be permitted.

33.2.2.5.5.3 Door-locking arrangements shall be permitted where the clinical needs of residents require specialized security measures or where residents pose a security threat, provided all of the following conditions are met:

(1) Staff can readily unlock doors at all times in accordance with 33.2.2.5.5.4
(2) The building is protected by an approved automatic sprinkler system in accordance with 33.2.3.5

33.2.2.5.5.4 Doors that are located in the means of egress and are permitted to be locked in accordance with 33.2.2.5.5.3 shall comply with all of the following:

(1) Provisions shall be made for the rapid removal of occupants by means of one of the following:
    (a) Remote control of locks from within the locked building
    (b) Keying of all locks to keys carried by staff at all times
    (c) Other such reliable means available to staff at all times
(2) Only one locking device shall be permitted on each door.

33.2.2.5.6 Forces to open doors shall comply with 7.2.1.4.5.

33.2.2.5.7 Door-latching devices shall comply with 7.2.1.5.10.

33.2.2.6 Stairs.

33.2.2.6.1 Stairs shall comply with 7.2.2, unless otherwise specified in this chapter.

33.2.2.6.2 Winders complying with 7.2.2.2.4 shall be permitted.

33.2.2.6.3* Exterior stairs shall be protected against blockage caused by fire within the building.

33.2.3 Protection.

33.2.3.1 Protection of Vertical Openings.

33.2.3.1.1 Vertical openings, other than stairs complying with 33.2.2.4.5, 33.2.2.4.6, or 33.2.2.4.7, shall be protected so as not to expose a primary means of escape.

33.2.3.1.2 Vertical openings required to be protected by 33.2.3.1.1 shall be considered protected where separated by smoke partitions in accordance with Section 8.4 that resist the passage of smoke from one story to any primary means of escape on another story.

33.2.3.1.3 Smoke partitions used to protect vertical openings shall have a minimum ½-hour fire resistance rating.

33.2.3.1.4 Any doors or openings to the protected vertical opening shall be capable of resisting fire for a minimum of 20 minutes.

33.2.3.2 Hazardous Areas.

33.2.3.2.1 Any space where there is storage or activity having fuel conditions exceeding those of a one- or two-family dwelling and that possesses the potential for a fully involved fire shall be protected in accordance with 33.2.3.2.4 and 33.2.3.2.5.

33.2.3.2.2 Spaces requiring protection in accordance with 33.2.3.2.1 shall include, but shall not be limited to, areas for cartoned storage, food or household maintenance items in wholesale or institutional-type quantities and concentrations, or mass storage of residents' belongings.

33.2.3.2.3 Areas containing approved, properly installed and maintained furnaces and heating equipment; furnace rooms; and cooking and laundry facilities shall not be classified as hazardous areas solely on the basis of such equipment.

33.2.3.2.4 Any hazardous area that is on the same floor as, and is in or abuts, a primary means of escape or a sleeping room shall be protected by one of the following means:

(1) Protection shall be an enclosure having a minimum 1-hour fire resistance rating, with self-closing or automatic-closing fire doors in accordance with 7.2.1.8 having a minimum ¾-hour fire protection rating.
(2) Protection shall be automatic sprinkler protection, in accordance with 33.2.3.5, and a smoke partition, in accordance with Section 8.4, located between the hazardous area and the sleeping area or primary escape route, with any doors in such separation self-closing or automatic-closing in accordance with 7.2.1.8.

33.2.3.2.5 Other hazardous areas shall be protected by one of the following:

(1) Enclosure having a minimum ½-hour fire resistance rating, with self-closing or automatic-closing doors in accordance with 7.2.1.8 equivalent to minimum 1¾ in. (44 mm) thick, solid-bonded wood-core construction
(2) Automatic sprinkler protection in accordance with 33.2.3.5, regardless of enclosure

33.2.3.3 Interior Finish.

33.2.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

33.2.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be as follows:

(1) Class A or Class B in facilities other than those having prompt evacuation capability
(2) Class A, Class B, or Class C in facilities having prompt evacuation capability

33.2.3.3.3 Interior Floor Finish. (No requirements.)

33.2.3.4 Detection, Alarm, and Communications Systems.

33.2.3.4.1 Fire Alarm Systems. A manual fire alarm system shall be provided in accordance with Section 9.6, unless the provisions of 33.2.3.4.1.1 or 33.2.3.4.1.2 are met.

33.2.3.4.1.1 A fire alarm system shall not be required where interconnected smoke alarms complying with 33.2.3.4.3 and not less than one manual fire alarm box per floor arranged to continuously sound the smoke detector alarms are provided.

33.2.3.4.1.2 Other manually activated continuously sounding alarms acceptable to the authority having jurisdiction shall be permitted in lieu of a fire alarm system.

33.2.3.4.2 Occupant Notification. Occupant notification shall be in accordance with 9.6.3.

33.2.3.4.3* Smoke Alarms.

33.2.3.4.3.1 Approved smoke alarms shall be provided in accordance with 9.6.2.10, unless otherwise indicated in 33.2.3.4.3.6 and 33.2.3.4.3.7.

33.2.3.4.3.2 Smoke alarms shall be installed on all levels, including basements but excluding crawl spaces and unfinished attics.

33.2.3.4.3.3 Additional smoke alarms shall be installed for living rooms, dens, day rooms, and similar spaces.

33.2.3.4.3.4 Reserved.

33.2.3.4.3.5 Smoke alarms shall be powered from the building electrical system and, when activated, shall initiate an alarm that is audible in all sleeping areas.

33.2.3.4.3.6 Smoke alarms in accordance with 33.2.3.4.3.1 shall not be required where buildings are protected throughout by an approved automatic sprinkler system, in accordance with 33.2.3.5, that uses quick-response or residential sprinklers, and are protected with approved smoke alarms installed in each sleeping room, in accordance with 9.6.2.10, that are powered by the building electrical system.

33.2.3.4.3.7 Smoke alarms in accordance with 33.2.3.4.3.1 shall not be required where buildings are protected throughout by an approved automatic sprinkler system, in accordance with 33.2.3.5, that uses quick-response or residential sprinklers, with existing battery-powered smoke alarms in each sleeping room, and where, in the opinion of the authority having jurisdiction, the facility has demonstrated that testing, maintenance, and a battery replacement program ensure the reliability of power to the smoke alarms.

33.2.3.5* Extinguishment Requirements.

33.2.3.5.1 Reserved.

33.2.3.5.2 Reserved.

33.2.3.5.3 Where an automatic sprinkler system is installed, for either total or partial building coverage, all of the following requirements shall be met:

(1) The system shall be in accordance with Section 9.7 and shall initiate the fire alarm system in accordance with 33.2.3.4.1, as modified by 33.2.3.5.3.1 through 33.2.3.5.3.6.
(2) The adequacy of the water supply shall be documented to the authority having jurisdiction.

33.2.3.5.3.1* In prompt evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall be permitted.
(2) Automatic sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

33.2.3.5.3.2 In slow and impractical evacuation capability facilities, all of the following shall apply:

(1) An automatic sprinkler system in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, with a 30-minute water supply, shall be permitted.
(2) All habitable areas and closets shall be sprinklered.
(3) Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

33.2.3.5.3.3 In prompt and slow evacuation capability facilities, where an automatic sprinkler system is in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

33.2.3.5.3.4 In prompt and slow evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

33.2.3.5.3.5 In impractical evacuation capability facilities in buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted. All habitable areas and closets shall be sprinklered. Automatic sprinklers shall not be required in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with lath and plaster or materials providing a 15-minute thermal barrier.

33.2.3.5.3.6 Initiation of the fire alarm system shall not be required for existing installations in accordance with 33.2.3.5.6.

33.2.3.5.3.7 All impractical evacuation capability facilities shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 33.2.3.5.3.

33.2.3.5.4 Reserved.

33.2.3.5.5 Reserved.

33.2.3.5.6 Sprinkler piping serving not more than six sprinklers for any isolated hazardous area shall be permitted to be installed in accordance with 9.7.1.2 and shall meet all of the following requirements:

(1) In new installations, where more than two sprinklers are installed in a single area, waterflow detection shall be provided to initiate the fire alarm system required by 33.2.3.4.1.
(2) The duration of water supplies shall be as required for the sprinkler systems addressed in 33.2.3.5.3.

33.2.3.5.7 Attics shall be protected in accordance with 33.2.3.5.7.1 or 33.2.3.5.7.2.

33.2.3.5.7.1 Where an automatic sprinkler system is installed, attics used for living purposes, storage, or fuel-fired equipment shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 9.7.1.1.

33.2.3.5.7.2 Where an automatic sprinkler system is installed, attics not used for living purposes, storage, or fuel-fired equipment shall meet one of the following criteria:

(1) Attics shall be protected throughout by a heat detection system arranged to activate the building fire alarm system in accordance with Section 9.6.
(2) Attics shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 9.7.1.1.
(3) Attics shall be of noncombustible or limited-combustible construction.
(4) Attics shall be constructed of fire-retardant-treated wood in accordance with NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials.*
(5) Attics shall be protected by heat alarms arranged to provide occupant notification in accordance with 33.2.3.4.2.

33.2.3.5.8 Systems installed in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, shall be inspected, tested, and maintained in accordance with 33.2.3.5.8.1 through 33.2.3.5.8.15, which reference specific sections of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.* The frequency of the inspection, test, or maintenance shall be in accordance with this *Code*, whereas the purpose and procedure shall be from NFPA 25.

33.2.3.5.8.1 Control valves shall be inspected monthly in accordance with 13.3.2 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.2 Gages shall be inspected monthly in accordance with 13.2.7.1 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.3 Alarm devices shall be inspected quarterly in accordance with 5.2.6 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.4 Alarm devices shall be tested semiannually in accordance with 5.3.3 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.5 Valve supervisory switches shall be tested semiannually in accordance with 13.3.3.5 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.6 Visible sprinklers shall be inspected annually in accordance with 5.2.1 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.7 Visible pipe shall be inspected annually in accordance with 5.2.2 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.8 Visible pipe hangers shall be inspected annually in accordance with 5.2.3 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.9 Buildings shall be inspected annually prior to the onset of freezing weather to ensure that there is adequate heat wherever water-filled piping is run in accordance with 5.2.5 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.10 A representative sample of fast-response sprinklers shall be tested once the sprinklers in the system are 20 years old in accordance with 5.3.1.1.1.2 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.* If the sample fails the test, all of the sprinklers represented by that sample shall be replaced. If the sprinklers pass the test, the test shall be repeated every 10 years thereafter.

33.2.3.5.8.11 A representative sample of dry-pendent sprinklers shall be tested once the sprinklers in the system are 10 years old in accordance with 5.3.1.1.1.5 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.* If the sample fails the test, all of the sprinklers represented by that sample shall be replaced. If the sprinklers pass the test, the test shall be repeated every 10 years thereafter.

33.2.3.5.8.12 Antifreeze solutions shall be tested annually in accordance with 5.3.4 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.13 Control valves shall be operated through their full range and returned to normal annually in accordance with 13.3.3.1 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.14 Operating stems of OS&Y valves shall be lubricated annually in accordance with 13.3.4 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.5.8.15 Dry-pipe systems that extend into the unheated portions of the building shall be inspected, tested, and maintained in accordance with 13.4.4 of NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

33.2.3.6 Construction of Corridor Walls.

33.2.3.6.1 Unless otherwise indicated in 33.2.3.6.1.1 through 33.2.3.6.1.4, corridor walls shall meet all of the following requirements:

(1) Walls separating sleeping rooms from corridors and areas open to the corridor shall have a minimum ½-hour fire resistance rating. The minimum ½-hour fire resistance rating shall be considered to be achieved if the partitioning is finished on both sides with lath and plaster or materials providing a 15-minute thermal barrier.
(2) Sleeping room doors shall be substantial doors, such as those of 1¾ in. (44 mm) thick, solid-bonded wood-core construction or of other construction of equal or greater stability and fire integrity.
(3) Any vision panels shall be fixed fire window assemblies in accordance with 8.3.4 or shall be wired glass not exceeding 9 ft^2 (0.84 m^2) each in area and installed in approved frames.

33.2.3.6.1.1 In prompt evacuation capability facilities, all sleeping rooms shall be separated from the escape route by smoke partitions in accordance with Section 8.4, and door closing shall be regulated by 33.2.3.6.4.

33.2.3.6.1.2 The requirement of 33.2.3.6.1 shall not apply to corridor walls that are smoke partitions in accordance with Section 8.4 and that are protected by automatic sprinklers in accordance with 33.2.3.5 on both sides of the wall and door, and all of the following shall also apply:

(1) In such instances, there shall be no limitation on the type or size of glass panels.
(2) Door closing shall comply with 33.2.3.6.4.

33.2.3.6.1.3 Sleeping arrangements that are not located in sleeping rooms shall be permitted for nonresident staff members, provided that the audibility of the alarm in the sleeping area is sufficient to awaken staff who might be sleeping.

33.2.3.6.1.4 In previously approved facilities, where the facility has demonstrated to the authority having jurisdiction that the group is capable of evacuating the building in 8 minutes or less, or where the group achieves an E-score of 3 or less using the board and care occupancies evacuation capability determination methodology of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, sleeping rooms shall be separated from escape routes by walls and doors that are smoke resistant.

33.2.3.6.2 Reserved.

33.2.3.6.3 No louvers, operable transoms, or other air passages shall penetrate the wall, except properly installed heating and utility installations other than transfer grilles, which shall be prohibited.

33.2.3.6.4 Doors shall meet all of the following requirements:

(1) Doors shall be provided with latches or other mechanisms suitable for keeping the doors closed.
(2) No doors shall be arranged to prevent the occupant from closing the door.
(3) Doors shall be self-closing or automatic-closing in accordance with 7.2.1.8 in buildings other than those protected throughout by an approved automatic sprinkler system in accordance with 33.2.3.5.3.

33.2.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

33.2.5 Building Services.

33.2.5.1 Utilities. Utilities shall comply with Section 9.1.

33.2.5.2 Heating, Ventilating, and Air-Conditioning.

33.2.5.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of 9.2.1 and 9.2.2, except as otherwise required in this chapter.

33.2.5.2.2 No stove or combustion heater shall be located to block escape in case of fire caused by the malfunction of the stove or heater.

33.2.5.2.3 Unvented fuel-fired heaters shall not be used in any residential board and care facility.

33.3 Large Facilities.

33.3.1 General.

33.3.1.1 Scope.

33.3.1.1.1 Section 33.3 shall apply to residential board and care occupancies providing sleeping accommodations for more than 16 residents.

33.3.1.1.2 Facilities having sleeping accommodations for not more than 16 residents shall be evaluated in accordance with Section 33.2.

33.3.1.1.3 Facilities meeting the requirements of Section 33.3 shall be considered to have met the requirements of Section 33.2 for the appropriate evacuation capability classification, except as amended in Section 33.3.

33.3.1.2 Requirements Based on Evacuation Capability.

33.3.1.2.1 Prompt and Slow. Large facilities classified as prompt or slow evacuation capability, other than those meeting the requirement of 33.3.1.2.1.1 or 33.3.1.2.1.2, shall comply with the requirements of Section 33.3, as indicated for the appropriate evacuation capability.

33.3.1.2.1.1* Facilities where the authority having jurisdiction has determined equivalent safety is provided in accordance with Section 1.4 shall not be required to comply with the requirements of Section 33.3, as indicated for the appropriate evacuation capability.

33.3.1.2.1.2 Facilities that were previously approved as complying with 33.3.1.2.2 shall not be required to comply with the requirements of Section 33.3, as indicated for the appropriate evacuation capability.

33.3.1.2.2 Impractical. Large facilities classified as impractical evacuation capability shall meet the requirements of Section 33.3 for impractical evacuation capability, or the requirements for limited care facilities in Chapter 19, unless the authority having jurisdiction has determined equivalent safety is provided in accordance with Section 1.4.

33.3.1.2.3 Evacuation Capability Determination.

33.3.1.2.3.1 Facility management shall furnish to the authority having jurisdiction, upon request, an evacuation capability determination using a procedure acceptable to the authority having jurisdiction.

33.3.1.2.3.2 Where the documentation required by 33.3.1.2.3.1 is not furnished, the evacuation capability shall be classified as impractical.

33.3.1.3 Minimum Construction Requirements. Large facilities shall be limited to the building construction types specified in Table 33.3.1.3. *(See 8.2.1.)*

33.3.1.4 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

33.3.2 Means of Egress.

33.3.2.1 General.

33.3.2.1.1 Means of egress from resident rooms and resident dwelling units to the outside of the building shall be in accordance with Chapter 7 and this chapter.

33.3.2.1.2 Means of escape within the resident room or resident dwelling unit shall comply with Section 24.2 for one- and two-family dwellings.

33.3.2.2 Means of Egress Components.

33.3.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 33.3.2.2.2 through 33.3.2.2.10.

33.3.2.2.2 Doors. Doors in means of egress shall be as follows:

(1) Doors complying with 7.2.1 shall be permitted.
(2) Doors within individual rooms and suites of rooms shall be permitted to be swinging or sliding.
(3) No door in any means of egress, other than those meeting the requirement of 33.3.2.2.2(4), 33.3.2.2.2(5), or 33.3.2.2.2(6), shall be locked against egress when the building is occupied.
(4) Delayed-egress locks in accordance with 7.2.1.6.1 shall be permitted.
(5) Access-controlled egress door assemblies in accordance with 7.2.1.6.2 shall be permitted.
(6) Door-locking arrangements shall be permitted where the clinical needs of residents require specialized security measures or where residents pose a security threat, provided both of the following conditions are met:
    (a) Staff can readily unlock doors at all times in accordance with 33.3.2.2.2(7).
    (b) The building is protected by an approved automatic sprinkler system in accordance with 33.3.3.5.
(7) Doors located in the means of egress that are permitted to be locked under other provisions of Chapter 33, other than those meeting the requirement of 33.3.2.2.2(4) or 33.3.2.2.2(5), shall have adequate provisions made for the rapid removal of occupants by means such as remote control of locks, keying of all locks to keys carried by staff at all times, or other such reliable means available to staff at all times.
(8) Only one such locking device, as described in 33.3.2.2.2(7), shall be permitted on each door.
(9) Revolving doors complying with 7.2.1.10 shall be permitted.

33.3.2.2.3 Stairs. Stairs complying with 7.2.2 shall be permitted.

33.3.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

33.3.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

33.3.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

33.3.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

33.3.2.2.8 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

33.3.2.2.9 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

33.3.2.2.10 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

33.3.2.3 Capacity of Means of Egress.

33.3.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

33.3.2.3.2 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging onto the street floor.

33.3.2.3.3 The width of corridors serving an occupant load of 50 or more in facilities having prompt or slow evacuation capability, and all facilities having impractical evacuation capability, shall be sufficient for the occupant load served but shall be not less than 44 in. (1120 mm).

33.3.2.3.4 The width of corridors serving an occupant load of less than 50 in facilities having prompt or slow evacuation capability shall be not less than 36 in. (915 mm).

33.3.2.4 Number of Means of Egress.

33.3.2.4.1 Means of egress shall comply with the following, except as otherwise permitted by 33.3.2.4.2:

(1) The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

33.3.2.4.2 Exit access, as required by 33.3.2.4.1(3), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 33.3.2.5.2 and 33.3.2.5.3.

33.3.2.5 Arrangement of Means of Egress.

33.3.2.5.1 Access to all required exits shall be in accordance with Section 7.5 unless otherwise modified by this chapter.

33.3.2.5.2 Common paths of travel shall not exceed 110 ft (33.5 m) in buildings not protected throughout by an automatic sprinkler system in accordance with 33.3.3.5.

33.3.2.5.3 In buildings protected throughout by automatic sprinkler systems in accordance with 33.3.3.5, common paths of travel shall not exceed 160 ft (48.8 m).

33.3.2.5.4 Dead-end corridors shall not exceed 50 ft (15 m).

33.3.2.6 Travel Distance to Exits.

33.3.2.6.1 Travel distance within a room, suite, or living unit to a corridor door shall not exceed 75 ft (23 m) in buildings not protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5.

Table 33.3.1.3 Construction Type Limitations

Construction Type	Sprinklered[a]	Stories in Height[b]						
		1[c]	2	3	4	5	6	>6
I (442)[d, e]	Yes	X	X	X	X	X	X	X
	No	X	X	X	X	X	X	X
I (332)[d, e]	Yes	X	X	X	X	X	X	X
	No	X	X	X	X	X	X	X
II (222)[d, e]	Yes	X	X	X	X	X	X	X
	No	X	X	X	X	X	X	X
II (111)[d, e]	Yes	X	X	X	X	X	X	X
	No	X	X	X	X	X	X	NP
II (000)	Yes	X	X	X2	X2	X2	X2	NP
	No	X1	X1	NP	NP	NP	NP	NP
III (211)	Yes	X	X	X	X	X	X	X
	No	X	X	X	X	X	X	NP
III (200)	Yes	X	X	X2	X2	X2	X2	NP
	No	X1	X1	NP	NP	NP	NP	NP
IV (2HH)	Yes	X	X	X	X	X	X	X
	No	X	X	NP	NP	NP	NP	NP
V (111)	Yes	X	X	X2	X2	X2	X2	NP
	No	X	X	NP	NP	NP	NP	NP
V (000)	Yes	X	X	X2	X2	NP	NP	NP
	No	X1	X1	NP	NP	NP	NP	NP

NP: Not permitted.
X: Permitted.
X1: Permitted if the interior walls are covered with lath and plaster or materials providing a 15-minute thermal barrier.
X2: Permitted if the interior walls are covered with lath and plaster or materials providing a 15-minute thermal barrier, and protected throughout by an approved automatic sprinkler system installed in accordance with 33.3.3.5.
[a]Building protected throughout by an approved, supervised automatic sprinkler system installed in accordance with Section 9.7. (*See 33.3.3.5.*)
[b]See 4.6.3.
[c]One-story prompt evacuation capability facilities having 30 or fewer residents, with egress directly to the exterior at the finished ground level, are permitted to be of any construction type.
[d]Any building of Type I, Type II(222), or Type II(111) construction is permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:
(1) The roof covering meets Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.
(2) The roof is separated from all occupied portions of the building by a noncombustible floor assembly having not less than a 2-hour fire resistance rating that includes not less than 2½ in. (63 mm) of concrete or gypsum fill, and the attic or other space so developed is either unused or protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5.1.
[e]Any building of Type I, Type II(222), or Type II(111) construction is permitted to include roofing systems involving combustible supports, decking, or roofing, provided that all of the following criteria are met:
(1) The roof covering meets Class A requirements in accordance with ASTM E 108, *Standard Test Methods for Fire Tests of Roof Coverings*, or ANSI/UL 790, *Test Methods for Fire Tests of Roof Coverings*.
(2) The roof/ceiling assembly is constructed with fire-retardant-treated wood meeting the requirements of NFPA 220, *Standard on Types of Building Construction*.
(3) The roof/ceiling assembly has the required fire resistance rating for the type of construction.

33.3.2.6.2 Travel distance within a room, suite, or living unit to a corridor door shall not exceed 125 ft (38 m) in buildings protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5.

33.3.2.6.3 Travel distance from the corridor door of any room to the nearest exit shall be in accordance with 33.3.2.6.3.1, 33.3.2.6.3.2, or 33.3.2.6.3.3.

33.3.2.6.3.1 Travel distance from the corridor door of any room to the nearest exit, measured in accordance with Section 7.6, shall not exceed 100 ft (30 m).

33.3.2.6.3.2 Travel distance to exits shall not exceed 200 ft (61 m) for exterior ways of exit access arranged in accordance with 7.5.3.

33.3.2.6.3.3 Travel distance to exits shall not exceed 200 ft (61 m) if the exit access and any portion of the building that is tributary to the exit access are protected throughout by approved automatic sprinkler systems in accordance with 33.3.3.5. In addition, the portion of the building in which 200 ft (61 m) travel distance is permitted shall be separated from the remainder of the building by construction having a minimum 1-hour fire resistance rating, for buildings three or fewer stories in height, and a minimum 2-hour fire resistance rating for buildings four or more stories in height.

33.3.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

33.3.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

33.3.2.9 Emergency Lighting. Emergency lighting in accordance with Section 7.9 shall be provided in all facilities meeting any of the following criteria:

(1) Facilities having an impractical evacuation capability
(2) Facilities having a prompt or slow evacuation capability with more than 25 sleeping rooms, unless each sleeping room has a direct exit to the outside of the building at the finished ground level.

33.3.2.10 Marking of Means of Egress. Means of egress shall be marked in accordance with Section 7.10.

33.3.2.11 Special Means of Egress Features.

33.3.2.11.1 Reserved.

33.3.2.11.2 Lockups. Lockups in residential board and care occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

33.3.3 Protection.

33.3.3.1 Protection of Vertical Openings.

33.3.3.1.1 Vertical openings shall comply with 33.3.3.1.1.1, 33.3.3.1.1.2, or 33.3.3.1.1.3.

33.3.3.1.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6.

33.3.3.1.1.2 Unprotected vertical openings not part of required egress shall be permitted by the authority having jurisdiction where such openings do not endanger required means of egress, provided that the building is protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5, and the exits and required ways of travel thereto are adequately safeguarded against fire and smoke within the building, or where every individual room has direct access to an exterior exit without passing through a public corridor.

33.3.3.1.1.3 In buildings two or fewer stories in height, unprotected vertical openings shall be permitted by the authority having jurisdiction, provided that the building is protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5.

33.3.3.1.2 Reserved.

33.3.3.1.3 No floor below the level of exit discharge and used only for storage, heating equipment, or purposes other than residential occupancy shall have unprotected openings to floors used for residential occupancy.

33.3.3.2 Protection from Hazards.

33.3.3.2.1 In other than buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), rooms containing high-pressure boilers, refrigerating machinery, transformers, or other service equipment subject to possible explosion shall not be located directly under or adjacent to exits, and such rooms shall be effectively separated from other parts of the building as specified in Section 8.7.

33.3.3.2.2 Hazardous areas, which shall include, but shall not be limited to, the following, shall be separated from other parts of the building by construction having a minimum 1-hour fire resistance rating, with communicating openings protected by approved self-closing fire doors, or such areas shall be equipped with automatic fire-extinguishing systems:

(1) Boiler and heater rooms
(2) Laundries
(3) Repair shops
(4) Rooms or spaces used for storage of combustible supplies and equipment in quantities deemed hazardous by the authority having jurisdiction

33.3.3.2.3 In facilities having impractical evacuation capability, hazardous areas shall be separated from other parts of the building by smoke partitions in accordance with Section 8.4.

33.3.3.3 Interior Finish.

33.3.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

33.3.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B.

33.3.3.3.3 Interior Floor Finish. Interior floor finish, other than approved existing floor coverings, shall be Class I or Class II in corridors or exits.

33.3.3.4 Detection, Alarm, and Communications Systems.

33.3.3.4.1 General. A fire alarm system in accordance with Section 9.6 shall be provided, unless all of the following conditions are met:

(1) The facility has an evacuation capability of prompt or slow.
(2) Each sleeping room has exterior exit access in accordance with 7.5.3.
(3) The building does not exceed three stories in height.

33.3.3.4.2 Initiation. The required fire alarm system shall be initiated by each of the following means:

(1) Manual means in accordance with 9.6.2, unless there are other effective means (such as a complete automatic sprinkler or detection system) for notification of fire as required
(2) Manual fire alarm box located at a convenient central control point under continuous supervision of responsible employees
(3) Automatic sprinkler system, other than that not required by another section of this *Code*
(4) Required detection system, other than sleeping room smoke alarms

33.3.3.4.3 Reserved.

33.3.3.4.4 Occupant Notification. Occupant notification shall be provided automatically, without delay, by internal audible alarm in accordance with 9.6.3.

33.3.3.4.5 Reserved.

33.3.3.4.6 Emergency Forces Notification.

33.3.3.4.6.1* Where the existing fire alarm system does not provide for automatic emergency forces notification in accordance with 9.6.4, provisions shall be made for the immediate notification of the public fire department by either telephone or other means, or, where there is no public fire department, notification shall be made to the private fire brigade.

33.3.3.4.6.2 Where a new fire alarm system is installed, or the existing fire alarm system is replaced, emergency forces notification shall be provided in accordance with 9.6.4.

33.3.3.4.7 Smoke Alarms. Smoke alarms shall be provided in accordance with 33.3.3.4.7.1, 33.3.3.4.7.2, or 33.3.3.4.7.3.

33.3.3.4.7.1 Each sleeping room shall be provided with an approved smoke alarm in accordance with 9.6.2.10 that is powered from the building electrical system.

33.3.3.4.7.2 Existing battery-powered smoke alarms, rather than building electrical service–powered smoke alarms, shall be accepted where, in the opinion of the authority having jurisdiction, the facility has demonstrated that testing, maintenance, and battery replacement programs ensure the reliability of power to the smoke alarms.

33.3.3.4.7.3 Sleeping room smoke alarms shall not be required in facilities having an existing corridor smoke detection system that complies with Section 9.6 and is connected to the building fire alarm system.

33.3.3.4.8 Smoke Detection Systems.

33.3.3.4.8.1 All living areas, as defined in 3.3.21.5, and all corridors shall be provided with smoke detectors that comply with *NFPA 72, National Fire Alarm and Signaling Code*, and are arranged to initiate an alarm that is audible in all sleeping areas, as modified by 33.3.3.4.8.2 and 33.3.3.4.8.3.

33.3.3.4.8.2 Smoke detection systems shall not be required in living areas of buildings having a prompt or slow evacuation capability protected throughout by an approved automatic sprinkler system installed in accordance with 33.3.3.5.

33.3.3.4.8.3 Smoke detection systems shall not be required in unenclosed corridors, passageways, balconies, colonnades, or other arrangements with one or more sides along the long dimension fully or extensively open to the exterior at all times.

33.3.3.5 Extinguishment Requirements.

33.3.3.5.1* General. Where an automatic sprinkler system is installed, for either total or partial building coverage, the system shall be installed in accordance with Section 9.7, as modified by 33.3.3.5.1.1, 33.3.3.5.1.2, and 33.3.3.5.1.3.

33.3.3.5.1.1 In buildings four or fewer stories above grade plane, systems in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, shall be permitted.

33.3.3.5.1.2 In facilities having prompt or slow evacuation capability, automatic sprinklers shall not be required in closets not exceeding 24 ft^2 (2.2 m^2) and in bathrooms not exceeding 55 ft^2 (5.1 m^2), provided that such spaces are finished with noncombustible or limited-combustible materials.

33.3.3.5.1.3 Initiation of the fire alarm system shall not be required for existing installations in accordance with 33.3.3.5.6.

33.3.3.5.2 Impractical Evacuation Capability. All facilities having impractical evacuation capability shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

33.3.3.5.3 High-Rise Buildings. All high-rise buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 33.3.3.5. Such systems shall initiate the fire alarm system in accordance with Section 9.6.

33.3.3.5.4 Attics shall be protected in accordance with 33.3.3.5.4.1 or 33.3.3.5.4.2.

33.3.3.5.4.1 Where an automatic sprinkler system is installed, attics used for living purposes, storage, or fuel-fired equipment shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 9.7.1.1.

33.3.3.5.4.2 Where an automatic sprinkler system is installed, attics not used for living purposes, storage, or fuel-fired equipment shall meet one of the following criteria:

(1) Attics shall be protected throughout by a heat detection system arranged to activate the building fire alarm system in accordance with Section 9.6.
(2) Attics shall be protected with automatic sprinklers that are part of the required, approved automatic sprinkler system in accordance with 9.7.1.1.
(3) Attics shall be of noncombustible or limited-combustible construction.
(4) Attics shall be constructed of fire-retardant-treated wood in accordance with NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*.

33.3.3.5.5 Supervision. Automatic sprinkler systems shall be supervised in accordance with Section 9.7; waterflow alarms shall not be required to be transmitted off-site.

33.3.3.5.6 Domestic Water Supply Option. Sprinkler piping serving not more than six sprinklers for any isolated hazardous area in accordance with 9.7.1.2 shall be permitted; in new installations where more than two sprinklers are installed in a single area, waterflow detection shall be provided to initiate the fire alarm system required by 33.3.3.4.1.

33.3.3.5.7 Portable Fire Extinguishers. Portable fire extinguishers in accordance with Section 9.9 shall be provided near hazardous areas.

33.3.3.6 Corridors and Separation of Sleeping Rooms.

33.3.3.6.1 Access shall be provided from every resident use area to not less than one means of egress that is separated from all other rooms or spaces by walls complying with 33.3.3.6.3 through 33.3.3.6.6.3, unless otherwise indicated in 33.3.3.6.1.1 through 33.3.3.6.1.3.

33.3.3.6.1.1 Rooms or spaces, other than sleeping rooms, protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5 shall not be required to comply with 33.3.3.6.1.

33.3.3.6.1.2 The requirements of 33.3.3.6.1 shall not apply where all of the following are met:

(1) The evacuation capability shall be prompt.
(2) The building shall be two or fewer stories in height.
(3) Not less than one required means of egress from each sleeping room shall provide a path of travel to the outside without traversing any corridor or other spaces exposed to unprotected vertical openings, living areas, and kitchens.

33.3.3.6.1.3 Rooms or spaces, other than sleeping rooms, provided with a smoke detection and alarm system connected to activate the building evacuation alarm shall not be required to comply with 33.3.3.6.1. Furnishings, finishes, and furniture, in combination with all other combustibles within the spaces, shall be of minimum quantity and arranged so that a fully developed fire is unlikely to occur.

33.3.3.6.2 Sleeping rooms shall be separated from corridors, living areas, and kitchens by walls complying with 33.3.3.6.3 through 33.3.3.6.6.3.

33.3.3.6.3 Walls required by 33.3.3.6.1 or 33.3.3.6.2 shall comply with 33.3.3.6.3.1, 33.3.3.6.3.2, or 33.3.3.6.3.3.

33.3.3.6.3.1 Walls shall have a minimum ½-hour fire resistance rating.

33.3.3.6.3.2 In buildings protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5, walls shall be smoke partitions in accordance with Section 8.4, and the provisions of 8.4.3.5 shall not apply.

33.3.3.6.3.3 In buildings two or fewer stories in height that are classified as prompt evacuation capability and that house not more than 30 residents, walls shall be smoke partitions in accordance with Section 8.4, and the provisions of 8.4.3.5 shall not apply.

33.3.3.6.4 Doors in walls required by 33.3.3.6.1 or 33.3.3.6.2 shall comply with 33.3.3.6.4.1, 33.3.3.6.4.2, 33.3.3.6.4.3, or 33.3.3.6.4.4.

33.3.3.6.4.1 Doors shall have a minimum 20-minute fire protection rating.

33.3.3.6.4.2 Solid-bonded wood-core doors of not less than 1¾ in. (44 mm) thickness shall be permitted to continue in use.

33.3.3.6.4.3 In buildings protected throughout by an approved automatic sprinkler system in accordance with 33.3.3.5, doors that are nonrated shall be permitted to continue in use.

33.3.3.6.4.4 Where automatic sprinkler protection is provided in the corridor in accordance with 31.3.5.8, all of the following requirements shall be met:

(1) Doors shall not be required to have a fire protection rating, but shall be in accordance with 8.4.3.
(2) The provisions of 8.4.3.5 shall not apply.
(3) Doors shall be equipped with latches for keeping the doors tightly closed.

33.3.3.6.5 Where walls and doors are required by 33.3.3.6.1 and 33.3.3.6.2, all of the following requirements shall be met:

(1) Such walls and doors shall be constructed as smoke partitions in accordance with Section 8.4.
(2) The provisions of 8.4.3.5 shall not apply.
(3) No louvers, transfer grilles, operable transoms, or other air passages shall penetrate such walls or doors, except properly installed heating and utility installations.

33.3.3.6.6 Doors in walls required by 33.3.3.6.1 and 33.3.3.6.2 shall comply with 33.3.3.6.6.1, 33.3.3.6.6.2, or 33.3.3.6.6.3.

33.3.3.6.6.1 Doors shall be self-closing or automatic-closing in accordance with 7.2.1.8, and doors in walls separating sleeping rooms from corridors shall be automatic-closing in accordance with 7.2.1.8.2.

33.3.3.6.6.2 Doors to sleeping rooms that have occupant-control locks such that access is normally restricted to the occupants or staff personnel shall be permitted to be self-closing.

33.3.3.6.6.3 In buildings protected throughout by an approved automatic sprinkler system installed in accordance with 33.3.3.5, doors, other than doors to hazardous areas, vertical openings, and exit enclosures, shall not be required to be self-closing or automatic-closing.

33.3.3.7 Subdivision of Building Spaces. The requirements of 33.3.3.7.1 through 33.3.3.7.6 shall be met for all sleeping floors, unless otherwise permitted by 33.3.3.7.7.

33.3.3.7.1 Every sleeping room floor shall be divided into not less than two smoke compartments of approximately the same size, with smoke barriers in accordance with Section 8.5, unless otherwise indicated in 33.3.3.7.4, 33.3.3.7.5, and 33.3.3.7.6.

33.3.3.7.2 Smoke dampers shall not be required.

33.3.3.7.3 Additional smoke barriers shall be provided such that the travel distance from a sleeping room corridor door to a smoke barrier shall not exceed 150 ft (46 m).

33.3.3.7.4 Smoke barriers shall not be required in buildings having prompt or slow evacuation capability where protected throughout by an approved automatic sprinkler system installed in accordance with 33.3.3.5.

33.3.3.7.5 Smoke barriers shall not be required in buildings having prompt or slow evacuation capability where each sleeping room is provided with exterior ways of exit access arranged in accordance with 7.5.3.

33.3.3.7.6 Smoke barriers shall not be required in buildings having prompt or slow evacuation capability where the aggregate corridor length on each floor is not more than 150 ft (46 m).

33.3.3.7.7 Positive latching hardware shall not be required on smoke barrier doors.

33.3.3.7.8 Smoke partitions in accordance with Section 8.4 shall be permitted in lieu of smoke barriers on stories used for sleeping by not more than 30 residents.

33.3.3.8 Cooking Facilities.

33.3.3.8.1 Cooking facilities shall be protected in accordance with 9.2.3, unless otherwise permitted by 33.3.3.8.2, 33.3.3.8.3, or 33.3.3.8.4.

33.3.3.8.2* Where residential cooking equipment is used for food warming or limited cooking, the equipment shall not be required to be protected in accordance with 9.2.3, and the presence of the equipment shall not require the area to be protected as a hazardous area.

33.3.3.8.3* Compliance with 9.2.3 shall not be required where all of the following conditions are met:

(1) Residential or commercial cooking equipment in a single kitchen per smoke compartment is used to prepare meals for 30 or fewer persons.
(2) The portion of the board and care facility served by the cooking facility is limited to 30 beds and is separated from other portions of the board and care facility by a smoke barrier constructed in accordance with 33.3.3.7.1 and with 33.3.3.7.7 through 33.3.3.7.8.
(3) The cooktop or range is equipped with a range hood of a width at least equal to the width of the cooking surface, with grease baffles or other grease-collecting and clean-out capability.
(4)*The hood systems have a minimum airflow of 500 cfm (14,000 L/min).
(5) The hood systems that are not ducted to the exterior additionally have a charcoal filter to remove smoke and odor.
(6) The cooktop or range complies with all of the following:
  (a) The cooktop or range is protected with a fire suppression system listed in accordance with ANSI/UL 300, *Standard for Fire Testing of Fire Extinguishing Systems for Protection of Commercial Cooking Equipment*, or is tested and meets all requirements of UL 300A, *Extinguishing System Units for Residential Range Top Cooking Surfaces*, in accordance with the applicable testing document's scope.
  (b) A manual release of the extinguishing system is provided in accordance with Section 10.5 of NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*.
  (c) An interlock is provided to turn off all sources of fuel and electrical power to the cooktop or range when the suppression system is activated.
(7)*The use of solid fuel for cooking is prohibited.
(8)*Deep-fat frying is prohibited.
(9) Portable fire extinguishers in accordance with NFPA 96 are located in all kitchen areas.
(10)*A switch meeting all of the following is provided:
  (a) A locked switch, or a switch located in a restricted location, is provided within the cooking facility that deactivates the cooktop or range.
  (b) The switch is used to deactivate the cooktop or range whenever the kitchen is not under staff supervision.
  (c) The switch is on a timer, not exceeding a 120-minute capacity, that automatically deactivates the cooktop or range, independent of staff action.
(11) Procedures for the use, inspection, testing, and maintenance of the cooking equipment are in accordance with Chapter 11 of NFPA 96, and the manufacturer's instructions are followed.
(12)*No fewer than two ac-powered photoelectric smoke alarms, interconnected in accordance with 9.6.2.10.3 and equipped with a silence feature, are located not closer than 20 ft (6.1 m) and not farther than 25 ft (7.6 m) from the cooktop or range.
(13) The smoke alarms required by 33.3.3.8.3(12) are permitted to be located outside the kitchen area where such placement is necessary for compliance with the 20 ft (6.1 m) minimum distance criterion.
(14) A single system smoke detector is permitted to be installed in lieu of the smoke alarms required in 33.3.3.8.3(12), provided the following criteria are met:
  (a) The detector is located not closer than 20 ft (6.1 m) and not farther than 25 ft (7.6 m) from the cooktop or range.
  (b) The detector is permitted to initiate a local audible alarm signal only.
  (c) The detector is not required to initiate a building-wide occupant notification signal.
  (d) The detector is not required to notify emergency forces.
  (e) The local audible signal initiated by the detector is permitted to be silenced and reset by a button on the detector or by a switch installed within 10 ft (3.0 m) of the system smoke detector.
  (f) System smoke detectors that are required by other sections of this chapter to be installed in corridors or spaces open to the corridor are not used to meet the requirements of 33.3.3.8.3(12) and are located not closer than 25 ft (7.6 m) to the cooktop or range.

33.3.3.8.4* Within a smoke compartment, residential or commercial cooking equipment that is used to prepare meals for 30 or fewer persons shall be permitted, provided that the cooking facility complies with all of the following conditions:

(1) The space containing the cooking equipment is not a sleeping room.
(2) The space containing the cooking equipment is separated from the corridor by partitions complying with 33.3.3.6.2 through 33.3.3.6.5.
(3) The requirements of 33.3.3.8.3(1) through (10) are met.

33.3.3.8.5* Where cooking facilities are protected in accordance with 9.2.3, the presence of the cooking equipment shall not cause the room or space housing the equipment to be classified as a hazardous area with respect to the requirements of 32.3.3.2, and the room or space shall not be permitted to be open to the corridor.

33.3.4 Special Provisions.

33.3.4.1 Reserved.

33.3.4.2 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permited.

33.3.5 Reserved.

33.3.6 Building Services.

33.3.6.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

33.3.6.2 Heating, Ventilating, and Air-Conditioning.

33.3.6.2.1 Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

33.3.6.2.2 No stove or combustion heater shall be located such that it blocks escape in case of fire caused by the malfunction of the stove or heater.

33.3.6.2.3 Unvented fuel-fired heaters shall not be used in any board and care occupancy.

33.3.6.3 Elevators, Dumbwaiters, and Vertical Conveyors. Elevators, dumbwaiters, and vertical conveyors shall comply with Section 9.4.

33.3.6.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

33.4* Suitability of an Apartment Building to House a Board and Care Occupancy.

33.4.1 General.

33.4.1.1 Scope.

33.4.1.1.1 Section 33.4 shall apply to apartment buildings that have one or more individual apartments used as a board and care occupancy. *(See 33.1.3.2.)*

33.4.1.1.2 The provisions of Section 33.4 shall be used to determine the suitability of apartment buildings to house a residential board and care facility.

33.4.1.1.3 The suitability of existing apartment buildings not used for board and care occupancies shall be determined in accordance with Chapter 31.

33.4.1.2 Requirements for Individual Apartments. Requirements for individual apartments used as residential board and care occupancies shall be as specified in Section 33.2. Egress from the apartment into the common building corridor shall be considered acceptable egress from the board and care facility.

33.4.1.3 Additional Requirements.

33.4.1.3.1* Apartment buildings housing board and care facilities shall comply with the requirements of Section 33.4, unless the authority having jurisdiction has determined that equivalent safety for housing a residential board and care facility is provided in accordance with Section 1.4.

33.4.1.3.2 All facilities shall meet the requirements of Chapter 31 and the additional requirements of Section 33.4.

33.4.1.4 Minimum Construction Requirements. In addition to the requirements of Chapter 31, apartment buildings housing residential board and care facilities for groups classified as prompt or slow evacuation capability shall meet the construction requirements of 33.3.1.3, and those for groups classified as impractical evacuation capability shall meet the construction requirements of 19.1.6.

33.4.2 Means of Egress. The requirements of Section 31.2 shall apply only to the parts of means of egress serving the apartment(s) used as a residential board and care occupancy.

33.4.3 Protection.

33.4.3.1 Interior Finish. The requirements of 31.3.3 shall apply only to the parts of means of egress serving the apartment(s) used as a residential board and care occupancy.

33.4.3.2 Construction of Corridor Walls. The requirements of 31.3.6 shall apply only to corridors serving the residential board and care facility, including that portion of the corridor wall separating the residential board and care facility from the common corridor.

33.4.3.3 Subdivision of Building Spaces. The requirements of 31.3.7 shall apply to those stories with an apartment(s) used as a residential board and care occupancy.

33.5 Reserved.

33.6 Reserved.

33.7 Operating Features.

33.7.1 Emergency Action Plan.

33.7.1.1 The administration of every residential board and care facility shall have, in effect and available to all supervisory personnel, written copies of a plan for protecting all persons in the event of fire, for keeping persons in place, for evacuating persons to areas of refuge, and for evacuating persons from the building when necessary.

33.7.1.2 The emergency action plan shall include special staff response, including the fire protection procedures needed to ensure the safety of any resident, and shall be amended or revised whenever any resident with unusual needs is admitted to the home.

33.7.1.3 All employees shall be periodically instructed and kept informed with respect to their duties and responsibilities under the plan, and such instruction shall be reviewed by the staff not less than every 2 months.

33.7.1.4 A copy of the plan shall be readily available at all times within the facility.

33.7.2 Resident Training.

33.7.2.1 All residents participating in the emergency action plan shall be trained in the proper actions to be taken in the event of fire.

33.7.2.2 The training required by 32.7.2.1 shall include actions to be taken if the primary escape route is blocked.

33.7.2.3 If the resident is given rehabilitation or habilitation training, training in fire prevention and the actions to be taken in the event of a fire shall be a part of the training program.

33.7.2.4 Residents shall be trained to assist each other in case of fire to the extent that their physical and mental abilities permit them to do so without additional personal risk.

33.7.3 Emergency Egress and Relocation Drills. Emergency egress and relocation drills shall be conducted in accordance with 33.7.3.1 through 33.7.3.6.

33.7.3.1 Emergency egress and relocation drills shall be conducted not less than six times per year on a bimonthly basis, with not less than two drills conducted during the night when residents are sleeping, as modified by 33.7.3.5 and 33.7.3.6.

33.7.3.2 The emergency drills shall be permitted to be announced to the residents in advance.

33.7.3.3* The drills shall involve the actual evacuation of all residents to an assembly point, as specified in the emergency action plan, and shall provide residents with experience in egressing through all exits and means of escape required by this *Code*.

33.7.3.4 Exits and means of escape not used in any drill shall not be credited in meeting the requirements of this *Code* for board and care facilities.

33.7.3.5 Actual exiting from windows shall not be required to comply with 33.7.3; opening the window and signaling for help shall be an acceptable alternative.

33.7.3.6 If the board and care facility has an evacuation capability classification of impractical, those residents who cannot meaningfully assist in their own evacuation or who have special health problems shall not be required to actively participate in the drill.

33.7.4 Smoking.

33.7.4.1* Smoking regulations shall be adopted by the administration of board and care occupancies.

33.7.4.2 Where smoking is permitted, noncombustible safety-type ashtrays or receptacles shall be provided in convenient locations.

33.7.5* Furnishings, Mattresses, and Decorations.

33.7.5.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations shall comply with 33.7.5.1.1 and 33.7.5.1.2.

33.7.5.1.1 New draperies, curtains, and other similar loosely hanging furnishings and decorations in board and care facilities shall be in accordance with the provisions of 10.3.1, unless otherwise permitted by 33.7.5.1.2.

33.7.5.1.2 In other than common areas, new draperies, curtains, and other similar loosely hanging furnishings and decorations shall not be required to comply with 33.7.5.1.1 where the building is protected throughout by an approved automatic sprinkler system installed in accordance with 33.2.3.5 for small facilities or 33.3.3.5 for large facilities.

33.7.5.2* New upholstered furniture within board and care facilities shall comply with 33.7.5.2.1 or 33.7.5.2.2.

33.7.5.2.1 New upholstered furniture shall be tested in accordance with the provisions of 10.3.2.1(1) and 10.3.3.

33.7.5.2.2 Upholstered furniture belonging to residents in sleeping rooms shall not be required to be tested, provided that a smoke alarm is installed in such rooms; battery-powered single-station smoke alarms shall be permitted in such rooms.

33.7.5.3* Newly introduced mattresses within board and care facilities shall comply with 33.7.5.3.1 or 33.7.5.3.2.

33.7.5.3.1 Newly introduced mattresses shall be tested in accordance with the provisions of 10.3.2.2 and 10.3.4.

33.7.5.3.2 Mattresses belonging to residents in sleeping rooms shall not be required to be tested, provided that a smoke alarm is installed in such rooms; battery-powered single-station smoke alarms shall be permitted in such rooms.

33.7.6 Staff. Staff shall be on duty and in the facility at all times when residents requiring evacuation assistance are present.

33.7.7 Inspection of Door Openings. Door assemblies for which the door leaf is required to swing in the direction of egress travel shall be inspected and tested not less than annually in accordance with 7.2.1.15.

Chapter 34 Reserved

Chapter 35 Reserved

Chapter 36 New Mercantile Occupancies

36.1 General Requirements.

36.1.1 Application.

36.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as mercantile occupancies. *(See 1.3.1.)*

36.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

36.1.1.3 General. The provisions of Chapter 4, General, shall apply.

36.1.1.4 The provisions of this chapter shall apply to life safety requirements for all new mercantile buildings. Specific requirements shall apply to suboccupancy groups, such as Class A, Class B, and Class C mercantile occupancies; mall buildings; and bulk merchandising retail buildings, and are contained in paragraphs pertaining thereto.

36.1.1.5 Additions to existing buildings shall comply with 36.1.1.5.1, 36.1.1.5.2, and 36.1.1.5.3.

36.1.1.5.1 Additions to existing buildings shall conform to the requirements of 4.6.7.

36.1.1.5.2 Existing portions of the structure shall not be required to be modified, provided that the new construction has not diminished the fire safety features of the facility.

36.1.1.5.3 Existing portions shall be upgraded if the addition results in a change of mercantile subclassification. *(See 36.1.2.2.)*

36.1.1.6 When a mercantile occupancy changes from Class C to Class A or Class B, or from Class B to Class A, the provisions of this chapter shall apply.

36.1.2 Classification of Occupancy.

36.1.2.1 General. Mercantile occupancies shall include all buildings and structures or parts thereof with occupancy as defined in 6.1.10.

36.1.2.2 Subclassification of Occupancy.

36.1.2.2.1 Mercantile occupancies shall be subclassified as follows:

(1) Class A, all mercantile occupancies having an aggregate gross area of more than 30,000 ft^2 (2800 m^2) or occupying more than three stories for sales purposes
(2) Class B, as follows:
    (a) All mercantile occupancies of more than 3000 ft^2 (280 m^2), but not more than 30,000 ft^2 (2800 m^2), aggregate gross area and occupying not more than three stories for sales purposes
    (b) All mercantile occupancies of not more than 3000 ft^2 (280 m^3) gross area and occupying two or three stories for sales purposes
(3) Class C, all mercantile occupancies of not more than 3000 ft^2 (280 m^2) gross area and used for sales purposes occupying one story only

36.1.2.2.2 For the purpose of the classification required in 36.1.2.2.1, the requirements of 36.1.2.2.2.1, 36.1.2.2.2.2, and 36.1.2.2.2.3 shall be met.

36.1.2.2.2.1 The aggregate gross area shall be the total gross area of all floors used for mercantile purposes.

36.1.2.2.2.2 Where a mercantile occupancy is divided into sections, regardless of fire separation, the aggregate gross area shall include the area of all sections used for sales purposes.

36.1.2.2.2.3 Areas of floors not used for sales purposes, such as an area used only for storage and not open to the public, shall not be counted for the purposes of the classifications in 36.1.2.2.1(1), (2), and (3), but means of egress shall be provided for such nonsales areas in accordance with their occupancy, as specified by other chapters of this *Code*.

36.1.2.2.3 Mezzanines shall comply with 8.6.10.

36.1.2.2.4 Where a number of tenant spaces under different management are located in the same building, the aggregate gross area for subclassification shall be one of the following:

(1) Where tenant spaces are not separated, the aggregate gross floor area of all such tenant spaces shall be used in determining classification per 36.1.2.2.1.
(2) Where individual tenant spaces are separated by fire barriers with a 2-hour fire resistance rating, each tenant space shall be individually classified.
(3) Where tenant spaces are separated by fire barriers with a 1-hour fire resistance rating, and the building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), each tenant space shall be individually classified.
(4) The tenant spaces in a mall building in accordance with 36.4.4 shall be classified individually.

36.1.3 Multiple Occupancies.

36.1.3.1 General.

36.1.3.1.1 All multiple occupancies shall be in accordance with 6.1.14 and 36.1.3.

36.1.3.1.2 Where there are differences in the specific requirements in this chapter and provisions for mixed occupancies or separated occupancies as specified in 6.1.14.3 and 6.1.14.4, the requirements of this chapter shall apply.

36.1.3.1.3 In other than bulk merchandising mercantile occupancies, atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis from nonhazardous spaces in assembly, educational, day care, health care, ambulatory health care, residential, residential board and care occupancies, and business occupancies.

36.1.3.2 Combined Mercantile Occupancies and Parking Structures.

36.1.3.2.1 The fire barrier separating parking structures from a building classified as a mercantile occupancy shall be a fire barrier having a minimum 2-hour fire resistance rating.

36.1.3.2.2 Openings in the fire barrier required by 36.1.3.2.1 shall not be required to be protected with fire protection–rated opening protectives in enclosed parking structures that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), or in open parking structures, provided that all of the following conditions are met:

(1) The openings do not exceed 25 percent of the area of the fire barrier in which they are located.
(2) The openings are used as a public entrance and for associated sidelight functions.
(3) The building containing the mercantile occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(4)*Means are provided to prevent spilled fuel from accumulating adjacent to the openings and entering the building.
(5) Physical means are provided to prevent vehicles from being parked or driven within 10 ft (3050 mm) of the openings.
(6) The openings are protected as a smoke partition in accordance with Section 8.4, with no minimum fire protection rating required.

36.1.4 Definitions.

36.1.4.1 General. For definitions, see Chapter 3, Definitions.

36.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Anchor Building.** See 3.3.36.2.
(2) **Bulk Merchandising Retail Building.** See 3.3.36.4.
(3) **Gross Leasable Area.** See 3.3.21.3.
(4) **Major Tenant.** See 3.3.168.
(5) **Mall.** See 3.3.169.
(6) **Mall Building.** See 3.3.36.9.
(7) **Open-Air Mercantile Operation.** See 3.3.199.

36.1.5 Classification of Hazard of Contents.

36.1.5.1 The contents of mercantile occupancies shall be classified in accordance with Section 6.2.

36.1.5.2 Mercantile occupancies classified as high hazard in accordance with Section 6.2 shall meet all of the following additional requirements:

(1) Exits shall be located so that not more than 75 ft (23 m) of travel from any point is needed to reach the nearest exit.
(2) From every point, there shall be not less than two exits accessible by travel in different directions (no common path of travel).
(3) All vertical openings shall be enclosed.

36.1.6 Minimum Construction Requirements. (Reserved.)

36.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

36.2 Means of Egress Requirements.

36.2.1 General.

36.2.1.1 All means of egress shall be in accordance with Chapter 7 and this chapter.

36.2.1.2 No inside open stairway or inside open ramp shall be permitted to serve as a component of the required means of egress system for more than one floor.

36.2.1.3 Where there are two or more floors below the street floor, the same stairway or other exit shall be permitted to serve all floors, but all required exits from such areas shall be independent of any open stairways between the street floor and the floor below it.

36.2.1.4 Where exits from the upper floor also serve as an entrance from a principal street, the upper floor shall be classified as a street floor in accordance with the definition of street floor in 3.3.271 and shall be subject to the requirements of this chapter for street floors.

36.2.1.5 High hazard mercantile occupancies shall be arranged in accordance with 36.1.5.2.

36.2.2 Means of Egress Components.

36.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 36.2.2.2 through 36.2.2.12.

36.2.2.2 Doors.

36.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

36.2.2.2.2* Locks complying with 7.2.1.5.5 shall be permitted only on principal entrance/exit doors.

36.2.2.2.3 Elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 shall be permitted.

36.2.2.2.4 Reserved.

36.2.2.2.5 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

36.2.2.2.6 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted in buildings protected throughout by an approved, supervised fire detection system in accordance with Section 9.6 or an approved automatic sprinkler system in accordance with 9.7.1.1(1).

36.2.2.2.7 Horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) shall be permitted to be used as a part of the required means of egress from a tenant space.

36.2.2.2.8 All doors at the foot of stairs from upper floors or at the head of stairs leading to floors below the street floor shall swing in the direction of egress travel.

36.2.2.2.9 Revolving doors complying with 7.2.1.10 shall be permitted.

36.2.2.3 Stairs.

36.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

36.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

36.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

36.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

36.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

36.2.2.7 Exit Passageways.

36.2.2.7.1 Exit passageways complying with 7.2.6 shall be permitted.

36.2.2.7.2* Exit passageways in a mall building shall be permitted to accommodate the following occupant loads independently:

(1) Portion of the occupant load assigned to the exit passageway from only the mall/pedestrian way
(2) Largest occupant load assigned to the exit passageway from a single tenant space

36.2.2.8 Reserved.

36.2.2.9 Reserved.

36.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

36.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

36.2.2.12 Areas of Refuge.

36.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted.

36.2.2.12.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), two rooms or spaces separated from each other by smoke-resistant partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

36.2.3 Capacity of Means of Egress.

36.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

36.2.3.2 In Class A and Class B mercantile occupancies, street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs and ramps discharging through the street floor.

36.2.4 Number of Means of Egress.

36.2.4.1 Means of egress shall comply with all of the following, except as otherwise permitted by 36.2.4.2 through 36.2.4.5:

(1) The number of means of egress shall be in accordance with Section 7.4.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

36.2.4.2 Exit access, as required by 36.2.4.1(3), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 36.2.5.3.

36.2.4.3 A single means of egress shall be permitted in a Class C mercantile occupancy, provided that the travel distance to the exit or to a mall pedestrian way (*see 36.4.4.2*) does not exceed 75 ft (23 m).

36.2.4.4 A single means of egress shall be permitted in a Class C mercantile occupancy, provided that the travel distance to the exit or to a mall does not exceed 100 ft (30 m), and the story on which the occupancy is located, and all communicating levels that are traversed to reach the exit or mall, are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

36.2.4.5 A single means of egress to an exit or to a mall shall be permitted from a mezzanine within any Class A, Class B, or Class C mercantile occupancy, provided that the common path of travel does not exceed 75 ft (23 m), or does not exceed 100 ft (30 m) if protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

36.2.5 Arrangement of Means of Egress.

36.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

36.2.5.2 Dead-end corridors shall comply with 36.2.5.2.1 or 36.2.5.2.2.

36.2.5.2.1 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), dead-end corridors shall not exceed 50 ft (15 m).

36.2.5.2.2 In all buildings not complying with 36.2.5.2.1, dead-end corridors shall not exceed 20 ft (6100 mm).

36.2.5.3 Common paths of travel shall be limited by any of the following:

(1) Common paths of travel shall not exceed 75 ft (23 m) in mercantile occupancies classified as low or ordinary hazard.

(2) Common paths of travel shall not exceed 100 ft (30 m) in mercantile occupancies classified as low or ordinary hazard where the building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(3) Common paths of travel shall not be permitted in mercantile occupancies classified as high hazard.

36.2.5.4 Aisles leading to each exit shall be required, and the aggregate width of such aisles shall be not less than the required width of the exit.

36.2.5.5 Required aisles shall be not less than 36 in. (915 mm) in clear width.

36.2.5.6 In Class A mercantile occupancies, not less than one aisle of a 60 in. (1525 mm) minimum clear width shall lead directly to an exit.

36.2.5.7 In mercantile occupancies other than bulk merchandising retail buildings, if the only means of customer entrance is through one exterior wall of the building, one-half of the required egress width from the street floor shall be located in such wall. Means of egress from floors above or below the street floor shall be arranged in accordance with Section 7.5.

36.2.5.8 Not less than one-half of the required exits shall be located so as to be reached without passing through checkout stands.

36.2.5.9 Checkout stands or associated railings or barriers shall not obstruct exits, required aisles, or approaches thereto.

36.2.5.10* Where wheeled carts or buggies are used by customers, adequate provision shall be made for the transit and parking of such carts to minimize the possibility that they might obstruct means of egress.

36.2.5.11 Exit access in Class A and Class B mercantile occupancies that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), and exit access in all Class C mercantile occupancies, shall be permitted to pass through storerooms, provided that all of the following conditions are met:

(1) Not more than 50 percent of exit access shall be provided through the storeroom.
(2) The storeroom shall not be subject to locking.
(3) The main aisle through the storeroom shall be not less than 44 in. (1120 mm) wide.
(4) The path of travel through the storeroom shall be defined, direct, and continuously maintained in an unobstructed condition.

36.2.6 Travel Distance to Exits. Travel distance shall be as specified in 36.2.6.1, 36.2.6.2, and 36.2.6.3 and shall be measured in accordance with Section 7.6.

36.2.6.1 In mercantile occupancies classified as ordinary hazard, travel distance shall not exceed 150 ft (46 m).

36.2.6.2 In mercantile occupancies classified as ordinary hazard in buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), travel distance shall not exceed 250 ft (76 m).

36.2.6.3 In mercantile occupancies classified as high hazard, travel distance shall not exceed 75 ft (23 m).

36.2.7 Discharge from Exits.

36.2.7.1 Exit discharge shall comply with Section 7.7 and 36.2.7.2.

36.2.7.2* Fifty percent of the exits shall be permitted to discharge through the level of exit discharge in accordance with 7.7.2 only where the building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

36.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

36.2.9 Emergency Lighting. Class A and Class B mercantile occupancies and mall buildings shall have emergency lighting facilities in accordance with Section 7.9.

36.2.10 Marking of Means of Egress. Where an exit is not immediately apparent from all portions of the sales area, means of egress shall have signs in accordance with Section 7.10.

36.2.11 Special Means of Egress Features.

36.2.11.1 Reserved.

36.2.11.2 Lockups. Lockups in mercantile occupancies shall comply with the requirements of 22.4.5.

36.3 Protection.

36.3.1 Protection of Vertical Openings. Any vertical opening shall be protected in accordance with Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
    (a) Between any two floors
    (b) Among the street floor, the first adjacent floor below, and the adjacent floor (or mezzanine) above
(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.
(3) The draft stop and closely spaced sprinkler requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required for unenclosed vertical openings permitted in 36.3.1(1) and 36.3.1(2).
(4) Unenclosed vertical openings in accordance with 8.6.9.2 shall be permitted and the provision of 8.6.9.2(5) shall not apply.
(5) Unenclosed vertical openings in accordance with 8.6.9.7 shall be permitted and the number of contiguous stories shall not be limited.

36.3.2 Protection from Hazards.

36.3.2.1* General. Hazardous areas shall be protected in accordance with 36.3.2.1.1 or 36.3.2.1.2.

36.3.2.1.1* Hazardous areas shall be protected in accordance with Section 8.7.

36.3.2.1.2 In general storage and stock areas protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2, an enclosure shall be exempt from the provisions of 8.7.1.2.

36.3.2.2* High Hazard Contents Areas. High hazard contents areas, as classified in Section 6.2, shall meet all of the following criteria:

(1) The area shall be separated from other parts of the building by fire barriers having a minimum 1-hour fire resistance rating, with all openings therein protected by self-closing fire door assemblies having a minimum ¾-hour fire protection rating.

(2) The area shall be protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2.
(3) In high hazard areas, all vertical openings shall be enclosed.

36.3.2.3* Commercial Cooking Operations. Commercial cooking operations shall be protected in accordance with 9.2.3, unless the cooking equipment is one of the following types:

(1) Outdoor equipment
(2) Equipment used only for food warming

36.3.3 Interior Finish.

36.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

36.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C.

36.3.3.3 Interior Floor Finish.

36.3.3.3.1 Interior floor finish shall comply with Section 10.2.

36.3.3.3.2 Interior floor finish in exit enclosures shall be Class I or Class II.

36.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

36.3.4 Detection, Alarm, and Communications Systems.

36.3.4.1 General. Class A mercantile occupancies shall be provided with a fire alarm system in accordance with Section 9.6.

36.3.4.2 Initiation. Initiation of the required fire alarm system shall be by any one of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 9.6.2.1(3) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.

36.3.4.3 Notification.

36.3.4.3.1 Occupant Notification. During all times that the mercantile occupancy is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate an alarm in accordance with 9.6.3 throughout the mercantile occupancy.
(2) Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

36.3.4.3.2 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 9.6.4
(2) Local emergency organization, if provided

36.3.5 Extinguishment Requirements.

36.3.5.1 Mercantile occupancies shall be protected by an approved automatic sprinkler system in accordance with 9.7.1.1(1) in any of the following specified locations:

(1) Throughout all mercantile occupancies three or more stories in height
(2) Throughout all mercantile occupancies exceeding 12,000 ft^2 (1115 m^2) in gross area
(3) Throughout stories below the level of exit discharge where such stories have an area exceeding 2500 ft^2 (232 m^2) and are used for the sale, storage, or handling of combustible goods and merchandise
(4) Throughout multiple occupancies protected as mixed occupancies in accordance with 6.1.14 where the conditions of 36.3.5.1(1), (2), or (3) apply to the mercantile occupancy

36.3.5.2 Automatic sprinkler systems in Class A mercantile occupancies shall be supervised in accordance with 9.7.2.

36.3.5.3 Portable fire extinguishers shall be provided in all mercantile occupancies in accordance with Section 9.9.

36.3.6 Corridors.

36.3.6.1* Where access to exits is provided by corridors, such corridors shall be separated from use areas by fire barriers in accordance with Section 8.3 having a minimum 1-hour fire resistance rating, except under any of the following conditions:

(1) Where exits are available from an open floor area
(2) Within a space occupied by a single tenant
(3) Within buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)

36.3.6.2 Openings in corridor walls required by 36.3.6.1 to have a fire resistance rating shall be protected in accordance with Section 8.3.

36.3.7 Subdivision of Building Spaces. (No special requirements.)

36.4 Special Provisions.

36.4.1 Limited Access or Underground Buildings. See Section 11.7.

36.4.2 High-Rise Buildings. High-rise buildings shall comply with the requirements of Section 11.8.

36.4.3 Open-Air Mercantile Operations.

36.4.3.1 Open-air mercantile operations, such as open-air markets, gasoline filling stations, roadside stands for the sale of farm produce, and other outdoor mercantile operations, shall be arranged and conducted to maintain free and unobstructed ways of travel at all times.

36.4.3.2 Ways of travel shall allow prompt escape from any point of danger in case of fire or other emergency, with no dead ends in which persons might be trapped due to display stands, adjoining buildings, fences, vehicles, or other obstructions.

36.4.3.3 Mercantile operations that are conducted in roofed-over areas shall be treated as mercantile buildings, provided that canopies over individual small stands to protect merchandise from the weather are not construed as constituting buildings for the purpose of this *Code*.

36.4.4 Mall Buildings.

36.4.4.1 The provisions of 36.4.4 shall apply to mall buildings three or fewer stories in height and any number of anchor buildings.

36.4.4.2 Special Definitions. The following is a list of special terms used in this chapter:

(1) **Anchor Building.** A building housing any occupancy having low-or ordinary-hazard contents and having direct access to a mall building, but having all required means of egress independent of the mall. *(See 3.3.36.2.)*

(2) **Food Court.** A public seating area located in a mall that serves adjacent food preparation tenant spaces. *(See 3.3.50.2.)*
(3) **Gross Leasable Area.** Fifty percent of major tenant areas, and 100 percent of all other floor areas designated for tenant occupancy and exclusive use, including storage areas. The area of tenant occupancy is measured from the centerlines of joint partitions to the outside of the tenant walls. *(See 3.3.21.3.)*
(4) **Mall.** A roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants and does not exceed three levels that are open to each other. *(See 3.3.169.)*
(5)* **Mall Building.** A single building enclosing a number of tenants and occupancies wherein two or more tenants have a main entrance into one or more malls. For the purpose of this chapter, anchor buildings shall not be considered as a part of the mall building. *(See 3.3.36.9.)*
(6) **Major Tenant.** A tenant space, in a mall building, with one or more main entrances from the exterior that also serve as exits and are independent of the mall. *(See 3.3.168.)*

36.4.4.3 General. The mall building shall be treated as a single building for the purpose of calculation of means of egress and shall be subject to the requirements for appropriate occupancies, except as modified by the provisions of 36.4.4; and the mall shall be of a clear width not less than that needed to accommodate egress requirements as set forth in other sections of this *Code*.

36.4.4.4 Pedestrian Way. The mall shall be permitted to be considered a pedestrian way, provided that the criteria of 36.4.4.4.1 and 36.4.4.4.2 are met.

36.4.4.4.1 The travel distance within a tenant space to an exit or to the mall shall not exceed the maximum travel distance permitted by the occupancy chapter.

36.4.4.4.2 An additional 200 ft (61 m) shall be permitted for travel through the mall space, provided that all the following requirements are met:

(1) The mall shall be of a clear width not less than that needed to accommodate egress requirements, as set forth in other sections of this chapter, but shall be not less than 20 ft (6100 mm) wide in its narrowest dimension.
(2) On each side of the mall floor area, the mall shall be provided with an unobstructed exit access of not less than 10 ft (3050 mm) in clear width parallel to, and adjacent to, the mall tenant front.
(3)*The exit access specified in 36.4.4.4.2(2) shall lead to an exit having a width of not less than 66 in. (1675 mm).
(4) The mall, and all buildings connected thereto, except open parking structures, shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), which shall be installed in such a manner that any portion of the system serving tenant spaces can be taken out of service without affecting the operation of the portion of the system serving the mall.
(5)*Walls dividing tenant spaces from each other shall have a fire resistance rating of not less than 1 hour, and all of the following also shall apply:
    (a) The partition shall extend to the underside of the ceiling or to the roof or floor above.
    (b) No separation shall be required between a tenant space and the mall.
(6)*Malls with a floor opening connecting more than two levels shall be provided with a smoke control system.

36.4.4.5 Mixed Occupancies. Assembly occupancies, other than stadiums and arenas, and business and mercantile occupancies located in mall buildings shall not be required to comply with the provisions of 6.1.14.4.

36.4.4.6 Means of Egress Details.

36.4.4.6.1 Dead ends not exceeding a length equal to twice the width of the mall, measured at the narrowest location within the dead-end portion of the mall, shall be permitted.

36.4.4.6.2 Every story of a mall building shall be provided with the number of means of egress specified by Section 7.4 and as modified by 36.4.4.6.2.1 or 36.4.4.6.2.2.

36.4.4.6.2.1 Exit access travel shall be permitted to be common for the distances permitted as common paths of travel by 36.2.5.3.

36.4.4.6.2.2 A single means of egress shall be permitted in a Class C mercantile occupancy or a business occupancy, provided that the travel distance to the exit or to a mall *(see 36.4.4.2)* does not exceed 100 ft (30 m).

36.4.4.6.3 Every floor of a mall shall be provided with the number of means of egress specified by Section 7.4, with not less than two means of egress remotely located from each other.

36.4.4.6.4 Class A and Class B mercantile occupancies connected to a mall shall be provided with the number of means of egress required by Section 7.4, with not less than two means of egress remotely located from one another.

36.4.4.6.5* Each individual anchor building shall have means of egress independent of the mall.

36.4.4.6.6 Each individual major tenant of a mall building shall have a minimum of one-half of its required means of egress independent of the mall.

36.4.4.6.7 Each assembly occupancy with an occupant load of 500 or more shall have not less than one-half of its required means of egress independent of the mall.

36.4.4.6.8 Emergency lighting shall be provided in accordance with 36.2.9.

36.4.4.7 Detection, Alarm, and Communications Systems.

36.4.4.7.1 General. Malls shall be provided with a fire alarm system in accordance with Section 9.6.

36.4.4.7.2 Initiation. Initiation of the required fire alarm system shall be by means of the required automatic sprinkler system in accordance with 9.6.2.1(3).

36.4.4.7.3 Notification.

36.4.4.7.3.1 Occupant Notification. During all times that the mall is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate a general alarm in accordance with 9.6.3 throughout the mall, and positive alarm sequence in accordance with 9.6.3.4 shall be permitted.
(2) Occupant notification shall be made via a voice communication or public address system in accordance with 9.6.3.9.2

36.4.4.7.3.2* Visible signals shall not be required in malls. *(See 9.6.3.5.7 and 9.6.3.5.8.)*

36.4.4.7.3.3 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying all of the following:

(1) Fire department in accordance with 9.6.4
(2) Local emergency organization, if provided

36.4.4.7.4 Emergency Control. The fire alarm system shall be arranged to automatically actuate smoke management or smoke control systems in accordance with 9.6.5.2(3).

36.4.4.8 Tenant Spaces. Each individual tenant space shall have means of egress to the outside or to the mall, based on occupant load calculated by using Table 7.3.1.2.

36.4.4.9 Exit Passageways. Exit passageways shall comply with 36.4.4.9.1 and 36.4.4.9.2.

36.4.4.9.1 Exit passageways in a mall building shall be permitted to accommodate the following occupant loads independently:

(1) Portion of the occupant load assigned to the exit passageway from only the mall
(2) Largest occupant load assigned to the exit passageway from a single tenant space

36.4.4.9.2* Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with 7.1.3.2.
(2) Such rooms or areas shall be protected by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), but the exceptions in NFPA 13, *Standard for the Installation of Sprinkler Systems*, allowing the omission of sprinklers from such rooms shall not be permitted.
(3) Service elevators opening into the exit passageway shall not open into areas other than exit passageways.
(4) Where exit stair enclosures discharge into the exit passageway, the provisions of 7.2.1.5.8 shall apply, regardless of the number of stories served.

36.4.4.10 Plastic Signs. Within every store or level, and from sidewall to sidewall of each tenant space facing the mall, plastic signs shall comply with all of the following:

(1) Plastic signs shall not exceed 20 percent of the wall area facing the mall.
(2) Plastic signs shall not exceed a height of 36 in. (915 mm), except if the sign is vertical, in which case the height shall not exceed 8 ft (2440 mm) and the width shall not exceed 36 in. (915 mm).
(3) Plastic signs shall be located a minimum distance of 18 in. (455 mm) from adjacent tenants.
(4) Plastics, other than foamed plastics, shall meet one of the following criteria:
    (a) They shall be light-transmitting plastics.
    (b) They shall have a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D 1929, *Standard Test Method for Determining Ignition Temperatures of Plastic*, and a flame spread index not greater than 75 and a smoke developed index not greater than 450 when tested in the manner intended for use in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.
(5) The edges and backs of plastic signs in the mall shall be fully encased in metal.
(6) Foamed plastics shall have a maximum heat release rate of 150 kW when tested in accordance with ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(7) Foamed plastics shall comply with all of the following:
    (a) The density of foamed plastic signs shall be not less than 20 lb/ft^3 (320 kg/m^3).
    (b) The thickness of foamed plastic signs shall be not greater than ½ in. (13 mm).

36.4.4.11 Kiosks. Kiosks and similar structures (temporary or permanent) shall not be considered tenant spaces and shall meet all of the following requirements:

(1) Combustible kiosks and similar structures shall be constructed of any of the following materials:
    (a) Fire-retardant-treated wood complying with the requirements for fire-retardant-impregnated wood in NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*
    (b) Light-transmitting plastics complying with the building code
    (c) Foamed plastics having a maximum heat release rate not greater than 100 kW when tested in accordance with ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source
    (d) Metal composite material (MCM) having a flame spread index not greater than 25 and a smoke developed index not greater than 450 in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, when tested as an assembly in the maximum thickness intended for use.
    (e) Textiles and films meeting the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*
(2) Kiosks or similar structures located within the mall shall be protected with approved fire suppression and detection devices.
(3) The minimum horizontal separation between kiosks, or groups of kiosks, and other structures within the mall shall be 20 ft (6100 mm).
(4) Each kiosk, or group of kiosks, or similar structure shall have a maximum area of 300 ft^2 (27.8 m^2).

36.4.4.12* Smoke Control. Smoke control in accordance with Section 9.3 and complying with 8.6.7(5) shall be provided in a mall with floor openings connecting more than two levels.

36.4.4.13 Automatic Extinguishing Systems.

36.4.4.13.1 The mall building and all anchor buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1) and 36.4.4.13.2.

36.4.4.13.2 The system shall be installed in such a manner that any portion of the system serving tenant spaces can be taken out of service without affecting the operation of the portion of the system serving the mall.

36.4.5 Bulk Merchandising Retail Buildings. New bulk merchandising retail buildings exceeding 12,000 ft^2 (1115 m^2) in area shall comply with the requirements of this chapter, as modified by 36.4.5.1 through 36.4.5.6.2.

36.4.5.1 Minimum Construction Requirements. Bulk merchandising retail buildings shall have a distance of not less than 16 ft (4875 mm) from the floor to the ceiling, from the floor to the floor above, or from the floor to the roof of any story.

36.4.5.2 Means of Egress Requirements.

36.4.5.2.1 All means of egress shall be in accordance with Chapter 7 and this chapter.

36.4.5.2.2 Not less than 50 percent of the required egress capacity shall be located independent of the main entrance/exit doors.

Paragraph 36.4.5.3 was revised by a tentative interim amendment. (TIA). See page 1.

36.4.5.3 Storage, Arrangement, Protection, and Quantities of Hazardous Commodities. The storage, arrangement, protection, and quantities of hazardous commodities shall be in accordance with the applicable provisions of the following:

(1) The fire code *(see 3.3.96)*
(2) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(3) NFPA 30, *Flammable and Combustible Liquids Code*
(4) NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*
(5) NFPA 400, *Hazardous Materials Code*, Chapter 14, for organic peroxide formulations
(6) NFPA 400, *Hazardous Materials Code*, Chapter 15, for oxidizer solids and liquids
(7) NFPA 400, *Hazardous Materials Code*, various chapters, depending on characteristics of a particular pesticide

36.4.5.4 Detection, Alarm, and Communications Systems.

36.4.5.4.1 General. Bulk merchandising retail buildings shall be provided with a fire alarm system in accordance with Section 9.6.

36.4.5.4.2 Initiation. Initiation of the required fire alarm system shall be by means of the required approved automatic sprinkler system *(see 36.4.5.5)* in accordance with 9.6.2.1(3).

36.4.5.4.3 Occupant Notification. During all times that the mercantile occupancy is occupied, the required fire alarm system, once initiated, shall activate an alarm in accordance with 9.6.3 throughout the mercantile occupancy, and positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

36.4.5.4.4 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 9.6.4
(2) Approved local emergency organization, if provided

36.4.5.5 Extinguishing Requirements. Bulk merchandising retail buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1) and the applicable provisions of the following:

(1) The fire code *(see 3.3.96)*
(2) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(3) NFPA 30, *Flammable and Combustible Liquids Code*
(4) NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*

36.4.5.6 Emergency Action Plan and Employee Training.

36.4.5.6.1 There shall be in effect an approved written plan for the emergency egress and relocation of occupants.

36.4.5.6.2 All employees shall be instructed and periodically drilled with respect to their duties under the plan.

Paragraph 36.4.6 was deleted by a tentative interim amendment (TIA). See page 1.

36.4.6 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

36.5 Building Services.

36.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

36.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

36.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

36.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

36.6 Reserved.

36.7 Operating Features.

36.7.1 Emergency Action Plans. Emergency action plans complying with Section 4.8 shall be provided in high-rise buildings.

36.7.2 Drills. In every Class A or Class B mercantile occupancy, employees shall be periodically trained in accordance with Section 4.7.

36.7.3 Extinguisher Training. Employees of mercantile occupancies shall be periodically instructed in the use of portable fire extinguishers.

36.7.4 Food Service Operations. Food service operations shall comply with 12.7.2.

36.7.5 Upholstered Furniture and Mattresses. The provisions of 10.3.2 shall not apply to upholstered furniture and mattresses.

36.7.6 Soiled Linen and Trash Receptacles. The requirements of 10.3.9 for containers for waste, waste, or linen with a capacity of 20 gal (75.7 L) or more shall not apply.

36.7.7 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 37 Existing Mercantile Occupancies

37.1 General Requirements.

37.1.1 Application.

37.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as mercantile occupancies.

37.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

37.1.1.3 General. The provisions of Chapter 4, General, shall apply.

37.1.1.4 The provisions of this chapter shall apply to life safety requirements for all existing mercantile buildings. Specific requirements shall apply to suboccupancy groups, such as Class A, Class B, and Class C mercantile occupancies; mall buildings; and bulk merchandising retail buildings, and are contained in paragraphs pertaining thereto.

37.1.1.5 Additions to existing buildings shall comply with 37.1.1.5.1, 37.1.1.5.2, and 37.1.1.5.3.

37.1.1.5.1 Additions to existing buildings shall conform to the requirements of 4.6.7.

37.1.1.5.2 Existing portions of the structure shall not be required to be modified, provided that the new construction has not diminished the fire safety features of the facility.

37.1.1.5.3 Existing portions shall be upgraded if the addition results in a change of mercantile subclassification. *(See 37.1.2.2.)*

37.1.1.6 When a change in mercantile occupancy subclassification occurs, either of the following requirements shall be met:

(1) When a mercantile occupancy changes from Class A to Class B or Class C, or from Class B to Class C, the provisions of this chapter shall apply.
(2) When a mercantile occupancy changes from Class C to Class A or Class B, or from Class B to Class A, the provisions of Chapter 36 shall apply.

37.1.2 Classification of Occupancy.

37.1.2.1 General. Mercantile occupancies shall include all buildings and structures or parts thereof with occupancy as defined in 6.1.10.

37.1.2.2 Subclassification of Occupancy.

37.1.2.2.1 Mercantile occupancies shall be subclassified as follows:

(1) Class A, all mercantile occupancies having an aggregate gross area of more than 30,000 ft^2 (2800 m^2) or occupying more than three stories for sales purposes
(2) Class B, as follows:
  (a) All mercantile occupancies of more than 3000 ft^2 (280 m^2), but not more than 30,000 ft^2 (2800 m^2), aggregate gross area and occupying not more than three stories for sales purposes
  (b) All mercantile occupancies of not more than 3000 ft^2 (280 m^2) gross area and occupying two or three stories for sales purposes
(3) Class C, all mercantile occupancies of not more than 3000 ft^2 (280 m^2) gross area used for sales purposes and occupying one story only, excluding mezzanines

37.1.2.2.2 For the purpose of the classification required in 37.1.2.2.1, the requirements of 37.1.2.2.2.1, 37.1.2.2.2.2, and 37.1.2.2.2.3 shall be met.

37.1.2.2.2.1 The aggregate gross area shall be the total gross area of all floors used for mercantile purposes.

37.1.2.2.2.2 Where a mercantile occupancy is divided into sections, regardless of fire separation, the aggregate gross area shall include the area of all sections used for sales purposes.

37.1.2.2.2.3 Areas of floors not used for sales purposes, such as an area used only for storage and not open to the public, shall not be counted for the purposes of the classifications in 37.1.2.2.1(1), (2), and (3), but means of egress shall be provided for such nonsales areas in accordance with their occupancy, as specified by other chapters of this *Code*.

37.1.2.2.3 The floor area of a mezzanine, or the aggregate floor area of multiple mezzanines, shall not exceed one-half of the floor area of the room or story in which the mezzanines are located; otherwise, such mezzanine or aggregated mezzanines shall be treated as floors.

37.1.2.2.4 Where a number of tenant spaces under different management are located in the same building, the aggregate gross area for subclassification shall be one of the following:

(1) Where tenant spaces are not separated, the aggregate gross floor area of all such tenant spaces shall be used in determining classification per 37.1.2.2.1.
(2) Where individual tenant spaces are separated by fire barriers with a 1-hour fire resistance rating, each tenant space shall be individually classified.
(3) The tenant spaces in a mall building in accordance with 37.4.4 shall be classified individually.

37.1.3 Multiple Occupancies.

37.1.3.1 General.

37.1.3.1.1 All multiple occupancies shall be in accordance with 6.1.14 and 37.1.3.

37.1.3.1.2 Where there are differences in the specific requirements in this chapter and provisions for mixed occupancies or separated occupancies as specified in 6.1.14.3 and 6.1.14.4, the requirements of this chapter shall apply.

37.1.3.1.3 In other than bulk merchandising mercantile occupancies, atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis from nonhazardous spaces in assembly, educational, day care, health care, ambulatory health care, residential, residential board and care occupancies, and business occupancies.

37.1.3.2 Combined Mercantile Occupancies and Parking Structures.

37.1.3.2.1 The fire barrier separating parking structures from a building classified as a mercantile occupancy shall be a fire barrier having a minimum 2-hour fire resistance rating.

37.1.3.2.2 Openings in the fire barrier required by 37.1.3.2.1 shall not be required to be protected with fire protection–rated opening protectives in enclosed parking structures that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), or in open parking structures, provided that all of the following conditions are met:

(1) The openings do not exceed 25 percent of the area of the fire barrier in which they are located.
(2) The openings are used as a public entrance and for associated sidelight functions.
(3) The building containing the mercantile occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(4)*Means are provided to prevent spilled fuel from accumulating adjacent to the openings and entering the building.

(5) Physical means are provided to prevent vehicles from being parked or driven within 10 ft (3050 mm) of the openings.
(6) The openings are protected as a smoke partition in accordance with Section 8.4, with no minimum fire protection rating required.

37.1.4 Definitions.

37.1.4.1 General. For definitions, see Chapter 3, Definitions.

37.1.4.2 Special Definitions. A list of special terms used in this chapter follows:

(1) **Anchor Building.** See 3.3.36.2.
(2) **Bulk Merchandising Retail Building.** See 3.3.36.4.
(3) **Gross Leasable Area.** See 3.3.21.3.
(4) **Major Tenant.** See 3.3.168.
(5) **Mall.** See 3.3.169.
(6) **Mall Building.** See 3.3.36.9.
(7) **Open-Air Mercantile Operation.** See 3.3.199.

37.1.5 Classification of Hazard of Contents.

37.1.5.1 The contents of mercantile occupancies shall be classified in accordance with Section 6.2.

37.1.5.2 Mercantile occupancies classified as high hazard in accordance with Section 6.2 shall meet all of the following additional requirements:

(1) Exits shall be located so that not more than 75 ft (23 m) of travel from any point is needed to reach the nearest exit.
(2) From every point, there shall be not less than two exits accessible by travel in different directions (no common path of travel).
(3) All vertical openings shall be enclosed.

37.1.6 Minimum Construction Requirements. (Reserved.)

37.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

37.2 Means of Egress Requirements.

37.2.1 General.

37.2.1.1 All means of egress shall be in accordance with Chapter 7 and this chapter.

37.2.1.2 No inside open stairway, inside open escalator, or inside open ramp shall be permitted to serve as a component of the required means of egress system for more than one floor.

37.2.1.3 Where there are two or more floors below the street floor, the same stairway or other exit shall be permitted to serve all floors, but all required exits from such areas shall be independent of any open stairways between the street floor and the floor below it.

37.2.1.4 Where exits from the upper floor also serve as an entrance from a principal street, the upper floor shall be classified as a street floor in accordance with the definition of street floor in 3.3.271 and shall be subject to the requirements of this chapter for street floors.

37.2.1.5 High hazard mercantile occupancies shall be arranged in accordance with 37.1.5.2.

37.2.2 Means of Egress Components.

37.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 37.2.2.2 through 37.2.2.12.

37.2.2.2 Doors.

37.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

37.2.2.2.2* Locks complying with 7.2.1.5.5 shall be permitted only on principal entrance/exit doors.

37.2.2.2.3 Elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 shall be permitted.

37.2.2.2.4 The re-entry provisions of 7.2.1.5.8 shall not apply. *[See 7.2.1.5.8.2(1).]*

37.2.2.2.5 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

37.2.2.2.6 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted in buildings protected throughout by an approved, supervised fire detection system in accordance with Section 9.6 or an approved automatic sprinkler system in accordance with 9.7.1.1(1).

37.2.2.2.7 Horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) shall be permitted to be used as part of the required means of egress from a tenant space.

37.2.2.2.8 All doors at the foot of stairs from upper floors or at the head of stairs leading to floors below the street floor shall swing in the direction of egress travel.

37.2.2.2.9 Revolving doors complying with 7.2.1.10 shall be permitted.

37.2.2.2.10 In Class C mercantile occupancies, doors shall be permitted to swing inward against the direction of egress travel where such doors serve only the street floor area.

37.2.2.3 Stairs.

37.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

37.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

37.2.2.3.3 Winders complying with 7.2.2.2.4 shall be permitted.

37.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

37.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

37.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

37.2.2.7 Exit Passageways.

37.2.2.7.1 Exit passageways complying with 7.2.6 shall be permitted.

37.2.2.7.2 Exit passageways in a mall building shall be permitted to accommodate the following occupant loads independently:

(1) Portion of the occupant load assigned to the exit passageway from only the mall/pedestrian way
(2) Largest occupant load assigned to the exit passageway from a single tenant space

37.2.2.8 Escalators and Moving Walks. Escalators and moving walks complying with 7.2.7 shall be permitted.

37.2.2.9 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted.

37.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

37.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

37.2.2.12 Areas of Refuge.

37.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted.

37.2.2.12.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), two rooms or spaces separated from each other by smoke-resistant partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

37.2.3 Capacity of Means of Egress.

37.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

37.2.3.2 In Class A and Class B mercantile occupancies, street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of stairs, ramps, escalators, and moving walks discharging through the street floor.

37.2.4 Number of Means of Egress.

37.2.4.1 Means of egress shall comply with all of the following, except as otherwise permitted by 37.2.4.2 through 37.2.4.5:

(1) The number of means of egress shall be in accordance with Section 7.4.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

37.2.4.2 Exit access as required by 37.2.4.1(3) shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 37.2.5.3.

37.2.4.3 A single means of egress shall be permitted in a Class C mercantile occupancy, provided that the travel distance to the exit or to a mall pedestrian way (*see 37.4.4.2*) does not exceed 75 ft (23 m).

37.2.4.4 A single means of egress shall be permitted in a Class C mercantile occupancy, provided that the travel distance to the exit or to a mall does not exceed 100 ft (30 m), and the story on which the occupancy is located, and all communicating levels that are traversed to reach the exit or mall, are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

37.2.4.5 A single means of egress to an exit or to a mall shall be permitted from a mezzanine within any Class A, Class B, or Class C mercantile occupancy, provided that the common path of travel does not exceed 75 ft (23 m), or does not exceed 100 ft (30 m) if protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

37.2.5 Arrangement of Means of Egress.

37.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

37.2.5.2* Dead-end corridors shall not exceed 50 ft (15 m).

37.2.5.3* Common paths of travel shall be limited in accordance with 37.2.5.3.1 or 37.2.5.3.2.

37.2.5.3.1 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), common paths of travel shall not exceed 100 ft (30 m).

37.2.5.3.2 In buildings not complying with 37.2.5.3.1, common paths of travel shall not exceed 75 ft (23 m).

37.2.5.4 Aisles leading to each exit shall be required, and the aggregate width of such aisles shall be not less than the required width of the exit.

37.2.5.5 Required aisles shall be not less than 28 in. (710 mm) in clear width.

37.2.5.6 In Class A mercantile occupancies, not less than one aisle of a 60 in. (1525 mm) minimum clear width shall lead directly to an exit.

37.2.5.7 In mercantile occupancies other than bulk merchandising retail buildings, if the only means of customer entrance is through one exterior wall of the building, one-half of the required egress width from the street floor shall be located in such wall. Means of egress from floors above or below the street floor shall be arranged in accordance with Section 7.5.

37.2.5.8 Not less than one-half of the required exits shall be located so as to be reached without passing through checkout stands.

37.2.5.9 Checkout stands or associated railings or barriers shall not obstruct exits, required aisles, or approaches thereto.

37.2.5.10* Where wheeled carts or buggies are used by customers, adequate provision shall be made for the transit and parking of such carts to minimize the possibility that they might obstruct means of egress.

37.2.5.11 Exit access in Class A mercantile occupancies that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), and exit access in all Class B and Class C mercantile occupancies, shall be permitted to pass through storerooms, provided that all of the following conditions are met:

(1) Not more than 50 percent of exit access shall be provided through the storeroom.
(2) The storeroom shall not be subject to locking.
(3) The main aisle through the storeroom shall be not less than 44 in. (1120 mm) wide.
(4) The path of travel through the storeroom shall be defined, direct, and continuously maintained in an unobstructed condition.

37.2.6 Travel Distance to Exits. Travel distance shall be as specified in 37.2.6.1 and 37.2.6.2 and shall be measured in accordance with Section 7.6.

37.2.6.1 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), travel distance shall not exceed 250 ft (76 m).

37.2.6.2 In buildings not complying with 37.2.6.1, the travel distance shall not exceed 150 ft (46 m).

37.2.7 Discharge from Exits.

37.2.7.1 Exit discharge shall comply with Section 7.7 and 37.2.7.2.

37.2.7.2* Fifty percent of the exits shall be permitted to discharge through the level of exit discharge in accordance with 7.7.2 only where the building is protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1).

37.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

37.2.9 Emergency Lighting. Class A and Class B mercantile occupancies and mall buildings shall have emergency lighting facilities in accordance with Section 7.9.

37.2.10 Marking of Means of Egress. Where an exit is not immediately apparent from all portions of the sales area, means of egress shall have signs in accordance with Section 7.10.

37.2.11 Special Means of Egress Features.

37.2.11.1 Reserved.

37.2.11.2 Lockups. Lockups in mercantile occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

37.3 Protection.

37.3.1 Protection of Vertical Openings. Any vertical opening shall be protected in accordance with Section 8.6, except under any of the following conditions:

(1) In Class A or Class B mercantile occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), unprotected vertical openings shall be permitted at one of the following locations:
    (a) Between any two floors
    (b) Among the street floor, the first adjacent floor below, and the adjacent floor (or mezzanine) above
(2) In Class C mercantile occupancies, unprotected openings shall be permitted between the street floor and the mezzanine.
(3) The draft stop and closely spaced sprinkler requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall not be required for unenclosed vertical openings permitted in 36.3.1(1) and (2).
(4) Unenclosed vertical openings in accordance with 8.6.9.2 shall be permitted.

37.3.2 Protection from Hazards.

37.3.2.1* General. Hazardous areas shall be protected in accordance with 37.3.2.1.1 or 37.3.2.1.2.

37.3.2.1.1* Hazardous areas shall be protected in accordance with Section 8.7.

37.3.2.1.2 In general storage and stock areas protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2, an enclosure shall be exempt from the provisions of 8.7.1.2.

37.3.2.2* High Hazard Contents Areas. High hazard contents areas, as classified in Section 6.2, shall meet all of the following criteria:

(1) The area shall be separated from other parts of the building by fire barriers having a minimum 1-hour fire resistance rating, with all openings therein protected by self-closing fire door assemblies having a minimum ¾-hour fire protection rating.
(2) The area shall be protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2.

37.3.2.3* Commercial Cooking Operations. Commercial cooking operations shall be protected in accordance with 9.2.3, unless the cooking equipment is one of the following types:

(1) Outdoor equipment
(2) Equipment used only for food warming

37.3.3 Interior Finish.

37.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

37.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C.

37.3.3.3 Interior Floor Finish. (No requirements.)

37.3.4 Detection, Alarm, and Communications Systems.

37.3.4.1 General. Class A mercantile occupancies shall be provided with a fire alarm system in accordance with Section 9.6.

37.3.4.2 Initiation. Initiation of the required fire alarm system shall be by one of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 9.6.2.1(3) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.

37.3.4.3 Notification.

37.3.4.3.1 Occupant Notification. During all times that the mercantile occupancy is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate an alarm in accordance with 9.6.3 throughout the mercantile occupancy, and both of the following also shall apply:
    (a) Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.
    (b) A presignal system in accordance with 9.6.3.3 shall be permitted.
(2) Occupant notification shall be made via a voice communication or public address system in accordance with 9.6.3.9.2.

37.3.4.3.2 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 9.6.4
(2) Local emergency organization, if provided

37.3.5 Extinguishment Requirements.

37.3.5.1 Mercantile occupancies, other than one-story buildings that meet the requirements of a street floor, as defined in 3.3.271, shall be protected by an approved automatic sprinkler system in accordance with 9.7.1.1(1) in any of the following specified locations:

(1) Throughout all mercantile occupancies with a story over 15,000 ft^2 (1400 m^2) in area
(2) Throughout all mercantile occupancies exceeding 30,000 ft^2 (2800 m^2) in gross area

(3) Throughout stories below the level of exit discharge where such stories have an area exceeding 2500 ft^2 (232 m^2) and are used for the sale, storage, or handling of combustible goods and merchandise
(4) Throughout multiple occupancies protected as mixed occupancies in accordance with 6.1.14 where the conditions of 37.3.5.1(1), (2), or (3) apply to the mercantile occupancy

37.3.5.2 Reserved.

37.3.5.3 Portable fire extinguishers shall be provided in all mercantile occupancies in accordance with Section 9.9.

37.3.6 Corridors. (No requirements.)

37.3.7 Subdivision of Building Spaces. (No special requirements.)

37.4 Special Provisions.

37.4.1 Limited Access or Underground Buildings. See Section 11.7.

37.4.2 High-Rise Buildings. (No additional requirements.)

37.4.3 Open-Air Mercantile Operations.

37.4.3.1 Open-air mercantile operations, such as open-air markets, gasoline filling stations, roadside stands for the sale of farm produce, and other outdoor mercantile operations, shall be arranged and conducted to maintain free and unobstructed ways of travel at all times.

37.4.3.2 Ways of travel shall allow prompt escape from any point of danger in case of fire or other emergency, with no dead ends in which persons might be trapped due to display stands, adjoining buildings, fences, vehicles, or other obstructions.

37.4.3.3 Mercantile operations that are conducted in roofed-over areas shall be treated as mercantile buildings, provided that canopies over individual small stands to protect merchandise from the weather are not construed as constituting buildings for the purpose of this *Code*.

37.4.4 Mall Buildings.

37.4.4.1 The provisions of 37.4.4 shall apply to mall buildings and any number of anchor buildings.

37.4.4.2 Special Definitions. The following is a list of special terms used in this chapter:

(1) **Anchor Building.** A building housing any occupancy having low- or ordinary-hazard contents and having direct access to a mall building, but having all required means of egress independent of the mall. *(See 3.3.36.2.)*
(2) **Food Court.** A public seating area located in a mall that serves adjacent food preparation tenant spaces. *(See 3.3.50.2.)*
(3) **Gross Leasable Area.** Fifty percent of major tenant areas, and 100 percent of all other floor areas designated for tenant occupancy and exclusive use, including storage areas. The area of tenant occupancy is measured from the centerlines of joint partitions to the outside of the tenant walls. *(See 3.3.21.3)*
(4) **Mall.** A roofed or covered common pedestrian area within a mall building that serves as access for two or more tenants and does not exceed three levels that are open to each other. *(See 3.3.169.)*
(5)* **Mall Building.** A single building enclosing a number of tenants and occupancies wherein two or more tenants have a main entrance into one or more malls. For the purpose of this chapter, anchor buildings shall not be considered as a part of the mall building. *(See 3.3.36.9.)*
(6) **Major Tenant.** A tenant space, in a mall building, with one or more main entrances from the exterior that also serve as exits and are independent of the mall. *(See 3.3.168.)*

37.4.4.3 General. The mall building shall be treated as a single building for the purpose of calculation of means of egress and shall be subject to the requirements for appropriate occupancies, except as modified by the provisions of 37.4.4; and the mall shall be of a clear width not less than that needed to accommodate egress requirements as set forth in other sections of this *Code*.

37.4.4.4 Pedestrian Way. The mall shall be permitted to be considered a pedestrian way, provided that the criteria of 37.4.4.4.1 and 37.4.4.4.2 are met.

37.4.4.4.1 The travel distance within a tenant space to an exit or to the mall shall not exceed the maximum travel distance permitted by the occupancy chapter.

37.4.4.4.2 An additional 200 ft (61 m) shall be permitted for travel through the mall space, provided that all the following requirements are met:

(1) The mall shall be of a clear width not less than that needed to accommodate egress requirements, as set forth in other sections of this chapter, but shall be not less than 20 ft (6100 mm) wide in its narrowest dimension.
(2) On each side of the mall floor area, the mall shall be provided with an unobstructed exit access of not less than 10 ft (3050 mm) in clear width parallel to, and adjacent to, the mall tenant front.
(3)* The exit access specified in 37.4.4.4.2(2) shall lead to an exit having a width of not less than 66 in. (1675 mm).
(4) The mall, and all buildings connected thereto, except open parking structures, shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(5) Walls dividing tenant spaces from each other shall extend from the floor to the underside of the roof deck, to the floor deck above, or to the ceiling where the ceiling is constructed to limit the transfer of smoke, and all of the following also shall apply:
    (a) Where the tenant areas are provided with an engineered smoke control system, walls shall not be required to divide tenant spaces from each other.
    (b) No separation shall be required between a tenant space and the mall.
(6)* Malls with a floor opening connecting more than two levels shall be provided with a smoke control system.

37.4.4.5 Mixed Occupancies. Assembly occupancies, other than stadiums and arenas, and business and mercantile occupancies located in mall buildings shall not be required to comply with the provisions of 6.1.14.4.

37.4.4.6 Means of Egress Details.

37.4.4.6.1 Dead ends not exceeding a length equal to twice the width of the mall, measured at the narrowest location within the dead-end portion of the mall, shall be permitted.

37.4.4.6.2 Every story of a covered mall building shall be provided with the number of means of egress specified by Section 7.4 and as modified by 37.4.4.6.2.1 or 37.4.4.6.2.2.

37.4.4.6.2.1 Exit access travel shall be permitted to be common for the distances permitted as common paths of travel by 37.2.5.3.

37.4.4.6.2.2 A single means of egress shall be permitted in a Class C mercantile occupancy or a business occupancy, provided that the travel distance to the exit or to a mall *(see 37.4.4.2)* does not exceed 100 ft (30 m).

37.4.4.6.3 Every floor of a mall shall be provided with the number of means of egress specified by Section 7.4, with not less than two means of egress remotely located from each other.

37.4.4.6.4 Class A and Class B mercantile occupancies connected to a mall shall be provided with the number of means of egress required by Section 7.4, with not less than two means of egress remotely located from one another.

37.4.4.6.5* Each individual anchor building shall have means of egress independent of the mall.

37.4.4.6.6 Each individual major tenant of a mall building shall have a minimum of one-half of its required means of egress independent of the mall.

37.4.4.6.7 Reserved.

37.4.4.6.8 Emergency lighting shall be provided in accordance with 37.2.9.

37.4.4.7 Detection, Alarm, and Communications Systems.

37.4.4.7.1 General. Malls shall be provided with a fire alarm system in accordance with Section 9.6.

37.4.4.7.2 Initiation. Initiation of the required fire alarm system shall be by means of the required automatic sprinkler system in accordance with 9.6.2.1(3).

37.4.4.7.3 Notification.

37.4.4.7.3.1 Occupant Notification. During all times that the mall is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate an alarm in accordance with 9.6.3 throughout the mall, and positive alarm sequence in accordance with 9.6.3.4 shall be permitted.
(2) Occupant notification shall be permitted to be made via a voice communication or public address system in accordance with 9.6.3.9.2.

37.4.4.7.3.2 *(See 9.6.3.5.3.)*

37.4.4.7.3.3 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying all of the following:

(1) Fire department in accordance with 9.6.4
(2) Local emergency organization, if provided

37.4.4.7.4 Emergency Control. The fire alarm system shall be arranged to automatically actuate smoke management or smoke control systems in accordance with 9.6.5.2(3).

37.4.4.8 Tenant Spaces. Each individual tenant space shall have means of egress to the outside or to the mall based on occupant load calculated by using Table 7.3.1.2.

37.4.4.9 Exit Passageways. Exit passageways shall comply with 37.4.4.9.1 and 37.4.4.9.2.

37.4.4.9.1 Exit passageways in a mall building shall be permitted to accommodate the following occupant loads independently:

(1) Portion of the occupant load assigned to the exit passageway from only the mall
(2) Largest occupant load assigned to the exit passageway from a single tenant space

37.4.4.9.2* Rooms housing building service equipment, janitor closets, and service elevators shall be permitted to open directly onto exit passageways, provided that all of the following criteria are met:

(1) The required fire resistance rating between such rooms or areas and the exit passageway shall be maintained in accordance with 7.1.3.2.
(2) Such rooms or areas shall be protected by an approved automatic sprinkler system in accordance with 9.7.1.1(1), but the exceptions in NFPA 13, *Standard for the Installation of Sprinkler Systems*, allowing the omission of sprinklers from such rooms shall not be permitted.
(3) Service elevators opening into the exit passageway shall not open into areas other than exit passageways.
(4) Where exit stair enclosures discharge into the exit passageway, the provisions of 7.2.1.5.8 shall apply, regardless of the number of stories served.

37.4.4.10 Plastic Signs. Within every store or level, and from sidewall to sidewall of each tenant space facing the mall, plastic signs shall comply with all of the following:

(1) Plastic signs shall not exceed 20 percent of the wall area facing the mall.
(2) Plastic signs shall not exceed a height of 36 in. (915 mm), except if the sign is vertical, in which case the height shall not exceed 8 ft (2440 mm) and the width shall not exceed 36 in. (915 mm).
(3) Plastic signs shall be located a minimum distance of 18 in. (455 mm) from adjacent tenants.
(4) Plastics, other than foamed plastics, shall meet one of the following criteria:
    (a) They shall be light-transmitting plastics.
    (b) They shall have a self-ignition temperature of 650°F (343°C) or greater when tested in accordance with ASTM D 1929, *Standard Test Method for Determining Ignition Temperatures of Plastic*, and a flame spread index not greater than 75 and a smoke developed index not greater than 450 when tested in the manner intended for use in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*.
(5) The edges and backs of plastic signs in the mall shall be fully encased in metal.
(6) Foamed plastics shall have a maximum heat release rate of 150 kW when tested in accordance with ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(7) Foamed plastics shall comply with all of the following:
    (a) The density of foamed plastic signs shall be not less than 20 lb/ft^3 (320 kg/m^3).
    (b) The thickness of foamed plastic signs shall be not greater than ½ in. (13 mm).

37.4.4.11 Kiosks. Kiosks and similar structures (temporary or permanent) shall not be considered as tenant spaces and shall meet all of the following requirements:

(1) Combustible kiosks and similar structures shall be constructed of any of the following materials:

(a) Fire-retardant-treated wood complying with the requirements for fire-retardant-impregnated wood in NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*
(b) Light-transmitting plastics complying with the building code
(c) Foamed plastics having a maximum heat release rate not greater than 100 kW when tested in accordance with ANSI/UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source
(d) Metal composite material (MCM) having a flame spread index not greater than 25 and a smoke developed index not greater than 450 in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, when tested as an assembly in the maximum thickness intended for use
(e) Textiles and films meeting the flame propagation performance criteria contained in Test Method 1 or Test Method 2, as appropriate, of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*

(2) Kiosks or similar structures located within the mall shall be protected with approved fire suppression and detection devices.
(3) The minimum horizontal separation between kiosks, or groups of kiosks, and other structures within the mall shall be 20 ft (6100 mm).
(4) Each kiosk, or group of kiosks, or similar structure shall have a maximum area of 300 ft^2 (27.8 m^2).

37.4.5 Bulk Merchandising Retail Buildings. Existing bulk merchandising retail buildings exceeding 15,000 ft^2 (1400 m^2) in area shall comply with the requirements of this chapter, as modified by 37.4.5.1 through 37.4.5.6.2.

37.4.5.1 Minimum Construction Requirements. (No requirements.)

37.4.5.2 Means of Egress Requirements.

37.4.5.2.1 All means of egress shall be in accordance with Chapter 7 and this chapter.

37.4.5.2.2 Not less than 50 percent of the required egress capacity shall be located independent of the main entrance/exit doors.

> Paragraph 37.4.5.3 was revised by a tentative interim amendment (TIA). See page 1.

37.4.5.3 Storage, Arrangement, Protection, and Quantities of Hazardous Commodities. The storage, arrangement, protection, and quantities of hazardous commodities shall be in accordance with the applicable provisions of the following:

(1) The fire code *(see 3.3.96)*
(2) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(3) NFPA 30, *Flammable and Combustible Liquids Code*
(4) NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*
(5) NFPA 400, *Hazardous Materials Code*, Chapter 14, for organic peroxide formulations
(6) NFPA 400, *Hazardous Materials Code*, Chapter 15, for oxidizer solids and liquids
(7) NFPA 400, *Hazardous Materials Code*, various chapters, depending on characteristics of a particular pesticide

37.4.5.4 Detection, Alarm, and Communications Systems.

37.4.5.4.1 General. Bulk merchandising retail buildings shall be provided with a fire alarm system in accordance with Section 9.6.

37.4.5.4.2 Initiation. Initiation of the required fire alarm system shall be by means of the required approved automatic sprinkler system (*see 37.4.5.5)* in accordance with 9.6.2.1(3).

37.4.5.4.3 Occupant Notification. During all times that the mercantile occupancy is occupied, the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate an alarm in accordance with 9.6.3 throughout the mercantile occupancy, and positive alarm sequence in accordance with 9.6.3.4 shall be permitted.
(2) Occupant notification shall be permitted to be made via a voice communication or public address system in accordance with 9.6.3.9.2.

37.4.5.4.4 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 9.6.4
(2) Approved local emergency organization, if provided

37.4.5.5 Extinguishing Requirements. Bulk merchandising retail buildings shall be protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1) and the applicable provisions of the following:

(1) The fire code *(see 3.3.96)*
(2) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(3) NFPA 30, *Flammable and Combustible Liquids Code*
(4) NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*

37.4.5.6 Emergency Action Plans and Employee Training.

37.4.5.6.1 There shall be in effect an approved written plan for the emergency egress and relocation of occupants.

37.4.5.6.2 All employees shall be instructed and periodically drilled with respect to their duties under the plan.

> Paragraph 37.4.6 was deleted by a tentative interim amendment (TIA). See page 1.

37.4.6 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

37.5 Building Services.

37.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

37.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

37.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

37.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

37.6 Reserved.

37.7 Operating Features.

37.7.1 Emergency Action Plan. Emergency action plans complying with Section 4.8 shall be provided in high-rise buildings.

37.7.2 Drills. In every Class A or Class B mercantile occupancy, employees shall be periodically trained in accordance with Section 4.7.

37.7.3 Extinguisher Training. Employees of mercantile occupancies shall be periodically instructed in the use of portable fire extinguishers.

37.7.4 Food Service Operations. Food service operations shall comply with 13.7.2.

37.7.5 Upholstered Furniture and Mattresses. The provisions of 10.3.2 shall not apply to upholstered furniture and mattresses.

37.7.6 Soiled Linen and Trash Receptacles. The requirements of 10.3.9 for containers for waste, or linen with a capacity of 20 gal (75.7 L) or more shall not apply.

37.7.7 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 38 New Business Occupancies

38.1 General Requirements.

38.1.1 Application.

38.1.1.1 The requirements of this chapter shall apply to new buildings or portions thereof used as business occupancies. *(See 1.3.1.)*

38.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

38.1.1.3 General. The provisions of Chapter 4, General, shall apply.

38.1.1.4 The provisions of this chapter shall apply to life safety requirements for all new business buildings.

38.1.1.5 Additions to existing buildings shall conform to the requirements of 4.6.7. Existing portions of the structure shall not be required to be modified, provided that the new construction has not diminished the fire safety features of the facility.

38.1.2 Classification of Occupancy. Business occupancies shall include all buildings and structures or parts thereof with occupancy as defined in 6.1.11.

38.1.3 Multiple Occupancies.

38.1.3.1 General.

38.1.3.1.1 All multiple occupancies shall be in accordance with 6.1.14 and 38.1.3.

38.1.3.1.2 Where there are differences in the specific requirements in this chapter and provisions for mixed occupancies or separated occupancies as specified in 6.1.14.3 and 6.1.14.4, the requirements of this chapter shall apply.

38.1.3.2 Combined Business Occupancies and Parking Structures.

38.1.3.2.1 The fire barrier separating parking structures from a building classified as a business occupancy shall be a fire barrier having a minimum 2-hour fire resistance rating.

38.1.3.2.2 Openings in the fire barrier required by 38.1.3.2.1 shall not be required to be protected with fire protection–rated opening protectives in enclosed parking structures that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), or in open parking structures, provided that all of the following conditions are met:

(1) The openings do not exceed 25 percent of the area of the fire barrier in which they are located.
(2) The openings are used as a public entrance and for associated sidelight functions.
(3) The building containing the business occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(4)*Means are provided to prevent spilled fuel from accumulating adjacent to the openings and entering the building.
(5) Physical means are provided to prevent vehicles from being parked or driven within 10 ft (3050 mm) of the openings.
(6) The openings are protected as a smoke partition in accordance with Section 8.4, with no minimum fire protection rating required.

38.1.3.3 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis from nonhazardous spaces in assembly, educational, day care, health care, ambulatory health care, residential, residential board and care occupancies, and mercantile occupancies other than bulk merchandise buildings.

38.1.4 Definitions.

38.1.4.1 General. For definitions, see Chapter 3, Definitions.

38.1.4.2 Special Definitions. Special terms applicable to this chapter are defined in Chapter 3.

38.1.5 Classification of Hazard of Contents. The contents of business occupancies shall be classified as ordinary hazard in accordance with Section 6.2.

38.1.6 Minimum Construction Requirements. (Reserved.)

38.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

38.2 Means of Egress Requirements.

38.2.1 General.

38.2.1.1 All means of egress shall be in accordance with Chapter 7 and this chapter.

38.2.1.2 If, owing to differences in the finished ground level, any street floor exits are located at points above or below the street or the finished ground level, such exits shall comply with the provisions for exits from upper floors or floors below the street floor.

38.2.1.3 Stairs and ramps serving two or more floors below a street floor occupied for business use shall be permitted in accordance with 38.2.1.3.1 and 38.2.1.3.2.

38.2.1.3.1 Where two or more floors below the street floor are occupied for business use, the same stairs or ramps shall be permitted to serve each floor.

38.2.1.3.2 An inside open stairway or inside open ramp shall be permitted to serve as a component of the required means of egress system from not more than one floor level below the street floor.

38.2.1.4 Floor levels that are below the street floor; are used only for storage, heating, and other service equipment; and are not subject to business occupancy shall have means of egress in accordance with Chapter 42.

38.2.2 Means of Egress Components.

38.2.2.1 General. Means of egress components shall be limited to the types described in 38.2.2.2 through 38.2.2.12.

38.2.2.2 Doors.

38.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

38.2.2.2.2* Locks complying with 7.2.1.5.5 shall be permitted only on principal entrance/exit doors.

38.2.2.2.3 Elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 shall be permitted.

38.2.2.2.4 Reserved.

38.2.2.2.5 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

38.2.2.2.6 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

38.2.2.2.7 Horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) shall be permitted to be used as part of the required means of egress from a tenant space.

38.2.2.2.8 Reserved.

38.2.2.2.9 Revolving doors complying with 7.2.1.10 shall be permitted.

38.2.2.3 Stairs.

38.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

38.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

38.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

38.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

38.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

38.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

38.2.2.8 Reserved.

38.2.2.9 Reserved.

38.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

38.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

38.2.2.12 Areas of Refuge.

38.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted.

38.2.2.12.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), two rooms or spaces separated from each other by smoke-resistant partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

38.2.3 Capacity of Means of Egress.

38.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

38.2.3.2* The clear width of any corridor or passageway serving an occupant load of 50 or more shall be not less than 44 in. (1120 mm).

38.2.3.3 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of open stairs and ramps discharging through the street floor.

38.2.4 Number of Means of Egress.

38.2.4.1 Means of egress shall comply with all of the following, except as otherwise permitted by 38.2.4.2 through 38.2.4.6:

(1) The number of means of egress shall be in accordance with Section 7.4.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

38.2.4.2 Exit access, as required by 38.2.4.1(3), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 38.2.5.3.

38.2.4.3 A single exit shall be permitted for a room or area with a total occupant load of less than 100 persons, provided that all of the following criteria are met:

(1) The exit shall discharge directly to the outside at the level of exit discharge for the building.
(2) The total distance of travel from any point, including travel within the exit, shall not exceed 100 ft (30 m).
(3) The total distance of travel specified in 38.2.4.3(2) shall be on the same story, or, if traversing of stairs is necessary, such stairs shall not exceed 15 ft (4570 mm) in height, and both of the following also shall apply:
    (a) Interior stairs shall be provided with complete enclosures to separate them from any other part of the building, with no door openings therein.
    (b) A single outside stair in accordance with 7.2.2 shall be permitted to serve all stories permitted within the 15 ft (4570 mm) vertical travel limitation.

38.2.4.4 Any business occupancy three or fewer stories in height, and not exceeding an occupant load of 30 people per story, shall be permitted a single separate exit to each story, provided that all of the following criteria are met:

(1) The exit shall discharge directly to the outside.
(2) The total travel distance to the outside of the building shall not exceed 100 ft (30 m).
(3) The exit shall be enclosed in accordance with 7.1.3.2, and both of the following also shall apply:
    (a) The stair shall serve as an exit from no other stories.
    (b) A single outside stair in accordance with 7.2.2 shall be permitted to service all stories.

38.2.4.5 A single means of egress shall be permitted from a mezzanine within a business occupancy, provided that the common path of travel does not exceed 75 ft (23 m), or 100 ft (30 m) if protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

38.2.4.6 A single means of egress shall be permitted for a maximum two-story, single-tenant space or building provided that both of the following criteria are met:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(2) The total travel to the outside does not exceed 100 ft (30 m).

38.2.5 Arrangement of Means of Egress.

38.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

38.2.5.2 Dead-end corridors shall be permitted in accordance with 38.2.5.2.1 or 38.2.5.2.2.

38.2.5.2.1 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), dead-end corridors shall not exceed 50 ft (15 m).

38.2.5.2.2 In buildings other than those complying with 38.2.5.2.1, dead-end corridors shall not exceed 20 ft (6100 mm).

38.2.5.3 Limitations on common path of travel shall be in accordance with 38.2.5.3.1, 38.2.5.3.2, and 38.2.5.3.3.

38.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) in a building protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).

38.2.5.3.2 Common path of travel shall not exceed 100 ft (30 m) within a single tenant space having an occupant load not exceeding 30 persons.

38.2.5.3.3 In buildings other than those complying with 38.2.5.3.1 or 38.2.5.3.2, common path of travel shall not exceed 75 ft (23 m).

38.2.6 Travel Distance to Exits. Travel distance shall comply with 38.2.6.1 through 38.2.6.3.

38.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

38.2.6.2 Travel distance to an exit shall not exceed 200 ft (61 m) from any point in a building, unless otherwise permitted by 38.2.6.3.

38.2.6.3 Travel distance shall not exceed 300 ft (91 m) in business occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

38.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

38.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

38.2.9 Emergency Lighting.

38.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9 in any building where any one of the following conditions exists:

(1) The building is three or more stories in height.
(2) The occupancy is subject to 50 or more occupants above or below the level of exit discharge.
(3) The occupancy is subject to 300 or more total occupants.

38.2.9.2 Emergency lighting in accordance with Section 7.9 shall be provided for all underground and limited access structures, as defined in 3.3.272.11 and 3.3.272.3, respectively.

38.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

38.2.11 Special Means of Egress Features.

38.2.11.1 Reserved.

38.2.11.2 Lockups. Lockups in business occupancies shall comply with the requirements of 22.4.5.

38.3 Protection.

38.3.1 Protection of Vertical Openings.

38.3.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by any of the following:

(1) Unenclosed vertical openings in accordance with 8.6.9.1 shall be permitted.
(2) Unenclosed vertical openings in accordance with 8.6.9.2 shall be permitted and the provisions of 8.6.9.2(5) shall not apply.
(3) Unenclosed vertical openings in accordance with 8.6.9.7 shall be permitted and the number of contiguous stories shall not be limited.
(4) Exit access stairs in accordance with 38.2.4.6 shall be permitted to be unenclosed.

38.3.1.2 Floors that are below the street floor and are used for storage or other than a business occupancy shall have no unprotected openings to business occupancy floors.

38.3.2 Protection from Hazards.

38.3.2.1* General. Hazardous areas including, but not limited to, areas used for general storage, boiler or furnace rooms, and maintenance shops that include woodworking and painting areas shall be protected in accordance with Section 8.7.

38.3.2.2* High Hazard Contents Areas. High hazard contents areas, as classified in Section 6.2, shall meet all of the following criteria:

(1) The area shall be separated from other parts of the building by fire barriers having a minimum 1-hour fire resistance rating, with all openings therein protected by self-closing fire door assemblies having a minimum ¾-hour fire protection rating.
(2) The area shall be protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2.

38.3.2.3* Commercial Cooking Operations. Commercial cooking operations shall be protected in accordance with 9.2.3, unless the cooking equipment is one of the following types:

(1) Outdoor equipment
(2) Equipment used only for food warming

38.3.3 Interior Finish.

38.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

38.3.3.2 Interior Wall and Ceiling Finish.

38.3.3.2.1 Interior wall and ceiling finish material complying with Section 10.2 shall be Class A or Class B in exits and in exit access corridors.

38.3.3.2.2 Interior wall and ceiling finishes shall be Class A, Class B, or Class C in areas other than those specified in 38.3.3.2.1.

38.3.3.3 Interior Floor Finish.

38.3.3.3.1 Interior floor finish shall comply with Section 10.2.

38.3.3.3.2 Interior floor finish in exit enclosures shall be Class I or Class II.

38.3.3.3.3 Interior floor finish shall comply with 10.2.7.1 or 10.2.7.2, as applicable.

38.3.4 Detection, Alarm, and Communications Systems.

38.3.4.1 General. A fire alarm system in accordance with Section 9.6 shall be provided in all business occupancies where any one of the following conditions exists:

(1) The building is three or more stories in height.
(2) The occupancy is subject to 50 or more occupants above or below the level of exit discharge.
(3) The occupancy is subject to 300 or more total occupants.

38.3.4.2 Initiation. Initiation of the required fire alarm system shall be by any one of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 9.6.2.1(3) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.

38.3.4.3 Occupant Notification. During all times that the building is occupied (see 7.2.1.1.3), the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate a general alarm in accordance with 9.6.3.
(2) A positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

38.3.4.4 Emergency Forces Notification. Emergency forces notification shall be provided and shall include notifying both of the following:

(1) Fire department in accordance with 9.6.4
(2) Approved local emergency organization, if provided

38.3.5 Extinguishment Requirements. Portable fire extinguishers shall be provided in every business occupancy in accordance with Section 9.9.

38.3.6 Corridors.

38.3.6.1* Where access to exits is provided by corridors, such corridors shall be separated from use areas by fire barriers in accordance with Section 8.3 having a minimum 1-hour fire resistance rating, unless one of the following conditions exists:

(1)*Where exits are available from an open floor area
(2)*Within a space occupied by a single tenant
(3) Within buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)

38.3.6.2 Openings in corridor walls required by 38.3.6.1 to have a fire resistance rating shall be protected in accordance with Section 8.3.

38.3.7 Subdivision of Building Spaces. (No special requirements.)

38.4 Special Provisions.

38.4.1 Limited Access or Underground Buildings. See Section 11.7.

38.4.2 High-Rise Buildings. High-rise buildings shall comply with Section 11.8.

38.4.3 Air Traffic Control Towers.

38.4.3.1 Air traffic control towers shall comply with the requirements of this chapter and Section 11.3.

38.4.3.2 The requirements of Section 11.8 shall not apply to air traffic control towers.

38.4.4 Alcohol-Based Hand-Rub Dispensers Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

38.5 Building Services.

38.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

38.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

38.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

38.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

38.6 Reserved.

38.7 Operating Features.

38.7.1 Emergency Action Plans. Emergency action plans complying with Section 4.8 shall be provided in high-rise buildings.

38.7.2 Drills. In all business occupancy buildings occupied by more than 500 persons, or by more than 100 persons above or below the street level, employees and supervisory personnel shall be periodically instructed in accordance with Section 4.7 and shall hold drills periodically where practicable.

38.7.3 Extinguisher Training. Designated employees of business occupancies shall be periodically instructed in the use of portable fire extinguishers.

38.7.4 Food Service Operations. Food service operations shall comply with 12.7.2.

38.7.5 Upholstered Furniture and Mattresses. The provisions of 10.3.2 shall not apply to upholstered furniture and mattresses.

38.7.6 Soiled Linen and Trash Receptacles. The requirements of 10.3.9 for containers for waste, or linen with a capacity of 20 gal (75.7 L) or more shall not apply.

38.7.7 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 39 Existing Business Occupancies

39.1 General Requirements.

39.1.1 Application.

39.1.1.1 The requirements of this chapter shall apply to existing buildings or portions thereof currently occupied as business occupancies.

39.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

39.1.1.3 General. The provisions of Chapter 4, General, shall apply.

39.1.1.4 The provisions of this chapter shall apply to life safety requirements for existing business buildings. Specific requirements shall apply to high-rise buildings *(see definition in 3.3.36.7)* and are contained in paragraphs pertaining thereto.

39.1.2 Classification of Occupancy. Business occupancies shall include all buildings and structures or parts thereof with occupancy as defined in 6.1.11.

39.1.3 Multiple Occupancies.

39.1.3.1 General.

39.1.3.1.1 All multiple occupancies shall be in accordance with 6.1.14 and 39.1.3.

39.1.3.1.2 Where there are differences in the specific requirements in this chapter and provisions for mixed occupancies or separated occupancies as specified in 6.1.14.3 and 6.1.14.4, the requirements of this chapter shall apply.

39.1.3.2 Combined Business Occupancies and Parking Structures.

39.1.3.2.1 The fire barrier separating parking structures from a building classified as a business occupancy shall be a fire barrier having a minimum 2-hour fire resistance rating.

39.1.3.2.2 Openings in the fire barrier required by 39.1.3.2.1 shall not be required to be protected with fire protection–rated opening protectives in enclosed parking structures that are protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), or in open parking structures, provided that all of the following conditions are met:

(1) The openings do not exceed 25 percent of the area of the fire barrier in which they are located.
(2) The openings are used as a public entrance and for associated sidelight functions.
(3) The building containing the business occupancy is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(4)*Means are provided to prevent spilled fuel from accumulating adjacent to the openings and entering the building.
(5) Physical means are provided to prevent vehicles from being parked or driven within 10 ft (3050 mm) of the openings.
(6) The openings are protected as a smoke partition in accordance with Section 8.4, with no minimum fire protection rating required.

39.1.3.3 Atrium walls in accordance with 6.1.14.4.6 shall be permitted to serve as part of the separation required by 6.1.14.4.1 for creating separated occupancies on a story-by-story basis from nonhazardous spaces in assembly, educational, daycare, health care, ambulatory health care, residential, residential board and care occupancies, and mercantile occupancies other than bulk merchandise buildings.

39.1.4 Definitions.

39.1.4.1 General. For definitions, see Chapter 3, Definitions.

39.1.4.2 Special Definitions. Special terms applicable to this chapter are defined in Chapter 3.

39.1.5 Classification of Hazard of Contents. The contents of business occupancies shall be classified as ordinary hazard in accordance with Section 6.2.

39.1.6 Minimum Construction Requirements. (Reserved.)

39.1.7 Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors that are characteristic of the use of the space or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

39.2 Means of Egress Requirements.

39.2.1 General.

39.2.1.1 All means of egress shall be in accordance with Chapter 7 and this chapter.

39.2.1.2 If, owing to differences in the finished ground level, any street floor exits are located at points above or below the street or the finished ground level, such exits shall comply with the provisions for exits from upper floors or floors below the street floor.

39.2.1.3 Stairs and ramps serving two or more floors below a street floor occupied for business use shall be permitted in accordance with 39.2.1.3.1 and 39.2.1.3.2.

39.2.1.3.1 Where two or more floors below the street floor are occupied for business use, the same stairs, escalators, or ramps shall be permitted to serve each floor.

39.2.1.3.2 An inside open stairway, inside open escalator, or inside open ramp shall be permitted to serve as a component of the required means of egress system from not more than one floor level below the street floor.

39.2.1.4 Floor levels that are below the street floor; are used only for storage, heating, and other service equipment; and are not subject to business occupancy shall have means of egress in accordance with Chapter 42.

39.2.2 Means of Egress Components.

39.2.2.1 Components Permitted. Means of egress components shall be limited to the types described in 39.2.2.2 through 39.2.2.12.

39.2.2.2 Doors.

39.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

39.2.2.2.2* Locks complying with 7.2.1.5.5 shall be permitted only on principal entrance/exit doors.

39.2.2.2.3 Elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 shall be permitted.

39.2.2.2.4 The re-entry provisions of 7.2.1.5.8 shall not apply to any of the following:

(1) Existing business occupancies that are not high-rise buildings

(2) Existing high-rise business occupancy buildings that are protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1)
(3) Existing high-rise business occupancy buildings having approved existing means for providing stair re-entry

39.2.2.2.5 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

39.2.2.2.6 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

39.2.2.2.7 Horizontal or vertical security grilles or doors complying with 7.2.1.4.1(3) shall be permitted to be used as part of the required means of egress from a tenant space.

39.2.2.2.8 Approved existing horizontal-sliding or vertical-rolling fire doors shall be permitted in the means of egress where they comply with all of the following conditions:

(1) They are held open by fusible links.
(2) The fusible links are rated at not less than 165°F (74°C).
(3) The fusible links are located not more than 10 ft (3050 mm) above the floor.
(4) The fusible links are in immediate proximity to the door opening.
(5) The fusible links are not located above a ceiling.
(6) The door is not credited with providing any protection under this *Code*.

39.2.2.2.9 Revolving doors complying with 7.2.1.10 shall be permitted.

39.2.2.3 Stairs.

39.2.2.3.1 Stairs complying with 7.2.2 shall be permitted.

39.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

39.2.2.3.3 Winders complying with 7.2.2.2.4 shall be permitted.

39.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

39.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

39.2.2.6 Ramps. Ramps complying with 7.2.5 shall be permitted.

39.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

39.2.2.8 Escalators and Moving Walks. Escalators and moving walks complying with 7.2.7 shall be permitted.

39.2.2.9 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted.

39.2.2.10 Fire Escape Ladders. Fire escape ladders complying with 7.2.9 shall be permitted.

39.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

39.2.2.12 Areas of Refuge.

39.2.2.12.1 Areas of refuge complying with 7.2.12 shall be permitted.

39.2.2.12.2 In buildings protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), two rooms or spaces separated from each other by smoke-resistant partitions in accordance with the definition of area of refuge in 3.3.22 shall not be required.

39.2.3 Capacity of Means of Egress.

39.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

39.2.3.2 The clear width of any corridor or passageway serving an occupant load of 50 or more shall be not less than 44 in. (1120 mm).

39.2.3.3 Street floor exits shall be sufficient for the occupant load of the street floor plus the required capacity of open stairs, ramps, escalators, and moving walks discharging through the street floor.

39.2.4 Number of Means of Egress.

39.2.4.1 Means of egress shall comply with all of the following, except as otherwise permitted by 39.2.4.2 through 39.2.4.6:

(1) The number of means of egress shall be in accordance with 7.4.1.1 and 7.4.1.3 through 7.4.1.6.
(2) Not less than two separate exits shall be provided on every story.
(3) Not less than two separate exits shall be accessible from every part of every story.

39.2.4.2 Exit access, as required by 39.2.4.1(3), shall be permitted to include a single exit access path for the distances permitted as common paths of travel by 39.2.5.3.

39.2.4.3 A single exit shall be permitted for a room or area with a total occupant load of less than 100 persons, provided that all of the following criteria are met:

(1) The exit shall discharge directly to the outside at the level of exit discharge for the building.
(2) The total distance of travel from any point, including travel within the exit, shall not exceed 100 ft (30 m).
(3) The total distance of travel specified in 39.2.4.3(2) shall be on the same story, or, if traversing of stairs is necessary, such stairs shall not exceed 15 ft (4570 mm) in height, and both of the following also shall apply:
   (a) Interior stairs shall be provided with complete enclosures to separate them from any other part of the building, with no door openings therein.
   (b) A single outside stair in accordance with 7.2.2 shall be permitted to serve all stories permitted within the 15 ft (4570 mm) vertical travel limitation.

39.2.4.4 Any business occupancy three or fewer stories in height, and not exceeding an occupant load of 30 people per story, shall be permitted a single separate exit to each story, provided that all of the following criteria are met:

(1) The exit shall discharge directly to the outside.
(2) The total travel distance to the outside of the building shall not exceed 100 ft (30 m).
(3) The exit shall be enclosed in accordance with 7.1.3.2, and both of the following also shall apply:
   (a) The stair shall serve as an exit from no other stories.
   (b) A single outside stair in accordance with 7.2.2 shall be permitted to service all stories.

39.2.4.5 A single means of egress shall be permitted from a mezzanine within a business occupancy, provided that the common path of travel does not exceed 75 ft (23 m), or 100 ft (30 m) if protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1).

39.2.4.6 A single means of egress shall be permitted for a maximum two-story, single-tenant space or building provided that both of the following criteria are met:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1).
(2) The total travel to the outside does not exceed 100 ft (30 m).

39.2.4.7 A single exit shall be permitted for a single-tenant building three or fewer stories in height and not exceeding an occupant load of 15 people per story, provided that all of the following criteria are met:

(1) The building is protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1) and an automatic smoke-detection system in accordance with Section 9.6.
(2) Activation of the building sprinkler or smoke detection system shall provide occupant notification throughout the building.
(3) The total travel to the outside does not exceed 100 ft (30 m).

39.2.5 Arrangement of Means of Egress.

39.2.5.1 Means of egress shall be arranged in accordance with Section 7.5.

39.2.5.2* Dead-end corridors shall not exceed 50 ft (15 m).

39.2.5.3* Limitations on common path of travel shall be in accordance with 39.2.5.3.1, 39.2.5.3.2, and 39.2.5.3.3.

39.2.5.3.1 Common path of travel shall not exceed 100 ft (30 m) on a story protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1).

39.2.5.3.2 Common path of travel shall not be limited in a single-tenant space with an occupant load not exceeding 30 people.

39.2.5.3.3 In buildings other than those complying with 39.2.5.3.1 or 39.2.5.3.2, common path of travel shall not exceed 75 ft (23 m).

39.2.6 Travel Distance to Exits. Travel distance shall comply with 39.2.6.1 through 39.2.6.3.

39.2.6.1 Travel distance shall be measured in accordance with Section 7.6.

39.2.6.2 Travel distance to an exit shall not exceed 200 ft (61 m) from any point in a building, unless otherwise permitted by 39.2.6.3.

39.2.6.3 Travel distance shall not exceed 300 ft (91 m) in business occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7.

39.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

39.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8.

39.2.9 Emergency Lighting.

39.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9 in any building where any one of the following conditions exists:

(1) The building is three or more stories in height.
(2) The occupancy is subject to 100 or more occupants above or below the level of exit discharge.
(3) The occupancy is subject to 1000 or more total occupants.

39.2.9.2 Emergency lighting in accordance with Section 7.9 shall be provided for all underground and limited access structures, as defined in 3.3.272.11 and 3.3.272.3, respectively.

39.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

39.2.11 Special Means of Egress Features.

39.2.11.1 Reserved.

39.2.11.2 Lockups. Lockups in business occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

39.3 Protection.

39.3.1 Protection of Vertical Openings.

39.3.1.1 Vertical openings shall be enclosed or protected in accordance with Section 8.6, unless otherwise permitted by any of the following:

(1) Unenclosed vertical openings in accordance with 8.6.9.1 shall be permitted.
(2) Unenclosed vertical openings in accordance with 8.6.9.2 shall be permitted.
(3) Unenclosed vertical openings in accordance with 8.6.9.7 shall be permitted.
(4) Exit access stairs in accordance with 39.2.4.6 or 39.2.4.7 shall be permitted to be unenclosed.
(5) Unprotected vertical openings shall be permitted in buildings complying with all of the following:
    (a) Where protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1)
    (b) Where no unprotected vertical opening serves as any part of any required means of egress
    (c) Where required exits consist of exit doors that discharge directly to the finished ground level in accordance with 7.2.1, outside stairs in accordance with 7.2.2, smokeproof enclosures in accordance with 7.2.3, or horizontal exits in accordance with 7.2.4

39.3.1.2 Floors that are below the street floor and are used for storage or other than a business occupancy shall have no unprotected openings to business occupancy floors.

39.3.2 Protection from Hazards.

39.3.2.1* General. Hazardous areas including, but not limited to, areas used for general storage, boiler or furnace rooms, and maintenance shops that include woodworking and painting areas shall be protected in accordance with Section 8.7.

39.3.2.2* High Hazard Contents Areas. High hazard contents areas, as classified in Section 6.2, shall meet all of the following criteria:

(1) The area shall be separated from other parts of the building by fire barriers having a minimum 1-hour fire resistance rating, with all openings therein protected by self-closing fire door assemblies having a minimum ¾-hour fire protection rating.
(2) The area shall be protected by an automatic extinguishing system in accordance with 9.7.1.1(1) or 9.7.1.2.

39.3.2.3* Commercial Cooking Operations. Commercial cooking operations shall be protected in accordance with 9.2.3, unless the cooking equipment is one of the following types:

(1) Outdoor equipment
(2) Equipment used only for food warming

39.3.3 Interior Finish.

39.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

39.3.3.2 Interior Wall and Ceiling Finish.

39.3.3.2.1 Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A or Class B in exits and in exit access corridors.

39.3.3.2.2 Interior wall and ceiling finishes shall be Class A, Class B, or Class C in areas other than those specified in 39.3.3.2.1.

39.3.3.3 Interior Floor Finish. (No requirements.)

39.3.4 Detection, Alarm, and Communications Systems.

39.3.4.1 General. A fire alarm system in accordance with Section 9.6 shall be provided in all business occupancies where any one of the following conditions exists:

(1) The building is three or more stories in height.
(2) The occupancy is subject to 100 or more occupants above or below the level of exit discharge.
(3) The occupancy is subject to 1000 or more total occupants.

39.3.4.2 Initiation. Initiation of the required fire alarm system shall be by one of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.
(3) Approved automatic sprinkler system in accordance with 9.6.2.1(3) that provides protection throughout the building and the provision of 9.6.2.6 shall apply.

39.3.4.3 Occupant Notification. During all times that the building is occupied (see 7.2.1.1.3), the required fire alarm system, once initiated, shall perform one of the following functions:

(1) It shall activate a general alarm in accordance with 9.6.3 and both of the following also shall apply:
    (a) Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.
    (b) A presignal system in accordance with 9.6.3.3 shall be permitted.
(2) Occupant notification shall be permitted to be made via a voice communication or public address system in accordance with 9.6.3.9.2.

39.3.4.4 Emergency Forces Notification. Emergency forces notification shall be accomplished in accordance with 9.6.4 when the existing fire alarm system is replaced.

39.3.5 Extinguishment Requirements. Portable fire extinguishers shall be provided in every business occupancy in accordance with Section 9.9.

39.3.6 Corridors. (No requirements.)

39.3.7 Subdivision of Building Spaces. (No special requirements.)

39.4 Special Provisions.

39.4.1 Limited Access or Underground Buildings. See Section 11.7.

39.4.2 High-Rise Buildings.

39.4.2.1 All high-rise business occupancy buildings shall be provided with a reasonable degree of safety from fire, and such degree of safety shall be accomplished by one of the following means:

(1) Installation of a complete, approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)
(2) Installation of an engineered life safety system complying with all of the following:
    (a) The engineered life safety system shall be developed by a registered professional engineer experienced in fire and life safety systems design.
    (b) The life safety system shall be approved by the authority having jurisdiction and shall be permitted to include any or all of the following systems:
        i. Partial automatic sprinkler protection
        ii. Smoke detection alarms
        iii. Smoke control
        iv. Compartmentation
        v. Other approved systems

39.4.2.2* A limited, but reasonable, time shall be permitted for compliance with any part of 39.4.2.1, commensurate with the magnitude of expenditure and the disruption of services.

39.4.2.3 In addition to the requirements of 39.4.2.1 and 39.4.2.2, all buildings, regardless of height, shall comply with all other applicable provisions of this chapter.

39.4.3 Air Traffic Control Towers.

39.4.3.1 Air traffic control towers shall comply with the requirements of this chapter and Section 11.3.

39.4.3.2 The requirements of Section 11.8 shall not apply to air traffic control towers.

39.4.4 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

39.5 Building Services.

39.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

39.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

39.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

39.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

39.6 Reserved.

39.7 Operating Features.

39.7.1 Emergency Action Plans. Emergency action plans complying with Section 4.8 shall be provided in high-rise buildings.

39.7.2 Drills. In all business occupancy buildings occupied by more than 500 persons, or by more than 100 persons above or below the street level, employees and supervisory personnel shall be periodically instructed in accordance with Section 4.7 and shall hold drills periodically where practicable.

39.7.3 Extinguisher Training. Designated employees of business occupancies shall be periodically instructed in the use of portable fire extinguishers.

39.7.4 Food Service Operations. Food service operations shall comply with 13.7.2.

39.7.5 Upholstered Furniture and Mattresses. The provisions of 10.3.2 shall not apply to upholstered furniture and mattresses.

39.7.6 Soiled Linen and Trash Receptacles. The requirements of 10.3.9 for containers for waste, or linen with a capacity of 20 gal (75.7 L) or more shall not apply.

39.7.7 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 40 Industrial Occupancies

40.1 General Requirements.

40.1.1 Application.

40.1.1.1 The requirements of this chapter shall apply to both new and existing industrial occupancies.

40.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

40.1.1.3 General. The provisions of Chapter 4, General, shall apply.

40.1.1.4 Industrial occupancies shall include factories making products of all kinds and properties used for operations such as processing, assembling, mixing, packaging, finishing or decorating, repairing, and similar operations.

40.1.1.5 Incidental high hazard operations protected in accordance with Section 8.7 and 40.3.2 in occupancies containing low or ordinary hazard contents shall not be the basis for high hazard industrial occupancy classification.

40.1.2 Classification of Occupancy. Classification of occupancy shall be in accordance with 6.1.12.

40.1.2.1 Subclassification of Occupancy. Each industrial occupancy shall be subclassified according to its use as described in 40.1.2.1.1, 40.1.2.1.2, and 40.1.2.1.3.

40.1.2.1.1 General Industrial Occupancy. General industrial occupancies shall include all of the following:

(1) Industrial occupancies that conduct ordinary and low hazard industrial operations in buildings of conventional design that are usable for various types of industrial processes
(2) Industrial occupancies that include multistory buildings where floors are occupied by different tenants, or buildings that are usable for such occupancy and, therefore, are subject to possible use for types of industrial processes with a high density of employee population

40.1.2.1.2 Special-Purpose Industrial Occupancy. Special-purpose industrial occupancies shall include all of the following:

(1) Industrial occupancies that conduct ordinary and low hazard industrial operations in buildings designed for, and that are usable only for, particular types of operations
(2) Industrial occupancies that are characterized by a relatively low density of employee population, with much of the area occupied by machinery or equipment

40.1.2.1.3* High-Hazard Industrial Occupancy. High-hazard industrial occupancies shall include all of the following:

(1) Industrial occupancies that conduct industrial operations that use high-hazard materials or processes or house high-hazard contents in excess of the maximum allowable quantities (MAQ) as permitted by the fire code.
(2) Industrial occupancies in which incidental high-hazard operations in low- or ordinary-hazard occupancies that are protected in accordance with Section 8.7 and 40.3.2 are not required to be the basis for overall occupancy classification.

40.1.2.2 Change of Industrial Occupancy Subclassification. A change from one subclassification of industrial occupancy to another shall comply with Chapter 43.

40.1.3 Multiple Occupancies. All multiple occupancies shall be in accordance with 6.1.14.

40.1.4 Definitions.

40.1.4.1 General. For definitions, see Chapter 3, Definitions.

40.1.4.2 Special Definitions. Special terms applicable to this chapter are defined in Chapter 3.

40.1.5 Classification of Hazard of Contents. Classification of hazard of contents shall be in accordance with Section 6.2.

40.1.6 Minimum Construction Requirements. (Reserved.)

40.1.7* Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the occupant load factors of Table 7.3.1.2 that are characteristic of the use of the space, or shall be determined as the maximum probable population of the space under consideration, whichever is greater.

40.2 Means of Egress Requirements.

40.2.1 General.

40.2.1.1 Each required means of egress shall be in accordance with the applicable portions of Chapter 7.

40.2.1.2* Normally unoccupied utility chases that are secured from unauthorized access and are used exclusively for routing of electrical, mechanical, or plumbing equipment shall not be required to comply with the provisions of Chapter 7

40.2.2 Means of Egress Components.

40.2.2.1 General. Components of means of egress shall be limited to the types described in 40.2.2.2 through 40.2.2.13.

40.2.2.2 Doors.

40.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

40.2.2.2.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

40.2.2.2.3 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

40.2.2.2.4 Locks in accordance with 7.2.1.6.3 shall be permitted.

40.2.2.2.5 Approved existing horizontal-sliding fire doors shall be permitted in the means of egress where they comply with all of the following conditions:

(1) They are held open by fusible links.
(2) The fusible links are rated at not less than 165°F (74°C).
(3) The fusible links are located not more than 10 ft (3050 mm) above the floor.
(4) The fusible links are in immediate proximity to the door opening.
(5) The fusible links are not located above a ceiling.
(6) The door is not credited with providing any protection under this *Code*.

40.2.2.3 Stairs.

40.2.2.3.1 Stairs shall comply with 7.2.2 and shall be permitted to be modified by any of the following:

(1) Noncombustible grated stair treads and noncombustible grated landing floors shall be permitted.
(2) Industrial equipment access stairs in accordance with 40.2.5.2 shall be permitted.

40.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

40.2.2.3.3 Existing winders complying with 7.2.2.2.4 shall be permitted.

40.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

40.2.2.5 Horizontal Exits.

40.2.2.5.1 Horizontal exits complying with 7.2.4 shall be permitted.

40.2.2.5.2* In horizontal exits where the opening is protected by a fire door assembly on each side of the wall in which it is located, one fire door shall be of the swinging type, as provided in 7.2.4.3.8, and the other shall be permitted to be an automatic-sliding fire door that shall be kept open whenever the building is occupied.

40.2.2.6 Ramps. Ramps complying with any of the following shall be permitted:

(1) Ramps in accordance with 7.2.5
(2) Industrial equipment access in accordance with 40.2.5.2

40.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

40.2.2.8 Escalators and Moving Walks. Existing previously approved escalators and moving walks complying with 7.2.7 and located within the required means of egress shall be permitted.

40.2.2.9 Fire Escape Stairs. Existing fire escape stairs complying with 7.2.8 shall be permitted.

40.2.2.10 Fire Escape Ladders.

40.2.2.10.1 Fire escape ladders complying with 7.2.9 shall be permitted.

40.2.2.10.2 Fixed industrial stairs in accordance with the minimum requirements for fixed stairs and stair railing systems in ANSI/ASSE A1264.1, *Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrails Systems*, shall be permitted where fire escape ladders are permitted in accordance with 7.2.9.1.

40.2.2.11 Slide Escapes.

40.2.2.11.1 Approved slide escapes complying with 7.2.10 shall be permitted as components in 100 percent of the required means of egress for both new and existing high hazard industrial occupancies.

40.2.2.11.2 Slide escapes permitted by 40.2.2.11.1 shall be counted as means of egress only where regularly used in emergency egress drills to ensure that occupants are familiar with their use through practice.

40.2.2.12 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

40.2.2.13 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

40.2.3 Capacity of Means of Egress. Capacity of means of egress shall comply with either 40.2.3.1 or 40.2.3.2.

40.2.3.1 The capacity of means of egress shall be in accordance with Section 7.3.

40.2.3.2 In industrial occupancies, means of egress shall be sized to accommodate the occupant load as determined in accordance with 40.1.7; spaces not subject to human occupancy because of the presence of machinery or equipment shall not be included in the computation.

40.2.4 Number of Means of Egress. See also Section 7.4.

40.2.4.1 The number of means of egress shall comply with either 40.2.4.1.1 or 40.2.4.1.2.

40.2.4.1.1 Not less than two means of egress shall be provided from every story or section, and not less than one exit shall be reached without traversing another story.

40.2.4.1.2 A single means of egress shall be permitted from any story or section in low and ordinary hazard industrial occupancies, provided that the exit can be reached within the distance permitted as a common path of travel.

40.2.4.2 In new buildings, floors or portions thereof with an occupant load of more than 500 shall have the minimum number of separate and remote means of egress specified by 7.4.1.2.

40.2.4.3 Areas with high hazard contents shall comply with Section 7.11.

40.2.5 Arrangement of Means of Egress.

40.2.5.1 General. Means of egress, arranged in accordance with Section 7.5, shall not exceed that provided by Table 40.2.5.1.

40.2.5.2 Ancillary Facilities.

40.2.5.2.1* New ancillary facilities shall be arranged to allow travel in independent directions after leaving the ancillary facility so that both means of egress paths do not become compromised by the same fire or similar emergency.

40.2.5.2.2* New ancillary facilities in special-purpose industrial occupancies where delayed evacuation is anticipated shall have not less than a 2-hour fire resistance–rated separation from the predominant industrial occupancy, and shall have one means of egress that is separated from the predominant industrial occupancy by 2-hour fire resistance–rated construction.

Table 40.2.5.1 Arrangement of Means of Egress

Level of Protection	General Industrial Occupancy ft	General Industrial Occupancy m	Special-Purpose Industrial Occupancy ft	Special-Purpose Industrial Occupancy m	High Hazard Industrial Occupancy
Dead-End Corridor					
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	50	15	50	15	Prohibited, except as permitted by 7.11.4
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	50	15	50	15	Prohibited, except as permitted by 7.11.4
Common Path of Travel					
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	100	30	100	30	Prohibited, except as permitted by 7.11.4
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	50	15	50	15	Prohibited, except as permitted by 7.11.4

40.2.5.3 Industrial Equipment Access.

40.2.5.3.1 Industrial equipment access doors, walkways, platforms, ramps, and stairs that serve as a component of the means of egress from the involved equipment shall be permitted in accordance with the applicable provisions of Chapter 7, as modified by Table 40.2.5.3.1.

40.2.5.3.2 Any means of egress component permitted by 40.2.5.3.1 shall serve not more than 20 people.

40.2.6 Travel Distance to Exits.

40.2.6.1 Travel distance, measured in accordance with Section 7.6, shall not exceed that provided by Table 40.2.6.1 except as otherwise permitted by 40.2.6.2.

40.2.6.2* Power-Generation Buildings. Buildings of noncombustible construction used exclusively for the enclosure of steam generators, steam turbines, gas turbines, heat recovery generators, and flue gas treatment equipment shall be permitted to have a maximum travel distance of 400 ft (122 m), where all special hazards are protected by approved automatic suppression systems in accordance with one or more of the following standards, as applicable:

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(3) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(4) NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*
(5) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(6) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(7) NFPA 750, *Standard on Water Mist Fire Protection Systems*
(8) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

40.2.7 Discharge from Exits. Discharge from exits shall be in accordance with Section 7.7.

40.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8 or with natural lighting that provides the required level of illumination in structures occupied only during daylight hours.

40.2.9* Emergency Lighting.

40.2.9.1 Emergency lighting shall be provided in accordance with Section 7.9.

40.2.9.2 Emergency lighting shall not be required for any of the following:

(1) Special-purpose industrial occupancies without routine human habitation
(2) Structures occupied only during daylight hours, with skylights or windows arranged to provide the required level of illumination on all portions of the means of egress during such hours

40.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

40.2.11 Special Means of Egress Features.

40.2.11.1 Reserved.

40.2.11.2 Lockups.

40.2.11.2.1 Lockups in new industrial occupancies shall comply with the requirements of 22.4.5.

40.2.11.2.2 Lockups in existing industrial occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

Table 40.2.5.3.1 Industrial Equipment Access Dimensional Criteria

Feature	Dimensional Criteria
Minimum horizontal dimension of any walkway, landing, or platform	22 in. (560 mm) clear
Minimum stair or ramp width	22 in. (560 mm) clear between rails
Minimum tread width	22 in. (560 mm) clear
Minimum tread depth	10 in. (255 mm)
Maximum riser height	9 in. (230 mm)
Handrails are permitted to terminate, at the required height, at a point directly above the top and bottom risers.	
Maximum height between landings	12 ft (3660 mm)
Minimum headroom	6 ft 8 in. (2030 mm)
Minimum width of door openings	22 in. (560 mm) clear

Table 40.2.6.1 Maximum Travel Distance to Exits

Level of Protection	General Industrial Occupancy		Special-Purpose Industrial Occupancy		High Hazard Industrial Occupancy	
	ft	m	ft	m	ft	m
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	250†	76†	400	122	75	23
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	200	61	300	91	NP	NP

NP: Not permitted.

†In one-story buildings, a travel distance of 400 ft (122 m) is permitted, provided that a performance-based analysis demonstrates that safe egress can be accomplished.

40.3 Protection.

40.3.1 Protection of Vertical Openings. Any vertical opening shall be protected in accordance with Section 8.6, unless otherwise permitted by one of the following:

(1) In special-purpose industrial and high-hazard industrial occupancies where unprotected vertical openings exist and are necessary to manufacturing operations, such openings shall be permitted beyond the specified limits, provided that every floor level has direct access to one or more enclosed stairs or other exits protected against obstruction by any fire or smoke in the open areas connected by the unprotected vertical openings.

(2) Approved existing open stairs, existing open ramps, and existing escalators shall be permitted where connecting only two floor levels.

(3) Approved, existing, unprotected vertical openings in buildings with low- or ordinary-hazard contents that are protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1) shall be permitted, provided that the following conditions exist:

   (a) The vertical opening does not serve as a required exit.

   (b) All required exits consist of outside stairs in accordance with 7.2.2, smokeproof enclosures in accordance with 7.2.3, or horizontal exits in accordance with 7.2.4.

(4) Vertical openings in accordance with 8.6.9.1 shall be permitted.

(5) Vertical openings in accordance with 8.6.9.2 shall be permitted.

40.3.2* Protection from Hazards.

40.3.2.1 All high hazard industrial occupancies, operations, or processes shall have approved, supervised automatic extinguishing systems in accordance with Section 9.7 or other protection appropriate to the particular hazard, such as explosion venting or suppression.

40.3.2.2 Protection in accordance with 40.3.2.1 shall be provided for any area subject to an explosion hazard in order to minimize danger to occupants in case of fire or other emergency before they have time to use exits to escape.

40.3.2.3 Activation of the fire-extinguishing or suppression system required by 40.3.2.1 shall initiate the required building fire alarm system in accordance with 40.3.4.3.4.

40.3.2.4 Hazardous areas in industrial occupancies protected by approved automatic extinguishing systems in accordance with Section 9.7 shall be exempt from the smoke-resisting enclosure requirement of 8.7.1.2.

40.3.2.5 Commercial cooking equipment shall be protected in accordance with NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations. (See Section 9.2.3.)*

40.3.3 Interior Finish.

40.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

40.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C in operating areas and shall be as required by 7.1.4 in exit enclosures.

40.3.3.3 Interior Floor Finish.

40.3.3.3.1 Interior floor finish in exit enclosures and in exit access corridors shall be Class I or Class II in accordance with 10.2.7.4.

40.3.3.3.2 Interior floor finish in areas other than those specified in 40.3.3.3.1 shall not be required to comply with Section 10.2.7.

40.3.4 Detection, Alarm, and Communications Systems.

40.3.4.1 General. A fire alarm system shall be required in accordance with Section 9.6 for industrial occupancies, unless the total occupant load of the building is under 100 persons and unless, of these, fewer than 25 persons are above or below the level of exit discharge.

40.3.4.2 Initiation. Initiation of the required fire alarm system shall be by any of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6
(3) Approved, supervised automatic sprinkler system in accordance with 9.6.2.1(3) throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6

40.3.4.3 Notification.

40.3.4.3.1 The required fire alarm system shall meet one of the following criteria:

(1) It shall provide occupant notification in accordance with 9.6.3.
(2) It shall sound an audible and visible signal in a constantly attended location for the purposes of initiating emergency action.

40.3.4.3.2 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

40.3.4.3.3 Existing presignal systems in accordance with 9.6.3.3 shall be permitted.

40.3.4.3.4 In high hazard industrial occupancies, as described in 40.1.2.1.3, the required fire alarm system shall automatically initiate an occupant evacuation alarm signal in accordance with 9.6.3.

40.3.5 Extinguishment Requirements. (Reserved)

40.3.6 Corridors. The provisions of 7.1.3.1 shall not apply.

40.4 Special Provisions.

40.4.1 Limited-Access or Underground Structures. Limited-access or underground structures shall comply with Section 11.7.

40.4.2 High-Rise Buildings.

40.4.2.1 New high-rise industrial occupancies shall comply with Section 11.8.

40.4.2.2 The provisions of 11.8.5.2.4(2) for jockey pumps and 11.8.5.2.4(3) for air compressors serving dry-pipe and preaction systems shall not apply to special-purpose industrial occupancies.

40.4.3 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

40.5 Building Services.

40.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

40.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

40.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

40.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

40.6* Special Provisions for Aircraft Servicing Hangars.

40.6.1 The requirements of Sections 40.1 through 40.5 shall be met, except as modified by 40.6.2 through 40.6.4.

40.6.2 The requirements for exits from aircraft servicing areas shall comply with 40.6.2.1 through 40.6.2.4.

40.6.2.1 There shall be not less than two means of egress from each aircraft servicing area.

40.6.2.2 Exits from aircraft servicing areas shall be provided at intervals not exceeding 150 ft (46 m) on all exterior walls.

40.6.2.3 Where horizontal exits are provided, doors shall be provided in the horizontal exit fire barrier at intervals not exceeding 100 ft (30 m).

40.6.2.4 Where dwarf, or “smash,” doors are provided in doors that accommodate aircraft, such doors shall be permitted for compliance with 40.6.2.1 through 40.6.2.3.

40.6.3 Means of egress from mezzanine floors in aircraft servicing areas shall be arranged so that the travel distance to the nearest exit from any point on the mezzanine does not exceed 75 ft (23 m), and such means of egress shall lead directly to a properly enclosed stair discharging directly to the exterior, to a suitable cutoff area, or to outside stairs.

40.6.4 Dead ends shall not exceed 50 ft (15 m) for other than high-hazard contents areas and shall not be permitted for high-hazard contents areas.

40.7 Operating Features.

40.7.1 Upholstered Furniture and Mattresses. The provisions of 10.3.2 shall not apply to upholstered furniture and mattresses.

40.7.2 Soiled Linen and Trash Receptacles. The requirements of 10.3.9 for containers for waste, or linen with a capacity of 20 gal (75.7 L) or more shall not apply.

40.7.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 41 Reserved

Chapter 42 Storage Occupancies

42.1 General Requirements.

42.1.1 Application.

42.1.1.1 The requirements of this chapter shall apply to both new and existing storage occupancies.

42.1.1.2 Administration. The provisions of Chapter 1, Administration, shall apply.

42.1.1.3 General. The provisions of Chapter 4, General, shall apply.

42.1.1.4 Storage occupancies shall include all buildings or structures used primarily for the storage or sheltering of goods, merchandise, products, or vehicles.

42.1.2 Classification of Occupancy.

42.1.2.1 Storage occupancies shall include all buildings and structures or parts thereof with occupancy as defined in 6.1.13.

42.1.2.2 Incidental storage in another occupancy shall not be the basis for overall occupancy classification.

42.1.2.3 Storage occupancies or areas of storage occupancies that are used for the purpose of packaging, labeling, sorting, special handling, or other operations requiring an occupant load greater than that normally contemplated for storage shall be classified as industrial occupancies. *(See Chapter 40.)*

42.1.3 Multiple Occupancies. All multiple occupancies shall be in accordance with 6.1.14.

42.1.4 Definitions.

42.1.4.1 General. For definitions, see Chapter 3, Definitions.

42.1.4.2 Special Definitions. Special terms applicable to this chapter are defined in Chapter 3.

42.1.5 Classification of Hazard of Contents.

42.1.5.1 Contents of storage occupancies shall be classified as low hazard, ordinary hazard, or high hazard in accordance with Section 6.2, depending on the quantity and character of the materials stored, their packaging, and other factors.

42.1.5.2 Hazardous materials that exceed the maximum allowable quantities (MAQ) as permitted in the fire code shall be classified as high-hazard contents.

42.1.6 Minimum Construction Requirements. (Reserved)

42.1.7* Occupant Load. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined on the basis of the maximum probable population of the space under consideration.

42.2 Means of Egress Requirements.

42.2.1 General.

42.2.1.1 Each required means of egress shall be in accordance with the applicable portions of Chapter 7.

42.2.1.2* Normally unoccupied utility chases that are secured from unauthorized access and are used exclusively for routing of electrical, mechanical, or plumbing equipment shall not be required to comply with the provisions of Chapter 7.

42.2.2 Means of Egress Components.

42.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 42.2.2.2 through 42.2.2.12.

42.2.2.2 Doors.

42.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

42.2.2.2.2 Delayed-egress locks complying with 7.2.1.6.1 shall be permitted.

42.2.2.2.3 Access-controlled egress doors complying with 7.2.1.6.2 shall be permitted.

42.2.2.2.4 Locks in accordance with 7.2.1.6.3 shall be permitted.

42.2.2.2.5 Approved existing horizontal-sliding fire doors shall be permitted in the means of egress where they comply with all of the following conditions:

(1) They are held open by fusible links.
(2) The fusible links are rated at not less than 165°F (74°C).
(3) The fusible links are located not more than 10 ft (3050 mm) above the floor.
(4) The fusible links are in immediate proximity to the door opening.
(5) The fusible links are not located above a ceiling.
(6) The door is not credited with providing any protection under this *Code*.

42.2.2.3 Stairs.

42.2.2.3.1 Stairs shall comply with 7.2.2 and shall be permitted to be modified by any of the following:

(1) Noncombustible grated stair treads and noncombustible grated landing floors shall be permitted.
(2) Industrial equipment access stairs in accordance with 40.2.5.3 shall be permitted.

42.2.2.3.2 Spiral stairs complying with 7.2.2.2.3 shall be permitted.

42.2.2.3.3 Existing winders complying with 7.2.2.2.4 shall be permitted.

42.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

42.2.2.5 Horizontal Exits.

42.2.2.5.1 Horizontal exits complying with 7.2.4 shall be permitted.

42.2.2.5.2* In horizontal exits where the opening is protected by a fire door assembly on each side of the wall in which it is located, one fire door shall be of the swinging type, as provided in 7.2.4.3.8, and the other shall be permitted to be an automatic-sliding fire door that shall be kept open whenever the building is occupied.

42.2.2.6 Ramps.

42.2.2.6.1 Ramps complying with 7.2.5 shall be permitted.

42.2.2.6.2 Industrial equipment access ramps in accordance with 40.2.5.3 shall be permitted.

42.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

42.2.2.8 Fire Escape Stairs. Existing fire escape stairs complying with 7.2.8 shall be permitted.

42.2.2.9 Fire Escape Ladders.

42.2.2.9.1 Fire escape ladders complying with 7.2.9 shall be permitted.

42.2.2.9.2 Fixed industrial stairs in accordance with the minimum requirements for fixed stairs in ANSI A1264.1, *Safety Requirements for Workplace Walking/Working Surfaces and Their Access; Workplace Floor, Wall and Roof Openings; Stairs and Guardrail Systems,* shall be permitted where fire escape ladders are permitted in accordance with 7.2.9.1.

42.2.2.10 Slide Escapes. Existing slide escapes complying with 7.2.10 shall be permitted.

42.2.2.11 Alternating Tread Devices. Alternating tread devices complying with 7.2.11 shall be permitted.

42.2.2.12 Areas of Refuge. Areas of refuge complying with 7.2.12 shall be permitted.

42.2.3 Capacity of Means of Egress. The capacity of means of egress shall be in accordance with Section 7.3.

42.2.4 Number of Means of Egress. The number of means of egress shall comply with 42.2.4.1 through 42.2.4.3. *(See also Section 7.4.)*

42.2.4.1 The number of means of egress shall comply with any of the following:

(1) In low hazard storage occupancies, a single means of egress shall be permitted from any story or section.
(2) In ordinary hazard storage occupancies, a single means of egress shall be permitted from any story or section, provided that the exit can be reached within the distance permitted as a common path of travel.
(3) All buildings or structures not complying with 42.2.4.1(1) or 42.2.4.1(2) and used for storage, and every section thereof considered separately, shall have not less than two separate means of egress as remotely located from each other as practicable.

42.2.4.2 In new buildings, floors or portions thereof with an occupant load of more than 500 persons shall have the minimum number of separate and remote means of egress specified by 7.4.1.2.

42.2.4.3 Areas with high hazard contents shall comply with Section 7.11.

42.2.5 Arrangement of Means of Egress. Means of egress, arranged in accordance with Section 7.5, shall not exceed that provided by Table 42.2.5.

Table 42.2.5 Arrangements of Means of Egress

Level of Protection	Low Hazard Storage Occupancy	Ordinary Hazard Storage Occupancy ft	Ordinary Hazard Storage Occupancy m	High Hazard Storage Occupancy
Dead-End Corridor				
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	NL	100	30	Prohibited, except as permitted by 7.11.4
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	NL	50	15	Prohibited, except as permitted by 7.11.4
Common Path of Travel				
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	NL	100	30	Prohibited, except as permitted by 7.11.4
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	NL	50	15	Prohibited, except as permitted by 7.11.4

NL: Not limited.

42.2.6* Travel Distance to Exits. Travel distance, measured in accordance with Section 7.6, shall not exceed that provided by Table 42.2.6.

42.2.7 Discharge from Exits. Discharge from exits shall be in accordance with Section 7.7.

42.2.8 Illumination of Means of Egress.

42.2.8.1 Means of egress shall be illuminated in accordance with Section 7.8.

42.2.8.2 In structures occupied only during daylight hours, means of egress shall be permitted to be illuminated with windows arranged to provide the required level of illumination on all portions of the means of egress during such hours, when approved by the authority having jurisdiction.

42.2.9 Emergency Lighting. Emergency lighting shall be provided in normally occupied storage occupancies in accordance with Section 7.9, except for spaces occupied only during daylight hours with natural illumination in accordance with 42.2.8.2.

42.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

42.2.11 Special Means of Egress Features.

42.2.11.1 Reserved.

42.2.11.2 Lockups.

42.2.11.2.1 Lockups in new storage occupancies shall comply with the requirements of 22.4.5.

42.2.11.2.2 Lockups in existing storage occupancies, other than approved existing lockups, shall comply with the requirements of 23.4.5.

42.3 Protection.

42.3.1 Protection of Vertical Openings. Any vertical opening shall be protected in accordance with Section 8.6, unless otherwise permitted by one of the following:

(1) Vertical openings in accordance with 8.6.9.1 or 8.6.9.2 shall be permitted.
(2) Existing open stairs, existing open ramps, and existing open escalators shall be permitted where connecting only two floor levels.

Table 42.2.6 Maximum Travel Distance to Exits

Level of Protection	Low Hazard Storage Occupancy	Ordinary Hazard Storage Occupancy		High Hazard Storage Occupancy	
		ft	m	ft	m
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	NL	400	122	100	30
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	NL	200	61	75	23
Flammable and combustible liquid products stored and protected in accordance with NFPA 30, *Flammable and Combustible Liquids Code*	NA	NA	NA	150	46

NL: Not limited. NA: Not applicable.

(3) Existing unprotected vertical openings in buildings with low- or ordinaryhazard contents, and protected throughout by an approved automatic sprinkler system in accordance with 9.7.1.1(1), shall be permitted where they do not serve as required exits, and where all required exits consist of outside stairs in accordance with 7.2.2, smokeproof enclosures in accordance with 7.2.3, or horizontal exits in accordance with 7.2.4.

42.3.2 Protection from Hazards. See also Section 8.7.

42.3.3 Interior Finish.

42.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

42.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials shall be Class A, Class B, or Class C in accordance with Section 10.2 in storage areas and shall be as required by 7.1.4 in exit enclosures.

42.3.3.3 Interior Floor Finish.

42.3.3.3.1 Interior floor finish in exit enclosures and in exit access corridors shall be Class I or Class II.

42.3.3.3.2 Interior floor finish in areas other than those specified in 42.3.3.3.1 shall not be required to comply with Section 10.2.7.

42.3.4 Detection, Alarm, and Communications Systems.

42.3.4.1 General. A fire alarm system shall be required in accordance with Section 9.6 for storage occupancies, except as modified by 42.3.4.1.1, 42.3.4.1.2, and 42.3.4.1.3.

42.3.4.1.1 Storage occupancies limited to low hazard contents shall not be required to have a fire alarm system.

42.3.4.1.2 Storage occupancies with ordinary or high hazard contents not exceeding an aggregate floor area of 100,000 ft^2 (9300 m^2) shall not be required to have a fire alarm system.

42.3.4.1.3 Storage occupancies protected throughout by an approved automatic sprinkler system in accordance with Section 9.7 shall not be required to have a fire alarm system.

42.3.4.2 Initiation. Initiation of the required fire alarm system shall be by any of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6
(3) Approved, supervised automatic sprinkler system in accordance with 9.6.2.1(3) throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6

42.3.4.3 Notification.

42.3.4.3.1 The required fire alarm system shall meet one of the following criteria:

(1) It shall provide occupant notification in accordance with 9.6.3.
(2) It shall sound an audible and visible signal in a constantly attended location for the purposes of initiating emergency action.

42.3.4.3.2 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

42.3.4.3.3 Existing presignal systems in accordance with 9.6.3.3 shall be permitted.

42.3.4.3.4 In high hazard storage occupancies, the required fire alarm system shall automatically initiate an occupant evacuation alarm signal in accordance with 9.6.3.

42.3.5 Extinguishment Requirements. (Reserved)

42.3.6 Corridors. The provisions of 7.1.3.1 shall not apply.

42.4 Special Provisions.

42.4.1 Limited-Access or Underground Structures. Limited-access or underground structures shall comply with Section 11.7.

42.4.2 High-Rise Buildings. New high-rise storage occupancies shall comply with Section 11.8.

42.4.3 Alcohol-Based Hand-Rub Dispensers. Alcohol-based hand-rub dispensers in accordance with 8.7.3.3 shall be permitted.

42.5 Building Services.

42.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

42.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

42.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

42.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

42.6* Special Provisions for Aircraft Storage Hangars.

42.6.1 The requirements of Sections 42.1 through 42.5 shall be met, except as modified by 42.6.1.1 through 42.6.3.

42.6.1.1 There shall be not less than two means of egress from each aircraft storage area.

42.6.1.2 Exits from aircraft storage areas shall be provided at intervals not exceeding 150 ft (46 m) on all exterior walls.

42.6.1.3 Where horizontal exits are provided, doors shall be provided in the horizontal exit fire barrier at intervals not exceeding 100 ft (30 m).

42.6.1.4 Where dwarf, or "smash," doors are provided in doors that accommodate aircraft, such doors shall be permitted for compliance with 42.6.1.1, 42.6.1.2, and 42.6.1.3.

42.6.2 Means of egress from mezzanine floors in aircraft storage areas shall be arranged so that the travel distance to the nearest exit from any point on the mezzanine does not exceed 75 ft (23 m), and such means of egress shall lead directly to a properly enclosed stair discharging directly to the exterior, to a suitable cutoff area, or to outside stairs.

42.6.3 Dead ends shall not exceed 50 ft (15 m) for other than high hazard contents areas and shall not be permitted for high hazard contents areas.

42.7* Special Provisions for Grain Handling, Processing, Milling, or Other Bulk Storage Facilities.

42.7.1 General. The requirements of Sections 42.1 through 42.5 shall be met, except as modified by 42.7.2 through 42.7.4.2.

42.7.2 Number of Means of Egress. There shall be not less than two means of egress from all working levels of the head house, as modified by 42.7.2.1, 42.7.2.2, and 42.7.2.3.

42.7.2.1 One of the two means of egress shall be a stair to the level of exit discharge, and, if this means of egress is interior to the structure, it shall be enclosed by a dust-resistant, 1-hour fire resistance–rated enclosure in accordance with 7.1.3.2. Exterior stair means of egress shall be protected from the structure by a 1-hour fire resistance–rated wall that extends at least 10 ft (3050 mm) beyond the stair.

42.7.2.2 The second means of egress shall be one of the following:

(1) Exterior stair or basket ladder–type fire escape that is accessible from all working levels of the structure and provides a passage to the finished ground level
(2) Exterior stair or basket ladder–type fire escape that is accessible from all working levels of the structure, provides access to adjoining structures, and provides a continuous path to the means of egress described in 42.7.3

42.7.2.3 Stair enclosures in existing structures shall be permitted to have non-fire-rated dust-resistant enclosures.

42.7.3 Means of Egress to Finished Ground Level. An exterior stair or basket ladder–type fire escape shall provide passage to the finished ground level from the top of the end of an adjoining structure, such as a silo, conveyor, gallery, or gantry.

42.7.4 Extinguishment Requirements. (Reserved)

42.7.5 Underground Spaces.

42.7.5.1 Number of Means of Egress.

42.7.5.1.1 Underground spaces shall have not less than two means of egress, one of which shall be permitted to be a means of escape, except as permitted in 42.7.4.1.2.

42.7.5.1.2 Where the horizontal travel distance to the means of egress is less than 50 ft (15 m) in normally unoccupied spaces, a single means of egress shall be permitted.

42.7.5.2 Travel Distance to Exits. Travel distance, measured in accordance with Section 7.6, shall not exceed that provided by Table 42.7.4.2.

Table 42.7.5.2 Maximum Travel Distance to Means of Escape or Exits

	Travel Distance	
Level of Protection	**ft**	**m**
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	400	122
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	200	61
Existing structures	Unlimited	

42.8 Special Provisions for Parking Structures.

42.8.1 General Requirements.

42.8.1.1* Application. The provisions of 42.8.1 through 42.8.5.4 shall apply to parking structures of the closed or open type, above or below grade plane, but shall not apply to assisted mechanical-type or automated-type parking facilities that are not occupied by customers. The requirements of Sections 42.1 through 42.7 shall not apply.

42.8.1.2 Multiple Occupancies.

42.8.1.2.1 Where both parking and repair operations are conducted in the same building, the entire building shall comply with Chapter 40, except as modified by 42.8.1.2.2.

42.8.1.2.2 Where the parking and repair sections are separated by not less than 1-hour fire-rated construction, the parking and repair sections shall be permitted to be treated separately.

42.8.1.2.3 In areas where repair operations are conducted, the means of egress shall comply with Chapter 40.

42.8.1.3 Open Parking Structures. Open parking structures shall comply with 42.8.1.3.1 through 42.8.1.3.3.

42.8.1.3.1 Each parking level shall have wall openings open to the atmosphere for an area of not less than 1.4 ft^2 for each linear foot (0.4 m^2 for each linear meter) of its exterior perimeter. [**88A:** 5.5.1]

42.8.1.3.2 The openings addressed in 42.8.1.3.1 shall be distributed over 40 percent of the building perimeter or uniformly over two opposing sides. [**88A:** 5.5.2]

42.8.1.3.3 Interior wall lines and column lines shall be at least 20 percent open, with openings distributed to provide ventilation. [**88A:** 5.5.3]

42.8.1.4 Classification of Occupancy. Incidental vehicle parking in another occupancy shall not be the basis for overall occupancy classification.

42.8.1.5 Classification of Hazard of Contents. Parking structures used only for the storage of vehicles shall be classified as ordinary hazard in accordance with Section 6.2.

42.8.1.6 Minimum Construction Requirements. (No requirements.)

42.8.1.7 Occupant Load. (No requirements.)

42.8.2 Means of Egress Requirements.

42.8.2.1 General. Means of egress shall be in accordance with Chapter 7 and 42.8.2.

42.8.2.2 Means of Egress Components.

42.8.2.2.1 Components Permitted. Components of means of egress shall be limited to the types described in 42.8.2.2.2 through 42.8.2.2.9.

42.8.2.2.2 Doors.

42.8.2.2.2.1 Doors complying with 7.2.1 shall be permitted.

42.8.2.2.2.2 Special locking arrangements complying with 7.2.1.6 shall be permitted.

42.8.2.2.2.3 An opening for the passage of automobiles shall be permitted to serve as an exit from a street floor, provided that no door or shutter is installed therein.

42.8.2.2.3 Stairs.

42.8.2.2.3.1 Stairs complying with 7.2.2 shall be permitted, unless otherwise permitted by 42.8.2.2.3.2.

42.8.2.2.3.2 In open parking structures, stairs complying with 7.2.2.5.1 shall not be required.

42.8.2.2.3.3 Existing winders complying with 7.2.2.2.4 shall be permitted.

42.8.2.2.3.4 Paragraph 7.2.2.4.5.3(2) shall not apply to guards for parking garages that are accessible to the general public.

42.8.2.2.4 Smokeproof Enclosures. Smokeproof enclosures complying with 7.2.3 shall be permitted.

42.8.2.2.5 Horizontal Exits. Horizontal exits complying with 7.2.4 shall be permitted.

42.8.2.2.6 Ramps.

42.8.2.2.6.1 Ramps shall be permitted in accordance with any of the following conditions:

(1) Ramps complying with 7.2.5 shall be permitted and shall not be subject to normal vehicular traffic where used as an exit.
(2) In a ramp-type open parking structure with open vehicle ramps not subject to closure, the ramp shall be permitted to serve in lieu of the second means of egress from floors above the level of exit discharge, provided that the ramp discharges directly outside at the street level.
(3) For parking structures extending only one floor level below the level of exit discharge, a vehicle ramp leading directly to the outside shall be permitted to serve in lieu of the second means of egress, provided that no door or shutter is installed therein.

42.8.2.2.6.2 Paragraph 7.2.2.4.5.3(2) shall not apply to guards for parking structures that are accessible to the general public.

42.8.2.2.7 Exit Passageways. Exit passageways complying with 7.2.6 shall be permitted.

42.8.2.2.8 Fire Escape Stairs. Fire escape stairs complying with 7.2.8 shall be permitted for existing parking structures only.

42.8.2.2.9 Areas of Refuge.

42.8.2.2.9.1 Areas of refuge complying with 7.2.12 shall be permitted, as modified by 42.8.2.2.9.2.

42.8.2.2.9.2 In open-air parking structures, the area of refuge requirements of 7.2.12.1.2(2) shall not apply.

42.8.2.3 Capacity of Means of Egress. See also 42.8.2.4 and 42.8.2.5.

42.8.2.4 Number of Means of Egress. The number of means of egress shall comply with 42.8.2.4.1 and 42.8.2.4.2. *(See also Section 7.4.)*

42.8.2.4.1 Not less than two means of egress shall be provided from every floor or section of every parking structure.

42.8.2.4.2 In new buildings, floors or portions thereof with an occupant load of more than 500 persons shall have the minimum number of separate and remote means of egress specified by 7.4.1.2.

42.8.2.5 Arrangement of Means of Egress. See also Section 7.5.

42.8.2.5.1 A common path of travel shall be permitted for the first 50 ft (15 m) from any point in the parking structure.

42.8.2.5.2 Dead ends shall not exceed 50 ft (15 m).

42.8.2.5.3 Where fuel-dispensing devices are located within a parking structure, 42.8.2.5.3.1 and 42.8.2.5.3.2 shall apply.

42.8.2.5.3.1 Travel away from the fuel-dispensing device in any direction shall lead to an exit with no dead end in which occupants might be trapped by fire.

42.8.2.5.3.2 Within closed parking structures containing fuel-dispensing devices, exits shall be arranged and located to meet all of the following additional requirements:

(1) Exits shall lead to the outside of the building on the same level or to stairs, with no upward travel permitted, unless direct outside exits are available from that floor.
(2) Any story below the story at which fuel is being dispensed shall have exits leading directly to the outside via outside stairs or doors at the finished ground level.

42.8.2.6 Travel Distance to Exits.

42.8.2.6.1 Travel distance, measured in accordance with Section 7.6, shall not exceed that provided by Table 42.8.2.6.1, except as otherwise permitted in 42.8.2.6.2.

42.8.2.6.2 In open parking structures, travel distance shall comply with one of the following:

(1) The travel distance to an exit shall not exceed the travel distance specified in Table 42.8.2.6.1.
(2) The travel distance to a stair that does not meet the provisions for an exit enclosure shall not exceed the travel distance specified in Table 42.8.2.6.1, and travel along the stair shall not be limited.

Table 42.8.2.6.1 Maximum Travel Distance to Exits

Level of Protection	Enclosed Parking Structure ft	Enclosed Parking Structure m	Open Parking Structure ft	Open Parking Structure m	Parking Structure Open Not Less than 50% on All Sides ft	Parking Structure Open Not Less than 50% on All Sides m
Protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	200	61	400	122	400	122
Not protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1)	150	46	300	91	400	122

42.8.2.7 Discharge from Exits. Exit discharge shall comply with Section 7.7.

42.8.2.8 Illumination of Means of Egress. Means of egress shall be illuminated in accordance with Section 7.8 or with natural lighting that provides the required level of illumination in structures occupied only during daylight hours.

42.8.2.9 Emergency Lighting. Parking structures shall be provided with emergency lighting in accordance with Section 7.9, except for structures occupied only during daylight hours and arranged to provide the required level of illumination of all portions of the means of egress by natural means.

42.8.2.10 Marking of Means of Egress. Means of egress shall have signs in accordance with Section 7.10.

42.8.2.11 Special Means of Egress Features. (Reserved)

42.8.3 Protection.

42.8.3.1 Protection of Vertical Openings.

42.8.3.1.1 Vertical Openings in Enclosed Parking Structures.

42.8.3.1.1.1 Unless otherwise provided in 42.8.3.1.1.3, 42.8.3.1.1.4, or 42.8.3.1.1.5, vertical openings through floors in enclosed parking structures four stories or more in height shall be enclosed with walls or partitions having a fire resistance rating of not less than 2 hours. [**88A:**5.4.3]

42.8.3.1.1.2 Unless otherwise provided in 42.8.3.1.1.3, 42.8.3.1.1.4, or 42.8.3.1.1.5, vertical openings through floors in enclosed parking structures less than four stories in height shall be enclosed with walls or partitions having a fire resistance rating of not less than 1 hour. [**88A:**5.4.4]

42.8.3.1.1.3 Ramps in enclosed parking structures shall not be required to be enclosed in accordance with 42.8.3.1.1.1 or 42.8.3.1.1.2 where the parking structure is protected throughout by an approved, automatic sprinkler system. [**88A:**5.4.5]

42.8.3.1.1.4 Ramps in enclosed parking structures shall not be required to be enclosed in accordance with 42.8.3.1.1.1 or 42.8.3.1.1.2 where the parking structure is protected throughout by an approved, supervised, automatic fire detection system and a mechanical ventilation system in accordance with 6.3.1 of NFPA 88A, *Standard for Parking Structures.* [**88A:**5.4.6]

42.8.3.1.1.5 Openings in the floor assembly between an enclosed parking structure and an open parking structure, except exit openings, shall not be required to be enclosed where the enclosed parking structure is protected in accordance with 42.8.3.1.1.1 or 42.8.3.1.1.2. [**88A:**5.4.7]

42.8.3.1.1.6 Sprinkler systems provided in accordance with 42.8.3.1.1.3 or 42.8.3.1.1.5 shall be supervised in accordance with 9.7.2.

42.8.3.1.2 Unprotected vertical openings through floors in open parking structures shall be permitted. [**88A:**5.4.8]

42.8.3.2 Protection from Hazards. (No requirements.)

42.8.3.3 Interior Finish.

42.8.3.3.1 General. Interior finish shall be in accordance with Section 10.2.

42.8.3.3.2 Interior Wall and Ceiling Finish. Interior wall and ceiling finish materials complying with Section 10.2 shall be Class A, Class B, or Class C in parking structures and shall be as required by 7.1.4 in exit enclosures.

42.8.3.3.3 Interior Floor Finish.

42.8.3.3.3.1 Interior floor finish in exit enclosures and exit access corridors shall be Class I or Class II.

42.8.3.3.3.2 Interior floor finish in areas other than those specified in 42.8.3.3.3.1 shall not be required to comply with 10.2.6.

42.8.3.4 Detection, Alarm, and Communications Systems.

42.8.3.4.1 General. A fire alarm system shall be required in accordance with Section 9.6 for parking structures, except as modified by 42.3.4.1.1, 42.3.4.1.2, and 42.3.4.1.3.

42.8.3.4.1.1 Parking structures not exceeding an aggregate floor area of 100,000 ft^2 (9300 m^2) shall not be required to have a fire alarm system.

42.8.3.4.1.2 Open parking structures shall not be required to have a fire alarm system.

42.8.3.4.1.3 Parking structures protected throughout by an approved automatic sprinkler system in accordance with Section 9.7 shall not be required to have a fire alarm system.

42.8.3.4.2 Initiation. Initiation of the required fire alarm system shall be by one of the following means:

(1) Manual means in accordance with 9.6.2.1(1)
(2) Approved automatic fire detection system in accordance with 9.6.2.1(2) throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6
(3) Approved, supervised automatic sprinkler system in accordance with 9.6.2.1(3) throughout the building, plus a minimum of one manual fire alarm box in accordance with 9.6.2.6

42.8.3.4.3 Notification.

42.8.3.4.3.1 The required fire alarm system shall sound an audible alarm in a continuously attended location for purposes of initiating emergency action.

42.8.3.4.3.2 Positive alarm sequence in accordance with 9.6.3.4 shall be permitted.

42.8.3.4.3.3 Existing presignal systems in accordance with 9.6.3.3 shall be permitted.

42.8.3.5 Extinguishing Requirements. (Reserved)

42.8.3.6 Corridors. The provisions of 7.1.3.1 shall not apply.

42.8.4 Special Provisions — High-Rise Buildings.

42.8.4.1 The provisions of Section 11.8 shall not apply to new high-rise, open parking structures, except as otherwise required by 42.8.4.2.

42.8.4.2 The provisions of 11.8.3 shall apply to new high-rise, open parking structures.

42.8.5 Building Services.

42.8.5.1 Utilities. Utilities shall comply with the provisions of Section 9.1.

42.8.5.2 Heating, Ventilating, and Air-Conditioning. Heating, ventilating, and air-conditioning equipment shall comply with the provisions of Section 9.2.

42.8.5.3 Elevators, Escalators, and Conveyors. Elevators, escalators, and conveyors shall comply with the provisions of Section 9.4.

42.8.5.4 Waste Chutes, Incinerators, and Laundry Chutes. Waste chutes, incinerators, and laundry chutes shall comply with the provisions of Section 9.5.

42.9 Operating Features.

42.9.1 Upholstered Furniture and Mattresses. The provisions of 10.3.2 shall not apply to upholstered furniture and mattresses.

42.9.2 Soiled Linen and Trash Receptacles. The requirements of 10.3.9 for containers for waste, or linen with a capacity of 20 gal (75.7 L) or more shall not apply.

42.9.3 Inspection of Door Openings. Door openings shall be inspected in accordance with 7.2.1.15.

Chapter 43 Building Rehabilitation

43.1 General.

43.1.1 Classification of Rehabilitation Work Categories. Rehabilitation work on existing buildings shall be classified as one of the following work categories:

(1) Repair
(2) Renovation
(3) Modification
(4) Reconstruction
(5) Change of use or occupancy classification
(6) Addition

43.1.2 Applicable Requirements.

43.1.2.1 Any building undergoing repair, renovation, modification, or reconstruction *(see 43.2.2.1.1 through 43.2.2.1.4)* shall comply with both of the following:

(1) Requirements of the applicable existing occupancy chapters *(see Chapters 13, 15, 17, 19, 21, 23, 24, 26, 29, 31, 33, 37, 39, 40, and 42)*
(2) Requirements of the applicable section of this chapter *(see Sections 43.3, 43.4, 43.5, and 43.6)*

43.1.2.2 Any building undergoing change of use or change of occupancy classification *(see 43.2.2.1.5 and 43.2.2.1.6)* shall comply with the requirements of Section 43.7.

43.1.2.3 Any building undergoing addition *(see 43.2.2.1.7)* shall comply with the requirements of Section 43.8.

43.1.2.4 Historic buildings undergoing rehabilitation shall comply with the requirements of Section 43.10.

43.1.2.5 Nothing in this chapter shall be interpreted as excluding the use of the performance-based option of Chapter 5.

43.1.3 Multiple Rehabilitation Work Categories.

43.1.3.1 Work of more than one rehabilitation work category shall be permitted to be part of a single work project.

43.1.3.2 Where a project includes one category of rehabilitation work in one building area and another category of rehabilitation work in a separate area of the building, each project area shall comply with the requirements of the respective category of rehabilitation work.

43.1.3.3 Where a project consisting of modification and reconstruction is performed in the same work area, or in contiguous work areas, the project shall comply with the requirements applicable to reconstruction, unless otherwise specified in 43.1.3.4.

43.1.3.4 Where the reconstruction work area is less than 10 percent of the modification work area, the two shall be considered as independent work areas, and the respective requirements shall apply.

43.1.4 Compliance.

43.1.4.1 Repairs, renovations, modifications, reconstruction, changes of use or occupancy classification, and additions shall conform to the specific requirements for each category in other sections of this chapter.

43.1.4.2 This chapter shall not prevent the use of any alternative material, alternative design, or alternative method of construction not specifically prescribed herein, provided that the alternative has been deemed to be equivalent and its use authorized by the authority having jurisdiction in accordance with Section 1.4.

43.1.4.3 Where compliance with this chapter, or with any provision required by this chapter, is technically infeasible or would impose undue hardship because of structural, construction, or dimensional difficulties, the authority having jurisdiction shall be authorized to accept alternative materials, design features, or operational features.

43.1.4.4 Elements, components, and systems of existing buildings with features that exceed the requirements of this *Code* for new construction, and not otherwise required as part of previously documented, approved, alternative arrangements, shall not be prevented by this chapter from being modified, provided that such elements, components, and systems remain in compliance with the applicable *Code* provisions for new construction.

43.1.4.5 Work mandated by any accessibility, property, housing, or fire code; mandated by the existing building requirements of this *Code*; or mandated by any licensing rule or ordinance, adopted pursuant to law, shall conform only to the requirements of that code, rule, or ordinance and shall not be required to conform to this chapter, unless the code requiring such work so provides.

43.2 Special Definitions.

43.2.1 General. The words and terms used in Chapter 43 shall be defined as detailed in 43.2.2, unless the context clearly indicates otherwise.

43.2.2 Special Definitions.

43.2.2.1 Categories of Rehabilitation Work. The nature and extent of rehabilitation work undertaken in an existing building.

43.2.2.1.1 Repair. The patching, restoration, or painting of materials, elements, equipment, or fixtures for the purpose of maintaining such materials, elements, equipment, or fixtures in good or sound condition.

43.2.2.1.2 Renovation. The replacement in kind, strengthening, or upgrading of building elements, materials, equipment, or fixtures, that does not result in a reconfiguration of the building spaces within.

43.2.2.1.3 Modification. The reconfiguration of any space; the addition, relocation, or elimination of any door or window; the addition or elimination of load-bearing elements; the reconfiguration or extension of any system; or the installation of any additional equipment.

43.2.2.1.4* Reconstruction. The reconfiguration of a space that affects an exit or a corridor shared by more than one occupant space; or the reconfiguration of a space such that the rehabilitation work area is not permitted to be occupied because existing means of egress and fire protection systems, or their equivalent, are not in place or continuously maintained.

43.2.2.1.5 Change of Use. A change in the purpose or level of activity within a structure that involves a change in application of the requirements of the *Code*.

43.2.2.1.6 Change of Occupancy Classification. The change in the occupancy classification of a structure or portion of a structure.

43.2.2.1.7 Addition. An increase in the building area, aggregate floor area, building height, or number of stories of a structure.

43.2.2.2* Equipment or Fixture. Any plumbing, heating, electrical, ventilating, air-conditioning, refrigerating, and fire protection equipment; and elevators, dumbwaiters, escalators, boilers, pressure vessels, or other mechanical facilities or installations related to building services.

43.2.2.3 Load-Bearing Element. Any column, girder, beam, joist, truss, rafter, wall, floor, or roof sheathing that supports any vertical load in addition to its own weight, or any lateral load.

43.2.2.4 Rehabilitation Work Area. That portion of a building affected by any renovation, modification, or reconstruction work as initially intended by the owner, and indicated as such in the permit, but excluding other portions of the building where incidental work entailed by the intended work must be performed, and excluding portions of the building where work not initially intended by the owner is specifically required.

43.2.2.5 Technically Infeasible. A change to a building that has little likelihood of being accomplished because the existing structural conditions require the removal or alteration of a load-bearing member that is an essential part of the structural frame, or because other existing physical or site constraints prohibit modification or addition of elements, spaces, or features that are in full and strict compliance with applicable requirements.

43.3 Repairs.

43.3.1 General Requirements.

43.3.1.1 A repair, as defined in 43.2.2.1.1, in other than historic buildings shall comply with the requirements of Section 43.3.

43.3.1.2 Repairs in historic buildings shall comply with the requirements of one of the following:

(1) Section 43.3
(2) Section 43.3, as modified by Section 43.10

43.3.1.3 The work shall be done using like materials or materials permitted by other sections of this *Code*.

43.3.1.4 The work shall not make the building less conforming with the other sections of this *Code*, or with any previously approved alternative arrangements, than it was before the repair was undertaken.

43.4 Renovations.

43.4.1 General Requirements.

43.4.1.1 A renovation, as defined in 43.2.2.1.2, in other than historic buildings shall comply with the requirements of Section 43.4.

43.4.1.2 Renovations in historic buildings shall comply with the requirements of one of the following:

(1) Section 43.4
(2) Section 43.4, as modified by Section 43.10

43.4.1.3 All new work shall comply with the requirements of this *Code* applicable to existing buildings.

43.4.1.4 The work shall not make the building less conforming with other sections of this *Code*, or with any previous approved alternative arrangements, than it was before the renovation was undertaken, unless otherwise specified in 43.4.1.5.

43.4.1.5 Minor reductions in the clear opening dimensions of replacement doors and windows that result from the use of different materials shall be permitted, unless such reductions are prohibited.

43.4.2 Capacity of Means of Egress. The capacity of means of egress, determined in accordance with Section 7.3, shall be sufficient for the occupant load thereof, unless one of the following conditions exists:

(1) The authority having jurisdiction shall be permitted to establish the occupant load as the number of persons for which existing means of egress is adequate, provided that measures are established to prevent occupancy by a greater number of persons.
(2)*The egress capacity shall have been previously approved as being adequate.

43.4.3 Interior Finish Requirements. New interior finish materials shall meet the requirements for new construction.

43.4.4 Other Requirements. The reconfiguration or extension of any system, or the installation of any additional equipment, shall comply with Section 43.5.

43.5 Modifications.

43.5.1 General Requirements.

43.5.1.1 A modification, as defined in 43.2.2.1.3, in other than historic buildings shall comply with both of the following:

(1) Section 43.5
(2) Section 43.4

43.5.1.2 Modifications in historic buildings shall comply with the requirements of one of the following:

(1) 43.5.1.1(1) and (2)
(2) 43.5.1.1(1) and (2), as modified by Section 43.10

43.5.1.3 Newly constructed elements, components, and systems shall comply with the requirements of other sections of this *Code* applicable to new construction.

43.5.2 Extensive Modifications.

43.5.2.1 The modification of an entire building or an entire occupancy within a building shall be considered as a reconstruction and shall comply with the requirements of Section 43.6 for the applicable occupancy, unless otherwise specified in 43.5.2.2.

43.5.2.2 Modification work that is exclusively electrical, plumbing, mechanical, fire protection system, or structural work shall not be considered a reconstruction, regardless of its extent.

43.5.2.3 Where the total area of all the rehabilitation work areas included in a modification exceeds 50 percent of the area of the building, the work shall be considered as a reconstruction and shall comply with the requirements of Section 43.6 for the applicable occupancy, unless otherwise specified in 43.5.2.4.

43.5.2.4 Rehabilitation work areas in which the modification work is exclusively plumbing, mechanical, fire protection system, or electrical work shall not be included in the computation of total area of all rehabilitation work areas.

43.6 Reconstruction.

43.6.1 General Requirements.

43.6.1.1 A reconstruction, as defined in 43.2.2.1.4, in other than historic buildings shall comply with all of the following:

(1) Section 43.6
(2) Section 43.5, except that any stairway replacing an existing stairway shall be permitted to comply with 7.2.2.2.1.1(3)
(3) Section 43.4

43.6.1.2 Reconstruction work in historic buildings shall comply with the requirements of one of the following:

(1) 43.6.1.1(1), (2), and (3)
(2) 43.6.1.1(1), (2), and (3), as modified by Section 43.10

43.6.1.3 Wherever the term *rehabilitation work area* is used in Section 43.6, it shall include only the area affected by reconstruction work and areas covered by 43.5.2.

43.6.1.4 Other rehabilitation work areas affected exclusively by renovation or modification work shall not be included in the rehabilitation work area required to comply with Section 43.6.

43.6.2 Means of Egress.

43.6.2.1 General. The means of egress shall comply with the requirements applicable to the existing occupancy *[see 43.1.2.1(1)]*, as modified by 43.6.2.

43.6.2.2* Illumination, Emergency Lighting, and Marking of Means of Egress.

43.6.2.2.1 Means of egress in rehabilitation work areas shall be provided with illumination, emergency lighting, and marking of means of egress in accordance with the requirements of other sections of this *Code* applicable to new construction for the occupancy.

43.6.2.2.2 Where the reconstruction rehabilitation work area on any floor exceeds 50 percent of that floor area, means of egress throughout the floor shall be provided with illumination, emergency lighting, and marking of means of egress in accordance with the requirements of other sections of this *Code* applicable to new construction for the occupancy, unless otherwise specified in 43.6.2.2.4.

43.6.2.2.3 In a building with rehabilitation work areas involving more than 50 percent of the aggregate floor area within the building, the means of egress within the rehabilitation work area and the means of egress, including the exit and exit discharge paths, serving the rehabilitation work area shall be provided with illumination, emergency lighting, and marking of means of egress in accordance with the requirements of other sections of this *Code* applicable to new construction for the occupancy, unless otherwise specified in 43.6.2.2.4.

43.6.2.2.4 Means of egress within a tenant space that is entirely outside the rehabilitation work area shall be permitted to comply with the requirements for illumination, emergency lighting, and marking of means of egress applicable to the existing occupancy in lieu of the requirements for illumination and emergency lighting applicable to new construction required by 43.6.2.2.2 and 43.6.2.2.3.

43.6.3 Fire Barriers and Smoke Barriers.

43.6.3.1 In small residential board and care occupancies and one- and two-family dwellings where the rehabilitation work area is in any attached dwelling unit, walls separating the dwelling units, where such walls are not continuous from the foundation to the underside of the roof sheathing, shall be constructed to provide a continuous fire separation using construction materials that are consistent with the existing wall or that comply with the requirements for new buildings of the occupancy involved.

43.6.3.2 The following shall apply to work required by 43.6.3.1:

(1) It shall be performed on the side of the wall of the dwelling unit that is part of the rehabilitation work area.
(2) It shall not be required to be continuous through concealed floor spaces.

43.6.4 Extinguishing Systems.

43.6.4.1 In a building with rehabilitation work areas involving over 50 percent of the aggregate building area, automatic sprinkler systems shall be provided on the highest floor containing a rehabilitation work area and on all floors below in accordance with the requirements of other sections of this *Code* applicable to new construction for the occupancy.

43.6.4.2 On any story with rehabilitation work areas involving over 50 percent of the area of the story, a sprinkler system shall be provided throughout the story in accordance with the requirements of other sections of this *Code* applicable to new construction for the occupancy.

43.6.4.3 Where sprinklers are installed in an elevator hoistway or elevator machine room as part of the rehabilitation work, the elevators shall comply with the fire fighters' emergency operations requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

43.6.4.4 Any rehabilitation work areas in a building that is required to be provided with a standpipe system by other sections of this *Code* shall be provided with standpipes up to and including the highest rehabilitation work area floor.

43.6.4.5 The standpipes required by 43.6.4.4 shall be located and installed in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, unless otherwise provided in 43.6.4.6 and 43.6.4.7.

43.6.4.6 No pump shall be required, provided that the following criteria are met:

(1) The standpipes are capable of accepting delivery by fire department apparatus of a minimum of 250 gpm at 65 psi (945 L/min at 4.5 bar) to the topmost floor in buildings equipped throughout with an automatic sprinkler system or a minimum of 500 gpm at 65 psi (1890 L/min at 4.5 bar) to the topmost floor in other buildings.
(2) Where the standpipe terminates below the topmost floor, the standpipe is designed to meet the flow/pressure requirements of 43.6.4.6(1) for possible future extension of the standpipe.

43.6.4.7 In other than high-rise buildings, the required interconnection of the standpipes for a wet system shall be permitted at the lowest level of the rehabilitation work area.

43.6.5 Fire Alarm Systems — Smoke Alarms.

43.6.5.1 In lodging or rooming houses, hotels and dormitories, and apartment buildings, individual sleeping rooms, guest rooms, and dwelling units within any rehabilitation work area shall be provided with smoke alarms complying with the requirements of other sections of this *Code* applicable to new construction for the occupancy.

43.6.5.2 Where the rehabilitation work area is located in residential board and care occupancies or one- and two-family dwelling units, smoke alarms complying with the requirements of other sections of this *Code* applicable to new construction for the occupancy shall be provided.

43.6.6 Elevators. In high-rise buildings, where the rehabilitation work area is one entire floor, or where the rehabilitation work area is 20 percent or more of the occupied floor area of the building, all floors shall be accessible by at least one elevator.

43.7 Change of Use or Occupancy Classification.

43.7.1 Change of Use.

43.7.1.1 A change of use that does not involve a change of occupancy classification shall comply with the requirements applicable to the new use in accordance with the applicable existing occupancy chapter, unless the change of use creates a hazardous contents area as addressed in 43.7.1.2.

43.7.1.2 A change of use that does not involve a change of occupancy classification but that creates a hazardous area shall comply with one of the following:

(1) The change of use shall comply with the requirements applicable to the new use in accordance with the applicable occupancy chapter for new construction.
(2) For existing health care occupancies protected throughout by an approved, supervised automatic sprinkler system in accordance with 9.7.1.1(1), where a change in use of a room or space not exceeding 250 ft^2 (23.2 m^2) results in a room or space that is described by 19.3.2.1.5(7), the requirements for new construction shall not apply, provided that the enclosure meets the requirements of 19.3.2.1.2 and 19.3.2.1.3.

43.7.1.3 Any repair, renovation, modification, or reconstruction work undertaken in connection with a change of use that does not involve a change of occupancy classification shall comply with the requirements of Sections 43.3, 43.4, 43.5, and 43.6, respectively.

43.7.2 Change of Occupancy Classification. Where the occupancy classification of an existing building or portion of an existing building is changed, in other than historic buildings, the building shall meet the requirements of 43.7.2.1 or 43.7.2.3.

43.7.2.1 Where a change of occupancy classification creates other than an assembly occupancy, and the change occurs within the same hazard classification category or to an occupancy classification of a lesser hazard classification category (i.e., a higher hazard category number), as addressed by Table 43.7.3, the building shall meet both of the following:

(1) Requirements of the applicable existing occupancy chapters for the occupancy created by the change *(see Chapters 15, 17, 19, 21, 23, 24, 26, 29, 31, 33, 37, 39, 40, and 42)*
(2)*Requirements for automatic sprinkler and detection, alarm, and communications systems and requirements for hazardous areas applicable to new construction for the occupancy created by the change *(see Chapters 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 36, 38, 40, and 42)*

43.7.2.2 Where a change of occupancy classification creates an assembly occupancy, and the change occurs within the same hazard classification category or to an occupancy classification of a lesser hazard classification category (i.e., a higher number), as addressed by 43.7.3, the building shall meet both of the following:

(1) Requirements of Chapter 13 for existing assembly occupancies
(2) Requirements for automatic sprinkler and detection, alarm, and communications systems, requirements for hazardous areas, and requirements for main entrance/exit of Chapter 12 for new assembly occupancies

43.7.2.3 Where a change of occupancy classification occurs to an occupancy classification of a higher hazard classification category (i.e., a lower hazard category number), as addressed by Table 43.7.3, the building shall comply with the requirements of the occupancy chapters applicable to new construction for the occupancy created by the change. *(See Chapters 12, 14, 16, 18, 20, 22, 24, 26, 28, 30, 32, 36, 38, 40, and 42.)*

43.7.2.4 In historic buildings where a change of occupancy classification occurs within the same hazard classification category or to an occupancy classification in a lesser hazard classification category (i.e., a higher hazard category number), as addressed by Table 43.7.3, the building shall meet the requirements of one of the following:

(1) 43.7.2.1 or 43.7.2.2, as applicable
(2) 43.7.2.1 or 43.7.2.2, as applicable, as modified by Section 43.10

43.7.2.5 In historic buildings where a change of occupancy classification occurs to an occupancy classification in a higher hazard classification category (i.e., a lower hazard category number), as addressed by Table 43.7.3, the building shall meet the requirements of one of the following:

(1) 43.7.2.3
(2) 43.7.2.3, as modified by Section 43.10

43.7.3* Hazard Category Classifications. The relative degree of hazard between different occupancy classifications shall be as set forth in the hazard category classifications of Table 43.7.3.

Table 43.7.3 Hazard Categories and Classifications

Hazard Category	Occupancy Classification
1 (highest hazard)	Industrial or storage occupancies with high hazard contents
2	Health care, detention and correctional, residential board and care
3	Assembly, educational, day care, ambulatory health care, residential, mercantile, business, general and special-purpose industrial, ordinary hazard storage
4 (lowest hazard)	Industrial or storage occupancies with low hazard contents

43.8 Additions.

43.8.1 General Requirements.

43.8.1.1 Where an addition, as defined in 43.2.2.1.7, is made to a building, both of the following criteria shall be met:

(1) The addition shall comply with other sections of this *Code* applicable to new construction for the occupancy.
(2) The existing portion of the building shall comply with the requirements of this *Code* applicable to existing buildings for the occupancy.

43.8.1.2 An addition shall not create or extend any nonconformity with regard to fire safety or the means of egress in the existing building for which the addition is constructed.

43.8.1.3 Any repair, renovation, alteration, or reconstruction work within an existing building to which an addition is being made shall comply with the requirements of Sections 43.3, 43.4, 43.5, and 43.6.

43.8.2 Heights. No addition shall increase the height of an existing building beyond that permitted under the applicable provisions for new building construction.

43.8.3 Fire Protection Systems. In other than one- and two-family dwellings, existing compartment areas without an approved separation from the addition shall be protected by an approved automatic sprinkler system where the combined areas would be required to be sprinklered by the provisions applicable to new construction for the occupancy.

43.8.4 Smoke Alarms. Where an addition is made to a one- or two-family dwelling or a small residential board and care occupancy, interconnected smoke alarms, powered by the electrical system, meeting the requirements of the other sections of this *Code* shall be installed and maintained in the addition.

43.9 Reserved.

43.10 Historic Buildings.

43.10.1 General Requirements. Historic buildings undergoing rehabilitation shall comply with the requirements of one of the following:

(1) Section 43.10
(2) Sections 43.3, 43.4, 43.5, 43.6, and 43.7, as they relate, respectively, to repair, renovation, modification, reconstruction, and change of use or occupancy classification
(3) NFPA 914, *Code for Fire Protection of Historic Structures*

43.10.2 Evaluation. A historic building undergoing modification, reconstruction, or change of occupancy classification in accordance with the requirements of Chapter 43 shall be investigated and evaluated as follows:

(1) A written report shall be prepared for such a building and filed with the authority having jurisdiction by a registered design professional.
(2) If the subject matter of the report does not require an evaluation by a registered design professional, the authority having jurisdiction shall be permitted to allow the report to be prepared by a licensed building contractor, electrician, plumber, or mechanical contractor responsible for the work.
(3) The licensed person preparing the report shall be knowledgeable in historic preservation, or the report shall be coauthored by a preservation professional.
(4) The report shall identify each required safety feature in compliance with Chapter 43 and where compliance with other chapters of this *Code* would be damaging to the contributing historic features.
(5) The report shall describe each feature not in compliance with this *Code* and demonstrate how the intent of this *Code* is met in providing an equivalent level of safety.
(6) The local preservation official shall be permitted to review and comment on the written report or shall be permitted to request review comments on the report from the historic preservation officer.
(7) Unless it is determined by the authority having jurisdiction that a report is required to protect the health and safety of the public, the submission of a report shall not be required for a building that is being rehabilitated for the personal use of the owner or a member of the owner's immediate family and is not intended for any use or occupancy by the public.

43.10.3 Repairs. Repairs to any portion of a historic building shall be permitted to be made with original or like materials and original methods of construction, except as otherwise provided in Section 43.10.

43.10.4 Repair, Renovation, Modification, or Reconstruction.

43.10.4.1 General. Historic buildings undergoing repair, renovation, modification, or reconstruction shall comply with the applicable requirements of Sections 43.3, 43.4, 43.5, and 43.6, except as specifically permitted in 43.10.4.

43.10.4.2 Replacement. Replacements shall meet the following criteria:

(1) Replacement of existing or missing features using original or like materials shall be permitted.

(2) Partial replacement for repairs that match the original in configuration, height, and size shall be permitted.
(3) Replacements shall not be required to meet the requirements of this *Code* that specify material standards, details of installation and connection, joints, or penetrations; or continuity of any element, component, or system in the building.

43.10.4.3 Means of Egress. Existing door openings, window openings intended for emergency egress, and corridor and stairway widths narrower than those required for nonhistoric buildings under this *Code* shall be permitted, provided that one of the following criteria is met:

(1) In the opinion of the authority having jurisdiction, sufficient width and height exists for a person to pass through the opening or traverse the exit, and the capacity of the egress system is adequate for the occupant load.
(2) Other operational controls to limit the number of occupants are approved by the authority having jurisdiction.

43.10.4.4 Door Swing. Where approved by the authority having jurisdiction, existing front doors shall not be required to swing in the direction of egress travel, provided that other approved exits have sufficient egress capacity to serve the total occupant load.

43.10.4.5 Transoms. In fully sprinklered buildings of hotel and dormitory occupancies, apartment occupancies, and residential board and care occupancies, existing transoms in corridors and other fire resistance–rated walls shall be permitted to remain in use, provided that the transoms are fixed in the closed position.

43.10.4.6 Interior Finishes.

43.10.4.6.1 Existing interior wall and ceiling finishes, in other than exits, shall be permitted to remain in place where it is demonstrated that such finishes are the historic finish.

43.10.4.6.2 Interior wall and ceiling finishes in exits, other than in one- and two-family dwellings, shall meet one of the following criteria:

(1) The material shall be Class A, Class B, or Class C in accordance with Section 10.2 of this *Code*.
(2) Existing materials not meeting the minimum Class C flame spread index shall be surfaced with an approved fire-retardant paint or finish.
(3) Existing materials not meeting the minimum Class C flame spread index shall be permitted to be continued in use, provided that the building is protected throughout by an approved automatic sprinkler system.

43.10.4.7 Stairway Enclosure.

43.10.4.7.1 Stairways shall be permitted to be unenclosed in a historic building where such stairways serve only one adjacent floor.

43.10.4.7.2 In buildings of three or fewer stories in height, exit enclosure construction shall limit the spread of smoke by the use of tight-fitting doors and solid elements; however, such elements shall not be required to have a fire rating.

43.10.4.8 One-Hour Fire-Rated Assemblies. Existing walls and ceilings shall be exempt from the minimum 1-hour fire resistance–rated construction requirements of other sections of this *Code* where the existing wall and ceiling are of wood lath and plaster construction in good condition.

43.10.4.9 Stairway Handrails and Guards.

43.10.4.9.1 Existing grand stairways shall be exempt from the handrail and guard requirements of other sections of this *Code*.

43.10.4.9.2 Existing handrails and guards on grand staircases shall be permitted to remain in use, provided that they are not structurally dangerous.

43.10.4.10 Exit Signs. The authority having jurisdiction shall be permitted to accept alternative exit sign or directional exit sign location, provided that signs installed in compliance with other sections of this *Code* would have an adverse effect on the historic character and such alternative signs identify the exits and egress path.

43.10.4.11 Sprinkler Systems.

43.10.4.11.1 Historic buildings that do not conform to the construction requirements specified in other chapters of this *Code* for the applicable occupancy or use and that, in the opinion of the authority having jurisdiction, constitute a fire safety hazard shall be protected throughout by an approved automatic sprinkler system.

43.10.4.11.2 The automatic sprinkler system required by 43.10.4.11.1 shall not be used as a substitute for, or serve as an alternative to, the required number of exits from the facility.

43.10.5 Change of Occupancy.

43.10.5.1 General. Historic buildings undergoing a change of occupancy shall comply with the applicable provisions of Section 43.7, except as otherwise permitted by 43.10.5.

43.10.5.2 Means of Egress. Existing door openings, window openings intended for emergency egress, and corridor and stairway widths narrower than those required for nonhistoric buildings under this *Code* shall be permitted, provided that one of the following criteria is met:

(1) In the opinion of the authority having jurisdiction, sufficient width and height exists for a person to pass through the opening or traverse the exit, and the capacity of the egress system is adequate for the occupant load.
(2) Other operational controls to limit the number of occupants are approved by the authority having jurisdiction.

43.10.5.3 Door Swing. Where approved by the authority having jurisdiction, existing front doors shall not be required to swing in the direction of egress travel, provided that other approved exits have sufficient capacity to serve the total occupant load.

43.10.5.4 Transoms. In corridor walls required to be fire rated by this *Code*, existing transoms shall be permitted to remain in use, provided that the transoms are fixed in the closed position and one of the following criteria is met:

(1) An automatic sprinkler shall be installed on each side of the transom.
(2) Fixed wired glass set in a steel frame or other approved glazing shall be installed on one side of the transom.

43.10.5.5 Interior Finishes. Existing interior wall and ceiling finishes shall meet one of the following criteria:

(1) The material shall comply with the requirements for flame spread index of other sections of this *Code* applicable to the occupancy.

(2) Materials not complying with 43.10.5.5(1) shall be permitted to be surfaced with an approved fire-retardant paint or finish.
(3) Materials not complying with 43.10.5.5(1) shall be permitted to be continued in use, provided that the building is protected throughout by an approved automatic sprinkler system, and the nonconforming materials are substantiated as being historic in character.

43.10.5.6 One-Hour Fire-Rated Assemblies. Existing walls and ceilings shall be exempt from the minimum 1-hour fire resistance–rated construction requirements of other sections of this *Code* where the existing wall and ceiling are of wood lath and plaster construction in good condition.

43.10.5.7 Stairs and Handrails.

43.10.5.7.1 Existing stairs and handrails shall comply with the requirements of this *Code*, unless otherwise specified in 43.10.5.7.2.

43.10.5.7.2 The authority having jurisdiction shall be permitted to accept alternatives for grand stairways and associated handrails where the alternatives are approved as meeting the intent of this *Code*.

43.10.5.8 Exit Signs. The authority having jurisdiction shall be permitted to accept alternative exit sign or directional exit sign location, provided that signs installed in compliance with other sections of this *Code* would have an adverse effect on the historic character and such alternative signs identify the exits and egress path.

43.10.5.9 Exit Stair Live Load. Existing historic stairways in buildings changed to hotel and dormitory occupancies and apartment occupancies shall be permitted to be continued in use, provided that the stairway can support a 75 lb/ft^2 (3600 N/m^2) live load.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 The following is a suggested procedure for determining the *Code* requirements for a building or structure:

(1) Determine the occupancy classification by referring to the occupancy definitions in Chapter 6 and the occupancy Chapters 12 through 42. *(See 6.1.14 for buildings with more than one use.)*
(2) Determine if the building or structure is new or existing. *(See the definitions in Chapter 3.)*
(3) Determine the occupant load. *(See 7.3.1.)*
(4) Determine the hazard of contents. *(See Section 6.2.)*
(5) Refer to the applicable occupancy chapter of the *Code*, Chapters 12 through 42. *[See Chapters 1 through 4 and Chapters 6 through 11, as needed, for general information (such as definitions) or as directed by the occupancy chapter.]*
(6) Determine the occupancy subclassification or special use condition, if any, by referring to Chapters 16 and 17, daycare occupancies; Chapters 18 and 19, health care occupancies; Chapters 22 and 23, detention and correctional occupancies; Chapters 28 and 29, hotels and dormitories; Chapters 32 and 33, residential board and care occupancies; Chapters 36 and 37, mercantile occupancies; and Chapter 40, industrial occupancies, which contain subclassifications or special use definitions.
(7) Proceed through the applicable occupancy chapter to verify compliance with each referenced section, subsection, paragraph, subparagraph, and referenced codes, standards, and other documents.
(8) Where two or more requirements apply, refer to the occupancy chapter, which generally takes precedence over the base Chapters 1 through 4 and Chapters 6 through 11.
(9) Where two or more occupancy chapters apply, such as in a mixed occupancy *(see 6.1.14)*, apply the most restrictive requirements.

A.1.1.5 Life safety in buildings includes more than safety from fire. Although fire safety has been the long-standing focus of NFPA *101*, its widely known title, *Life Safety Code*, and its technical requirements respond to a wider range of concerns, including, for example, crowdsafety. *Code* requirements that contribute to the safe movement of people during fire emergencies might also assist in responding to many other hazards that require decisions about where people can be safely located.

A.1.1.6(1) This *Code* is intended to be adopted and used as part of a comprehensive program of building regulations that include building, mechanical, plumbing, electrical, fuel gas, fire prevention, and land use regulations.

A.1.2 The *Code* endeavors to avoid requirements that might involve unreasonable hardships or unnecessary inconvenience or interference with the normal use and occupancy of a building but provides for fire safety consistent with the public interest.

Protection of occupants is achieved by the combination of prevention, protection, egress, and other features, with due regard to the capabilities and reliability of the features involved. The level of life safety from fire is defined through requirements directed at the following:

(1) Prevention of ignition
(2) Detection of fire
(3) Control of fire development
(4) Confinement of the effects of fire
(5) Extinguishment of fire
(6) Provision of refuge or evacuation facilities, or both
(7) Staff reaction
(8) Provision of fire safety information to occupants

A.1.3.1 Various chapters contain specific provisions for existing buildings and structures that might differ from those for new construction.

A.1.4 Before a particular mathematical fire model or evaluation system is used, its purpose and limitations need to be known. The technical documentation should clearly identify any assumptions included in the evaluation. Also, it is the intent of the Committee on Safety to Life to recognize that future editions of this *Code* are a further refinement of this edition and earlier editions. The changes in future editions will reflect the continuing input of the fire protection/life safety community in its attempt to meet the purpose stated in this *Code*.

A.1.4.3 An equivalent method of protection provides an equal or greater level of safety. It is not a waiver or deletion of a *Code* requirement.

The prescriptive provisions of this *Code* provide specific requirements for broad classifications of buildings and structures. These requirements are stated in terms of fixed values, such as maximum travel distance, minimum fire resistance ratings, and minimum features of required systems, such as detection, alarm, suppression, and ventilation, and not in terms of overall building or system performance.

However, the equivalency clause in 1.4.3 permits the use of alternative systems, methods, or devices to meet the intent of the prescribed code provisions where approved as being equivalent. Through the rigor of a performance-based design, it can be demonstrated whether a building design is satisfactory and complies with the implicit or explicit intent of the applicable code requirement.

When employing the equivalency clause, it is important to clearly identify the prescriptive-based code provision being addressed (scope), to provide an interpretation of the intent of the provision (goals and objectives), to provide an alternative approach (proposed design), and to provide appropriate support for the suggested alternative (evaluation of proposed designs).

Performance resulting from proposed designs can be compared to the performance of the design features required by this *Code*. Using prescribed features as a baseline for comparison, it can then be demonstrated in the evaluation whether a proposed design offers the intended level of performance. A comparison of safety provided can be used as the basis for establishing equivalency.

A.2.1(1) For example, NFPA 10, *Standard for Portable Fire Extinguishers*, is referenced in Chapter 2. This does not mean that all buildings must have portable fire extinguishers. Portable fire extinguishers are mandatory only to the extent called for elsewhere in the *Code*.

A.2.1(3) The Committee on Safety to Life recognizes that it is impractical to continually upgrade existing buildings or installations to comply with all the requirements of the referenced publications included in Chapter 2.

A.2.2 It is possible that governing authorities have adopted a code or standard other than one that is listed in Chapter 2. Where such is the case, and where a provision of a code or standard is referenced by this *Code* but the text of the requirement is not extracted into this *Code*, the code or standard adopted by the governing authority is permitted to be utilized where it is deemed by the authority having jurisdiction to adequately address the issue or condition of concern. Where the adopted code or standard does not address the issue, the requirement from the referenced code or standard should be applied by the authority having jurisdiction, unless the governing authority has established other procedures, policies, or guidelines. Where the text of a requirement is extracted from another NFPA code or standard and appears in this *Code*, it is the intent that the requirement be met as if it had originated in this *Code*, regardless of whether the governing authority has adopted the code or standard from which the text is extracted.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.4 Actuating Member or Bar. The active surface of the actuating bar needs to be visually and physically distinct from the rest of the device. The actuating bar is also called a cross bar or push pad.

A.3.3.11 Aisle Accessway. *Aisle accessway* is the term used for the previously unnamed means of egress component leading to an aisle or other means of egress. For example, circulation space between parallel rows of seats having a width of 12 in. to 24 in. (305 mm to 610 mm) and a length not exceeding 100 ft (30 m) is an aisle accessway. Some of the circulation space between tables or seats in restaurants might be considered aisle accessway.

Depending on the width of aisle accessway, which is influenced by its length and expected utilization, the movement of a person through the aisle accessway might require others to change their individual speed of movement, alter their postures, move their chairs out of the way, or proceed ahead of the person.

A.3.3.21.2.1 Gross Floor Area. Where the term *floor area* is used, it should be understood to be gross floor area, unless otherwise specified.

A.3.3.21.4 Hazardous Area. Hazardous areas include areas for the storage or use of combustibles or flammables; toxic, noxious, or corrosive materials; or heat-producing appliances.

A.3.3.21.6 Normally Unoccupied Building Service Equipment Support Area. Normally unoccupied building service support areas are often found in attics, crawl spaces, chases, and interstitial areas where the space is vacant or intended exclusively for routing ductwork, cables, conduits, piping, and similar services and is rarely accessed. In such spaces, it is often difficult or impossible to fully comply with the egress requirements of Chapter 7. Where portions of such spaces are routinely visited for storage, maintenance, testing, or inspection, that portion is excluded from this definition, but the remainder of the space might be considered a normally unoccupied building service equipment support area. Storage and fuel-fired equipment would not be expected to be permitted in these locations. Roofs are not considered to be normally unoccupied building service equipment support areas.

A.3.3.22 Area of Refuge. An area of refuge has a temporary use during egress. It generally serves as a staging area that provides relative safety to its occupants while potential emergencies are assessed, decisions are made, and mitigating activities are begun. Taking refuge within such an area is, thus, a stage of the total egress process, a stage between egress from the immediately threatened area and egress to a public way.

An area of refuge might be another building connected by a bridge or balcony, a compartment of a subdivided story, an elevator lobby, or an enlarged story-level exit stair landing. An area of refuge is accessible by means of horizontal travel or, as a minimum, via an accessible route meeting the requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*.

This *Code* recognizes any floor in a building protected throughout by an approved, supervised automatic sprinkler system as an area of refuge. This recognition acknowledges the ability of a properly designed and functioning automatic sprinkler system to control a fire at its point of origin and to limit the production of toxic products to a level that is not life threatening.

The requirement for separated rooms or spaces can be met on an otherwise undivided floor by enclosing the elevator lobby with ordinary glass or other simple enclosing partitions that are smoke resisting.

For some occupancies, one accessible room or space is permitted.

A.3.3.27 Atrium. As defined in NFPA 92, *Standard for Smoke Control Systems*, a large-volume space is an uncompartmented space, generally two or more stories high, within which smoke from a fire either in the space or in a communicating space can move and accumulate without restriction. Atria and covered malls are examples of large-volume spaces.

A.3.3.28 Attic. The attic space might be used for storage. The concealed rafter space between the ceiling membrane and the roof sheathing that are attached to the rafters is not considered an attic.

A.3.3.31.1 Fire Barrier. A fire barrier, such as a wall or floor assembly, might be aligned vertically or horizontally. Although the continuity of a fire barrier will often limit the transfer of smoke, it should not be confused with either a smoke barrier or a smoke partition.

A.3.3.31.2 Smoke Barrier. A smoke barrier might be vertically or horizontally aligned, such as a wall, floor, or ceiling assembly. A smoke barrier might or might not have a fire resistance rating. Application of smoke barrier criteria where required elsewhere in the *Code* should be in accordance with Section 8.3.

A.3.3.31.3 Thermal Barrier. Finish ratings, as published in the UL *Fire Resistance Directory*, are one way of determining thermal barrier. A test method was developed in order to assess whether a material, product, or assembly constitutes a thermal barrier (see NFPA 275). It requires thermal barriers to meet both a test for fire resistance (temperature transmission test), which limits temperature rise on the unexposed side, and a test for reaction-to-fire (integrity fire test), intended to demonstrate that the material can prevent or delay ignition of the material on the unexposed side. The reaction to fire test is one of the following: NFPA 286, FM 4880, ANSI/UL 1040, or ANSI/UL 1715.

A.3.3.33 Birth Center. A birth center is a low-volume service for healthy, childbearing women, and their families, who are capable of ambulation in the event of fire or fire-threatening events. Birth center mothers and babies have minimal analgesia, receive no general or regional anesthesia, and are capable of ambulation, even in second-stage labor.

A.3.3.36 Building. The term *building* is to be understood as if followed by the words *or portions thereof. (See also Structure, A.3.3.272.)*

A.3.3.36.3 Apartment Building. The *Code* specifies that, wherever there are three or more living units in a building, the building is considered an apartment building and is required to comply with either Chapter 30 or Chapter 31, as appropriate. Townhouse units are considered to be apartment buildings if there are three or more units in the building. The type of wall required between units in order to consider them to be separate buildings is normally established by the authority having jurisdiction. If the units are separated by a wall of sufficient fire resistance and structural integrity to be considered as separate buildings, then the provisions of Chapter 24 apply to each townhouse. Condominium status is a form of ownership, not occupancy; for example, there are condominium warehouses, condominium apartments, and condominium offices.

A.3.3.36.5 Existing Building. With respect to judging whether a building should be considered existing, the deciding factor is not when the building was designed or when construction started but, rather, the date plans were approved for construction by the appropriate authority having jurisdiction.

A.3.3.36.6 Flexible Plan and Open Plan Educational or Day-Care Building. Flexible plan buildings have movable corridor walls and movable partitions of full-height construction with doors leading from rooms to corridors. Open plan buildings have rooms and corridors delineated by tables, chairs, desks, bookcases, counters, low-height partitions, or similar furnishings. It is the intent that low-height partitions not exceed 60 in. (1525 mm).

A.3.3.36.7 High-Rise Building. It is the intent of this definition that, in determining the level from which the highest occupiable floor is to be measured, the enforcing agency should exercise reasonable judgment, including consideration of overall accessibility to the building by fire department personnel and vehicular equipment. Where a building is situated on a sloping terrain and there is building access on more than one level, the enforcing agency might select the level that provides the most logical and adequate fire department access.

A.3.3.36.8 Historic Building. Designation for a historic building might be in an official national, regional, or local historic register, listing, or inventory.

A.3.3.36.9 Mall Building. A mall building might enclose one or more uses, such as retail and wholesale stores, drinking and dining establishments, entertainment and amusement facilities, transportation facilities, offices, and other similar uses.

A.3.3.36.10 Special Amusement Building. Special amusement buildings include amusements such as a haunted house, a roller coaster–type ride within a building, a multilevel play structure within a building, a submarine ride, and similar amusements where the occupants are not in the open air.

A.3.3.37 Building Code. Where no building code has been adopted, *NFPA 5000, Building Construction and Safety Code,* should be used where the building code is referenced in this *Code.*

A.3.3.41 Cellular or Foamed Plastic. Cellular or foamed plastic might contain foamed and unfoamed polymeric or monomeric precursors (prepolymer, if used), plasticizers, fillers, extenders, catalysts, blowing agents, colorants, stabilizers, lubricants, surfactants, pigments, reaction control agents, processing aids, and flame retardants.

A.3.3.47 Common Path of Travel. Common path of travel is measured in the same manner as travel distance but terminates at that point where two separate and distinct routes become available. Paths that merge are common paths of travel.

A.3.3.48.1 Fire Compartment. Additional fire compartment information is contained in 8.2.2.

In the provisions for fire compartments utilizing the outside walls of a building, it is not intended that the outside wall be specifically fire resistance rated, unless required by other standards. Likewise, it is not intended that outside windows or doors be protected, unless specifically required for exposure protection by another section of this *Code* or by other standards.

A.3.3.48.2 Smoke Compartment. Where smoke compartments using the outside walls or the roof of a building are provided, it is not intended that outside walls or roofs, or any openings therein, be capable of resisting the passage of smoke. Application of smoke compartment criteria where required elsewhere in the *Code* should be in accordance with Section 8.5.

A.3.3.51 Critical Radiant Flux. Critical radiant flux is the property determined by the test procedure of NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source.* The unit of measurement of critical radiant flux is watts per square centimeter (W/cm^2).

A.3.3.61.1 Emergency Stair Travel Device. An emergency stair travel device should be designed, constructed, and operated in accordance with ANSI/RESNA ED-1, *Emergency Stair Travel Devices Used by Individuals with Disabilities.* The device typically requires the assistance of a trained operator.

A.3.3.64 Dormitory. Rooms within dormitories intended for the use of individuals for combined living and sleeping purposes are guest rooms or guest suites. Examples of dormitories are college dormitories, fraternity and sorority houses, and military barracks.

A.3.3.66 Dwelling Unit. It is not the intent of the *Code* that the list of spaces in the definition of the term *dwelling unit* in 3.3.65 is to be all inclusive. It is the intent of the *Code* that the list of spaces is a minimal set of criteria that must be provided to be considered a dwelling unit, and, therefore, the dwelling unit can contain other spaces that are typical to a single-family dwelling.

A.3.3.66.1 One- and Two-Family Dwelling Unit. The application statement of 24.1.1.1 limits each dwelling unit to being "occupied by members of a single family with not more than three outsiders." The *Code* does not define the term *family.* The definition of family is subject to federal, state, and local regulations and might not be restricted to a person or a couple (two people) and their children. The following examples aid in differentiating between a single-family dwelling and a lodging or rooming house:

(1) An individual or a couple (two people) who rent a house from a landlord and then sublease space for up to three individuals should be considered a family renting to a maximum of three outsiders, and the house should be regulated as a single-family dwelling in accordance with Chapter 24.
(2) A house rented from a landlord by an individual or a couple (two people) in which space is subleased to 4 or more individuals, but not more than 16, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26.
(3) A residential building that is occupied by 4 or more individuals, but not more than 16, each renting from a landlord, without separate cooking facilities, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26.

A.3.3.68 Electroluminescent. This light source is typically contained inside the device.

A.3.3.78 Evacuation Capability. The evacuation capability of the residents and staff is a function of both the ability of the residents to evacuate and the assistance provided by the staff. It is intended that the evacuation capability be determined by the procedure acceptable to the authority having jurisdiction. It is also intended that the timing of drills, the rating of residents, and similar actions related to determining the evacuation capability be performed by persons approved by or acceptable to the authority having jurisdiction. The evacuation capability can be determined by the use of the definitions in 3.3.78, the application of NFPA 101A, *Guide on Alternative Approaches to Life Safety,* Chapter 6, or a program of drills (timed).

Evacuation does not include the relocation of occupants within a building.

Where drills are used in determining evacuation capability, it is suggested that the facility conduct and record fire drills six times per year on a bimonthly basis, with a minimum of two drills conducted during the night when residents are sleeping, and that the facility conduct the drills in consultation with the authority having jurisdiction. Records should indicate the time taken to reach a point of safety, date and time of day, location of simulated fire origin, escape paths used, and comments relating to residents who resisted or failed to participate in the drills.

Translation of drill times to evacuation capability is determined as follows:

(1) 3 minutes or less — prompt
(2) Over 3 minutes, but not in excess of 13 minutes — slow
(3) More than 13 minutes — impractical

Evacuation capability, in all cases, is based on the time of day or night when evacuation of the facility would be most difficult, such as when residents are sleeping or fewer staff are present.

Evacuation capability determination is considered slow if the following conditions are met:

(1) All residents are able to travel to centralized dining facilities without continuous staff assistance.
(2) There is continuous staffing whenever there are residents in the facility.

A.3.3.81 Existing. See *Existing Building,* A.3.3.36.5.

A.3.3.83 Exit. Exits include exterior exit doors, exit passageways, horizontal exits, exit stairs, and exit ramps. In the case of a stairway, the exit includes the stair enclosure, the door to the stair enclosure, the stairs and landings inside the enclosure, the door from the stair enclosure to the outside or to the level of exit discharge, and any exit passageway and its associated doors, if such are provided, so as to discharge the stair directly to the outside. In the case of a door leading directly from the street floor to the street or open air, the exit comprises only the door. *(See also 7.2.2.6.3.1 and A.7.2.2.6.3.1.)*

Doors of small individual rooms, as in hotels, while constituting exit access from the room, are not referred to as exits, except where they lead directly to the outside of the building from the street floor.

A.3.3.83.1 Horizontal Exit. Horizontal exits should not be confused with egress through doors in smoke barriers. Doors in smoke barriers are designed only for temporary protection against smoke, whereas horizontal exits provide protection against serious fire for a relatively long period of time in addition to providing immediate protection from smoke. *(See 7.2.4.)*

A.3.3.85.1 Level of Exit Discharge. Low occupancy, ancillary spaces with exit doors discharging directly to the outside, such as mechanical equipment rooms or storage areas, that are located on levels other than main occupiable floors should not be considered in the determination of level of exit discharge.

A.3.3.88 Exposure Fire. An exposure fire usually refers to a fire that starts outside a building, such as a wildlands fire or vehicle fire, and that, consequently, exposes the building to a fire.

A.3.3.90.2 Limited Care Facility. Limited care facilities and residential board and care occupancies both provide care to people with physical and mental limitations. However, the goals and programs of the two types of occupancies differ greatly. The requirements in this *Code* for limited care facilities are based on the assumption that these are medical facilities, that they provide medical care and treatment, and that the patients are not trained to respond to the fire alarm; that is, the patients do not participate in fire drills but, rather, await rescue. *(See Section 18.7.)*

The requirements for residential board and care occupancies are based on the assumption that the residents are provided with personal care and activities that foster continued independence, that the residents are encouraged and taught to overcome their limitations, and that most residents, including all residents in prompt and slow homes, are trained to respond to fire drills to the extent they are able. Residents are required to participate in fire drills. *(See Section 32.7.)*

Persons with Alzheimer's and related illnesses might be located in a nursing home, limited care facility, or board and care facility. For such persons, it is the level of care provided, not the medical diagnosis, that matters for the purposes of determining whether the facility should meet the requirements for limited care. Where personal care is provided but medical or custodial care is not, the limited care definition does not typically apply. It is the intent of this definition that it not apply to persons not receiving medical or custodial care, provided they are able to assist in their own evacuation, regardless of their medical diagnosis.

A.3.3.92.2 Interior Finish. Interior finish is not intended to apply to surfaces within spaces such as those that are concealed or inaccessible. Furnishings that, in some cases, might be secured in place for functional reasons should not be considered as interior finish.

A.3.3.92.3 Interior Floor Finish. Interior floor finish includes coverings applied over a normal finished floor or stair treads and risers.

A.3.3.96 Fire Code. Where no fire code has been adopted, NFPA 1, *Fire Code*, should be used where the fire code is referenced in this *Code*.

A.3.3.101 Fire Model. Due to the complex nature of the principles involved, models are often packaged as computer software. Any relevant input data, assumptions, and limitations needed to properly implement the model will be attached to the fire models.

A.3.3.105 Fire Scenario. A fire scenario defines the conditions under which a proposed design is expected to meet the fire safety goals. Factors typically include fuel characteristics, ignition sources, ventilation, building characteristics, and occupant locations and characteristics. The term *fire scenario* includes more than the characteristics of the fire itself but excludes design specifications and any characteristics that do not vary from one fire to another; the latter are called assumptions. The term *fire scenario* is used here to mean only those specifications required to calculate the fire's development and effects, but, in other contexts, the term might be used to mean both the initial specifications and the subsequent development and effects (i.e., a complete description of fire from conditions prior to ignition to conditions following extinguishment).

A.3.3.112 Flame Spread. See Section 10.2.

A.3.3.126 Grade Plane. See 4.6.15 for provisions for establishing the grade plane. Vertical measurements might be used in determining the number of stories or building height.

A.3.3.127 Grandstand. Where the term *grandstand* is preceded by an adjective denoting a material, it means a grandstand the essential members of which, exclusive of seating, are of the material designated.

A.3.3.138 Heat Release Rate (HRR). The heat release rate of a fuel is related to its chemistry, physical form, and availability of oxidant and is ordinarily expressed as British thermal units per second (Btu/s) or kilowatts (kW).

Chapters 40 and 42 include detailed provisions on high hazard industrial and storage occupancies.

A.3.3.142.1 Day-Care Home. A day-care home is generally located within a dwelling unit.

A.3.3.145 Hotel. So-called apartment hotels should be classified as hotels, because they are potentially subject to the same transient occupancy as hotels. Transients are those who occupy accommodations for less than 30 days.

A.3.3.146.1 Externally Illuminated. The light source is typically a dedicated incandescent or fluorescent source.

A.3.3.146.2 Internally Illuminated. The light source is typically incandescent, fluorescent, electroluminescent, photoluminescent, or self-luminous or is a light-emitting diode(s).

A.3.3.164.1 Fuel Load. Fuel load includes interior finish and trim.

A.3.3.172 Means of Egress. A means of egress comprises the vertical and horizontal travel and includes intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, elevators, enclosures, lobbies, escalators, horizontal exits, courts, and yards.

A.3.3.174 Membrane. For the purpose of fire protection features, a membrane can consist of materials such as gypsum board, plywood, glass, or fabric. For the purpose of membrane structures, a membrane consists of thin, flexible, water-impervious material capable of being supported by an air pressure of 1½ in. (38 mm) water column.

A.3.3.180 Modification. Modification does not include repair or replacement of interior finishes.

A.3.3.189 Objective. Objectives define a series of actions necessary to make the achievement of a goal more likely. Objectives are stated in more specific terms than goals and are measured on a more quantitative, rather than qualitative, basis.

A.3.3.190.1 Ambulatory Health Care Occupancy. It is not the intent that occupants be considered to be incapable of self-preservation just because they are in a wheelchair or use assistive walking devices, such as a cane, a walker, or crutches. Rather, it is the intent to address emergency care centers that receive patients who have been rendered incapable of self-preservation due to the emergency, such as being rendered unconscious as a result of an accident or being unable to move due to sudden illness.

It is not the intent that the term *anesthesia* be limited to general anesthesia.

A.3.3.190.2 Assembly Occupancy. Assembly occupancies might include the following:

(1) Armories
(2) Assembly halls
(3) Auditoriums
(4) Bowling lanes
(5) Club rooms
(6) College and university classrooms, 50 persons and over
(7) Conference rooms
(8) Courtrooms
(9) Dance halls
(10) Drinking establishments
(11) Exhibition halls
(12) Gymnasiums
(13) Libraries
(14) Mortuary chapels
(15) Motion picture theaters
(16) Museums
(17) Passenger stations and terminals of air, surface, underground, and marine public transportation facilities
(18) Places of religious worship
(19) Pool rooms
(20) Recreation piers
(21) Restaurants
(22) Skating rinks
(23) Special amusement buildings, regardless of occupant load
(24) Theaters

Assembly occupancies are characterized by the presence or potential presence of crowds with attendant panic hazard in case of fire or other emergency. They are generally open or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. Such buildings are ordinarily occupied by able-bodied persons and are not used for sleeping purposes. Special conference rooms, snack areas, and other areas incidental to, and under the control of, the management of other occupancies, such as offices, fall under the 50-person limitation.

Restaurants and drinking establishments with an occupant load of fewer than 50 persons should be classified as mercantile occupancies.

For special amusement buildings, see 12.4.8 and 13.4.8.

A.3.3.190.3 Business Occupancy. Business occupancies include the following:

(1) Air traffic control towers (ATCTs)
(2) City halls
(3) College and university instructional buildings, classrooms under 50 persons, and instructional laboratories
(4) Courthouses
(5) Dentists' offices
(6) Doctors' offices
(7) General offices
(8) Outpatient clinics (ambulatory)
(9) Town halls

Doctors' and dentists' offices are included, unless of such character as to be classified as ambulatory health care occupancies. *(See 3.3.190.1.)*

Birth centers should be classified as business occupancies if they are occupied by fewer than four patients, not including infants, at any one time; do not provide sleeping facilities for four or more occupants; and do not provide treatment procedures that render four or more patients, not including infants, incapable of self-preservation at any one time. For birth centers occupied by patients not meeting these parameters, see Chapter 18 or Chapter 19, as appropriate.

Service facilities common to city office buildings, such as newsstands, lunch counters serving fewer than 50 persons, barber shops, and beauty parlors are included in the business occupancy group.

City halls, town halls, and courthouses are included in this occupancy group, insofar as their principal function is the transaction of public business and the keeping of books and records. Insofar as they are used for assembly purposes, they are classified as assembly occupancies.

A.3.3.190.4 Day-Care Occupancy. Day-care occupancies include the following:

(1) Adult day-care occupancies, except where part of a health care occupancy
(2) Child day-care occupancies
(3) Day-care homes
(4) Kindergarten classes that are incidental to a child day-care occupancy
(5) Nursery schools

In areas where public schools offer only half-day kindergarten programs, many child day-care occupancies offer state-approved kindergarten classes for children who need full-day care. Because these classes are normally incidental to the day-care occupancy, the requirements of the day-care occupancy should be followed.

A.3.3.190.5 Detention and Correctional Occupancy. Detention and correctional occupancies include the following:

(1) Adult and juvenile substance abuse centers
(2) Adult and juvenile work camps
(3) Adult community residential centers
(4) Adult correctional institutions
(5) Adult local detention facilities
(6) Juvenile community residential centers

(7) Juvenile detention facilities
(8) Juvenile training schools

See A.22.1.1.1.6 and A.23.1.1.1.6.

A.3.3.190.6 Educational Occupancy. Educational occupancies include the following:

(1) Academies
(2) Kindergartens
(3) Schools

An educational occupancy is distinguished from an assembly occupancy in that the same occupants are regularly present.

A.3.3.190.7 Health Care Occupancy. Health care occupancies include the following:

(1) Hospitals
(2) Limited care facilities
(3) Nursing homes

Occupants of health care occupancies typically have physical or mental illness, disease, or infirmity. They also include infants, convalescents, or infirm aged persons. It is not the intent to consider occupants incapable of self-preservation because they are in a wheelchair or use assistive walking devices, such as a cane, a walker, or crutches.

A.3.3.190.8 Industrial Occupancy. Industrial occupancies include the following:

(1) Drycleaning plants
(2) Factories of all kinds
(3) Food processing plants
(4) Gas plants
(5) Hangars (for servicing/maintenance)
(6) Laundries
(7) Power plants
(8) Pumping stations
(9) Refineries
(10) Sawmills
(11) Telephone exchanges

In evaluating the appropriate classification of laboratories, the authority having jurisdiction should treat each case individually, based on the extent and nature of the associated hazards. Some laboratories are classified as occupancies other than industrial; for example, a physical therapy laboratory or a computer laboratory.

A.3.3.190.8.1 General Industrial Occupancy. General industrial occupancies include multistory buildings where floors are occupied by different tenants or buildings suitable for such occupancy and, therefore, are subject to possible use for types of industrial processes with a high density of employee population.

A.3.3.190.8.2 High Hazard Industrial Occupancy. A high hazard industrial occupancy includes occupancies where gasoline and other flammable liquids are handled, used, or stored under such conditions that involve possible release of flammable vapors; where grain dust, wood flour or plastic dust, aluminum or magnesium dust, or other explosive dusts are produced; where hazardous chemicals or explosives are manufactured, stored, or handled; where materials are processed or handled under conditions that might produce flammable flyings; and where other situations of similar hazard exist. Chapters 40 and 42 include detailed provisions on high hazard industrial and storage occupancies.

A.3.3.190.9 Mercantile Occupancy. Mercantile occupancies include the following:

(1) Auction rooms
(2) Department stores
(3) Drugstores
(4) Restaurants with fewer than 50 persons
(5) Shopping centers
(6) Supermarkets

Office, storage, and service facilities incidental to the sale of merchandise and located in the same building should be considered part of the mercantile occupancy classification.

A.3.3.190.12 Residential Board and Care Occupancy. The following are examples of facilities that are classified as residential board and care occupancies:

(1) Group housing arrangement for physically or mentally handicapped persons who normally attend school in the community, attend worship in the community, or otherwise use community facilities
(2) Group housing arrangement for physically or mentally handicapped persons who are undergoing training in preparation for independent living, for paid employment, or for other normal community activities
(3) Group housing arrangement for the elderly that provides personal care services but that does not provide nursing care
(4) Facilities for social rehabilitation, alcoholism, drug abuse, or mental health problems that contain a group housing arrangement and that provide personal care services but do not provide acute care
(5) Assisted living facilities
(6) Other group housing arrangements that provide personal care services but not nursing care

A.3.3.190.13 Residential Occupancy. Residential occupancies are treated as separate occupancies in this *Code* as follows:

(1) One- and two-family dwellings (Chapter 24)
(2) Lodging or rooming houses (Chapter 26)
(3) Hotels, motels, and dormitories (Chapters 28 and 29)
(4) Apartment buildings (Chapters 30 and 31)

A.3.3.190.15 Storage Occupancy. Storage occupancies include the following:

(1) Barns
(2) Bulk oil storage
(3) Cold storage
(4) Freight terminals
(5) Grain elevators
(6) Hangars (for storage only)
(7) Parking structures
(8) Truck and marine terminals
(9) Warehouses

Storage occupancies are characterized by the presence of relatively small numbers of persons in proportion to the area.

A.3.3.206 Performance Criteria. Performance criteria are stated in engineering terms. Engineering terms include temperatures, radiant heat flux, and levels of exposure to fire products. Performance criteria provide threshold values used to evaluate a proposed design.

A.3.3.208 Personal Care. Personal care involves responsibility for the safety of the resident while inside the building. Personal care might include daily awareness by management of the resident's functioning and whereabouts, making and reminding a resident of appointments, the ability and readiness for intervention in the event of a resident experiencing a crisis, supervision in the areas of nutrition and medication, and actual provision of transient medical care.

A.3.3.209 Photoluminescent. The released light is normally visible for a limited time if the ambient light sources are removed or partially obscured.

A.3.3.211 Platform. Platforms also include the head tables for special guests; the raised area for lecturers and speakers; boxing and wrestling rings; theater-in-the-round; and for similar purposes wherein there are no overhead drops, pieces of scenery, or stage effects other than lighting and a screening valance.

A platform is not intended to be prohibited from using a curtain as a valance to screen or hide the electric conduit, lighting track, or similar fixtures, nor is a platform prohibited from using curtains that are used to obscure the back wall of the stage; from using a curtain between the auditorium and the stage (grand or house curtain); from using a maximum of four leg drops; or from using a valance to screen light panels, plumbing, and similar equipment from view.

A.3.3.218 Proposed Design. The design team might develop a number of trial designs that will be evaluated to determine whether they meet the performance criteria. One of the trial designs will be selected from those that meet the performance criteria for submission to the authority having jurisdiction as the proposed design.

The proposed design is not necessarily limited to fire protection systems and building features. It also includes any component of the proposed design that is installed, established, or maintained for the purpose of life safety, without which the proposed design could fail to achieve specified performance criteria. Therefore, the proposed design often includes emergency procedures and organizational structures that are needed to meet the performance criteria specified for the proposed design.

A.3.3.221 Ramp. See 7.2.5.

A.3.3.223.1 Fire Protection Rating. The acceptance criteria for determining fire protection ratings for fire door assemblies are described in NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* and those for fire window assemblies are described in NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies.*

A.3.3.224 Reconstruction. It is not the intent that a corridor, an aisle, or a circulation space within a suite be considered as a corridor that is shared by more than one occupant space. The suite should be considered as only one occupant space. The following situations should be considered to involve more than one occupant space:

(1) Work affecting a corridor that is common to multiple guest rooms on a floor of a hotel occupancy
(2) Work affecting a corridor that is common to multiple living units on a floor of an apartment building occupancy
(3) Work affecting a corridor that is common to multiple tenants on a floor of a business occupancy

A.3.3.239.1 Festival Seating. Festival seating describes situations in assembly occupancies where live entertainment events are held that are expected to result in overcrowding and high audience density that can compromise public safety. It is not the intent to apply the term *festival seating* to exhibitions; sports events; dances; conventions; and bona fide political, religious, and educational events. Assembly occupancies with 15 ft^2 (1.4 m^2) or more per person should not be considered festival seating.

A.3.3.241 Self-Luminous. An example of a self-contained power source is tritium gas. Batteries do not qualify as a self-contained power source. The light source is typically contained inside the device.

A.3.3.242 Self-Preservation (Day-Care Occupancy). Examples of clients who are incapable of self-preservation include infants, clients who are unable to use stairs because of confinement to a wheelchair or other physical disability, and clients who cannot follow directions or a group to the outside of a facility due to mental or behavioral disorders. It is the intent of this *Code* to classify children under the age of 24 months as incapable of self-preservation. Examples of direct intervention by staff members include carrying a client, pushing a client outside in a wheelchair, and guiding a client by direct hand-holding or continued bodily contact. If clients cannot exit the building by themselves with minimal intervention from staff members, such as verbal orders, classification as incapable of self-preservation should be considered.

A.3.3.249 Situation Awareness. Situation awareness (also called situational awareness), described in a simpler fashion, is being aware of what is happening around you and understanding what that information means to you now and in the future. This definition, and the more formal definition, come from the extensive work of human factors (ergonomics) experts in situation awareness, most notably Mica R. Endsley (Endsley, Bolte and Jones, *Designing for Situation Awareness: An approach to user-centered design*, CRC Press, Taylor and Francis, Boca Raton, FL, 2003). Within the *Code*, and the standards it references, are long-standing requirements for systems and facilities that enhance situation awareness. Included are fire/smoke detection, alarm, and communication systems plus the system status panels in emergency command centers; supervisory systems for various especially critical components (e.g., certain valves) of fire protection systems; waterflow indicators; certain signs; and the availability of trained staff, notably in health care occupancies. Serious failures of situation awareness have been identified as central to unfortunate outcomes in various emergencies; for example, typical responses of people to developing fires also exhibit situation awareness problems as incorrect assumptions are made about the rapidity of fire growth or the effect of opening a door. Good situation awareness is critical to decision making, which, in turn, is critical to performance during an emergency.

A.3.3.256 Smoke Partition. A smoke partition is not required to have a fire resistance rating.

A.3.3.257 Smokeproof Enclosure. For further guidance, see the following publications:

(1) ASHRAE *Handbook and Product Directory — Fundamentals*
(2) *Principles of Smoke Management*, by Klote and Milke
(3) NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*

A.3.3.262.1 Design Specification. Design specifications include both hardware and human factors, such as the conditions produced by maintenance and training. For purposes of performance-based design, the design specifications of interest are those that affect the ability of the building to meet the stated goals and objectives.

A.3.3.265 Stair. See 7.2.2.6.

A.3.3.268 Stories in Height. Stories below the level of exit discharge are not counted as stories for determining the stories in height of a building.

A.3.3.269 Story. Stories used exclusively for mechanical equipment rooms, elevator penthouses, and similar spaces are not occupiable stories.

A.3.3.271 Street Floor. Where, due to differences in street levels, two or more stories are accessible from the street, each is a street floor. Where there is no floor level within the specified limits for a street floor above or below the finished ground level, the building has no street floor.

A.3.3.272 Structure. The term *structure* is to be understood as if followed by the words *or portion thereof. (See also Building, A.3.3.36.)*

A.3.3.272.2 Air-Supported Structure. A cable-restrained air-supported structure is one in which the uplift is resisted by cables or webbing that is anchored by various methods to the membrane or that might be an integral part of the membrane. An air-supported structure is not a tensioned-membrane structure.

A.3.3.272.6 Open Structure. Open structures are often found in oil refining, chemical processing, or power plants. Roofs or canopies without enclosing walls are not considered an enclosure.

A.3.3.272.7 Parking Structure. A parking structure is permitted to be enclosed or open, use ramps, and use mechanical control push-button-type elevators to transfer vehicles from one floor to another. Motor vehicles are permitted to be parked by the driver or an attendant or are permitted to be parked mechanically by automated facilities. Where automated-type parking is provided, the operator of those facilities is permitted either to remain at the entry level or to travel to another level. Motor fuel is permitted to be dispensed, and motor vehicles are permitted to be serviced in a parking structure in accordance with NFPA 30A. [**88A,** 2015]

A.3.3.272.11 Underground Structure. In determining openings in exterior walls, doors or access panels are permitted to be included. Windows are also permitted to be included, provided that they are openable or provide a breakable glazed area.

A.3.3.279 Tent. A tent might also include a temporary tensioned-membrane structure.

A.3.3.286 Vertical Opening. Vertical openings might include items such as stairways; hoistways for elevators, dumbwaiters, and inclined and vertical conveyors; shaftways used for light, ventilation, or building services; or expansion joints and seismic joints used to allow structural movements.

A.3.3.289 Wall or Ceiling Covering. Wall or ceiling coverings with ink or top coat layers added as part of the manufacturing process are included in this definition. The term “polymeric” is intended to include “vinyl.”

A.4.1 The goals in Section 4.1 reflect the scope of this *Code (see Section 1.1).* Other fire safety goals that are outside the scope of this *Code* might also need to be considered, such as property protection and continuity of operations. Compliance with this *Code* can assist in meeting goals outside the scope of the *Code.*

A.4.1.1 Reasonable safety risk is further defined by subsequent language in this *Code.*

A.4.1.1(1) The phrase “intimate with the initial fire development” refers to the person(s) at the ignition source or first materials burning, not to all persons within the same room or area.

A.4.1.2 “Comparable emergencies” refers to incidents where the hazard involves thermal attributes similar to fires or airborne contaminants similar to smoke, such that features mandated by this *Code* can be expected to mitigate the hazard. Examples of such incidents might be explosions and hazardous material releases. The *Code* recognizes that features mandated by this *Code* might be less effective against such hazards than against fires.

A.4.1.3 An assembly occupancy is an example of an occupancy where the goal of providing for reasonably safe emergency and nonemergency crowd movement has applicability. A detention or correctional occupancy is an example of an occupancy where emergency and nonemergency crowd movement is better addressed by detention and correctional facilities specialists than by this *Code.*

A.4.3 Additional assumptions that need to be identified for a performance-based design are addressed in Chapter 5.

A.4.3.1 Protection against certain terrorist acts will generally require protection methods beyond those required by this *Code.*

A.4.4.2.3(1) As an example, Table 7.2.2.2.1.1(a) limits a new stair to having a maximum riser height of 7 in. (180 mm) and 12.2.5.6.6 limits a new aisle stair in an assembly occupancy to having a maximum riser height of 8 in. (205 mm), 9 in. (230 mm), or 11 in. (280 mm). The specific provisions of 12.2.5.6.6 are intended to govern the maximum riser height for the new aisle stairs in assembly occupancies, not the general riser height requirement of Table 7.2.2.2.1.1(a).

A.4.4.2.3(2) As an example, 7.1.3.2.1 requires an exit stair to be enclosed and separated from the remainder of the building by fire resistance–rated construction of at least one hour and 8.6.5 requires a minimum fire resistance rating of ½ hour for the enclosure of an existing floor opening. A existing hole in a floor used for a stair creates a vertical opening subject to the enclosure and protection requirements of 8.6.5. Where such stair is used as an exit stair, it is subject to the requirements of 7.1.3.2.1 for the separation and enclosure of exits. The case of a stair used as an exit stair is more specific than the case of a non-exit stair that creates a vertical opening. The provision of 7.1.3.2.1 governs with respect to the required fire resistance rating of the exit stair enclosure.

A.4.4.2.3(3) As an example, the provision of 11.8.2.2 that prohibits elevator lobby door locking in new high-rise buildings is more specific than the provision of 38.2.2.2.3 that permits elevator lobby exit access door-locking arrangements in accordance with 7.2.1.6.3 in new business occupancies. New high-rise business occupancy buildings are a specific subset of the general category of new business occupancy buildings. Extra provisions and limitations are mandated for new high-rise business occupancy buildings that are not mandated for new non–high-rise business occupancy buildings. The specific provision of 11.8.2.2 is intended to govern the locking of elevator lobby doors, not the general provision of 38.2.2.2.3.

A.4.5.4 Fire alarms alert occupants to initiate emergency procedures, facilitate orderly conduct of fire drills, and might initiate response by emergency services.

A.4.5.5 Systems encompass facilities or equipment and people. Included are fire/smoke detection, alarm, and communication systems plus the system status panels in emergency command centers; supervisory systems for various especially critical components (e.g., certain valves) of fire protection systems; certain signs; and the availability of trained staff, notably in health care occupancies.

A.4.6.4.2 See A.4.6.5.

A.4.6.5 In existing buildings, it is not always practical to strictly apply the provisions of this *Code*. Physical limitations can cause the need for disproportionate effort or expense with little increase in life safety. In such cases, the authority having jurisdiction needs to be satisfied that reasonable life safety is ensured.

In existing buildings, it is intended that any condition that represents a serious threat to life be mitigated by the application of appropriate safeguards. It is not intended to require modifications for conditions that do not represent a significant threat to life, even though such conditions are not literally in compliance with the *Code*.

An example of what is intended by 4.6.5 would be a historic ornamental guardrail baluster with spacing that does not comply with the 4 in. (100 mm) requirement. Because reducing the spacing would have minimal impact on life safety but could damage the historic character of the guardrail, the existing spacing might be approved by the authority having jurisdiction.

A.4.6.7.4 In some cases, the requirements for new construction are less restrictive, and it might be justifiable to permit an existing building to use the less restrictive requirements. However, extreme care needs to be exercised when granting such permission, because the less restrictive provision might be the result of a new requirement elsewhere in the *Code*. For example, in editions of the *Code* prior to 1991, corridors in new health care occupancies were required to have a 1-hour fire resistance rating. Since 1991, such corridors have been required only to resist the passage of smoke. However, this provision is based on the new requirement that all new health care facilities be protected throughout by automatic sprinklers. *(See A.4.6.7.5.)*

A.4.6.7.5 An example of what is intended by 4.6.7.4 and 4.6.7.5 follows. In a hospital that has 6 ft (1830 mm) wide corridors, such corridors cannot be reduced in width, even though the provisions for existing hospitals do not require 6 ft (1830 mm) wide corridors. However, if a hospital has 10 ft (3050 mm) wide corridors, they are permitted to be reduced to 8 ft (2440 mm) in width, which is the requirement for new construction. If the hospital corridor is 36 in. (915 mm) wide, it would have to be increased to 48 in. (1220 mm), which is the requirement for existing hospitals.

A.4.6.10.1 Fatal fires have occurred when, for example, a required stair has been closed for repairs or removed for rebuilding, or when a required automatic sprinkler system has been shut off to change piping.

A.4.6.10.2 See also NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*.

A.4.6.12.3 Examples of such features include automatic sprinklers, fire alarm systems, standpipes, and portable fire extinguishers. The presence of a life safety feature, such as sprinklers or fire alarm devices, creates a reasonable expectation by the public that these safety features are functional. When systems are inoperable or taken out of service but the devices remain, they present a false sense of safety. Also, before taking any life safety features out of service, extreme care needs to be exercised to ensure that the feature is not required, was not originally provided as an alternative or equivalent, or is no longer required due to other new requirements in the current *Code*. It is not intended that the entire system or protection feature be removed. Instead, components such as sprinklers, initiating devices, notification appliances, standpipe hose, and exit systems should be removed to reduce the likelihood of relying on inoperable systems or features. Conversely, equipment, such as fire or smoke dampers, that is not obvious to the public should be able to be taken out of service if no longer required by this *Code*. Where a door that is not required to be fire protection-rated is equipped with a fire protection listing label, it is not the intent of 4.6.12.3 to require such door to be self- or automatic-closing due merely to the presence of the label.

A.4.6.13 The provisions of 4.6.13 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials.

A.4.6.13.1(1) Examples of such materials include steel, concrete, masonry, and glass.

A.4.6.14 Materials subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmospheric condition are considered combustible. (See NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, and NFPA 220, *Standard on Types of Building Construction*.)

A.4.7 The purpose of emergency egress and relocation drills is to educate the participants in the fire safety features of the building, the egress facilities available, and the procedures to be followed. Speed in emptying buildings or relocating occupants, while desirable, is not the only objective. Prior to an evaluation of the performance of an emergency egress and relocation drill, an opportunity for instruction and practice should be provided. This educational opportunity should be presented in a nonthreatening manner, with consideration given to the prior knowledge, age, and ability of audience.

The usefulness of an emergency egress and relocation drill, and the extent to which it can be performed, depends on the character of the occupancy.

In buildings where the occupant load is of a changing character, such as hotels or department stores, no regularly organized emergency egress and relocation drill is possible. In such cases, the emergency egress and relocation drills are to be limited to the regular employees, who can be thoroughly schooled in the proper procedure and can be trained to properly direct other occupants of the building in case of emergency evacuation or relocation. In occupancies such as hospitals, regular employees can be rehearsed in the proper procedure in case of fire; such training is always advisable in all occupancies, regardless of whether regular emergency egress and relocation drills can be held.

A.4.7.2 If an emergency egress and relocation drill is considered merely as a routine exercise from which some persons are allowed to be excused, there is a grave danger that, in an actual emergency, the evacuation and relocation will not be successful. However, there might be circumstances under which all occupants do not participate in an emergency egress and relocation drill; for example, infirm or bedridden patients in a health care occupancy.

A.4.7.4 Fire is always unexpected. If the drill is always held in the same way at the same time, it loses much of its value. When, for some reason during an actual fire, it is not possible to follow the usual routine of the emergency egress and relocation drill to which occupants have become accustomed, confusion and panic might ensue. Drills should be carefully planned to simulate actual fire conditions. Not only should drills be held at varying times, but different means of exit or relocation areas should be used, based on an assumption that fire or smoke might prevent the use of normal egress and relocation avenues.

A.4.7.6 The written record required by this paragraph should include such details as the date, time, participants, location, and results of that drill.

A.4.8.2.1 Items to be considered in preparing an emergency action plan should include the following:

(1) Purpose of plan
(2) Building description, including certificate of occupancy
(3) Appointment, organization, and contact details of designated building staff to carry out the emergency duties
(4) Identification of events (man-made and natural) considered life safety hazards impacting the building
(5) Responsibilities matrix (role-driven assignments)
(6) Policies and procedures for those left behind to operate critical equipment
(7) Specific procedures to be used for each type of emergency
(8) Requirements and responsibilities for assisting people with disabilities
(9) Procedures for accounting for employees
(10) Training of building staff, building emergency response teams, and other occupants in their responsibilities
(11) Documents, including diagrams, showing the type, location, and operation of the building emergency features, components, and systems
(12) Practices for controlling life safety hazards in the building
(13) Inspection and maintenance of building facilities that provide for the safety of occupants
(14) Conducting fire and evacuation drills
(15) Interface between key building management and emergency responders
(16) Names or job titles of persons who can be contacted for further information or explanation of duties
(17) Post-event (including drill) critique/evaluation, as addressed in 5.14 of *NFPA 1600, Standard on Disaster/Emergency Management and Business Continuity Programs*
(18) Means to update the plan, as necessary

A.4.8.2.1(3) It is assumed that a majority of buildings will use a total evacuation strategy during a fire. It should be noted that evacuation from a building could occur for reasons other than a fire, but such other reasons are not the primary focus of the *Code*. As used herein, total evacuation is defined as the process in which all, or substantially all, occupants leave a building or facility in either an unmanaged or managed sequence or order. An alternative to total evacuation is partial evacuation, which can be defined as the process in which a select portion of a building or facility is cleared or emptied of its occupants while occupants in other portions mostly carry on normal activity. In either case, the evacuation process can be ordered or managed in accordance with an established priority in which some or all occupants of a building or facility clear their area and utilize means of egress routes. This is typically done so that the more-endangered occupants are removed before occupants in less-endangered areas. Alternative terms describing this sequencing or ordering of evacuation are *staged evacuation* and *phased evacuation*.

Table A.4.8.2.1(3) illustrates options for extent of management and extent of evacuation. Some of the options shown might not be appropriate. As noted in Table A.4.8.2.1(3), either total or partial evacuation can include staged (zoned) evacuation or phased evacuation, which is referred to as managed or controlled evacuation. It should also be noted that the evacuation process might not include relocation to the outside of the building but might instead include relocation to an area of refuge or might defend the occupants in place to minimize the need for evacuation.

Table A.4.8.2.1(3) Occupant Evacuation Strategies

	Managed Sequence	Unmanaged Sequence
Shelter in place	No movement — Shelter in place upon direction	No movement — Shelter in place per prior instruction
Relocation or partial evacuation	Managed or controlled partial evacuation In-building relocation on same floor In-building relocation to different floors Occupants of some floors leave building	Unmanaged movement
Total evacuation	Managed or controlled total evacuation	Unmanaged or controlled total evacuation

The different methods of evacuation are also used in several contexts throughout the *Code*. Though most of the methods of evacuation are not specifically defined or do not have established criteria, various sections of the *Code* promulgate them as alternatives to total evacuation. The following sections discuss these alternatives in more detail:

(1) Section 4.7 — Provides requirements for fire and relocation drills
(2) 7.2.12 — Provides requirements for area of refuge
(3) 7.2.4 — Provides requirements for horizontal exits
(4) 9.6.3.6 — Provides the alarm signal requirements for different methods of evacuation
(5) 9.6.3.9 — Permits automatically transmitted or live voice evacuation or relocation instructions to occupants and requires them in accordance with *NFPA 72, National Fire Alarm and Signaling Code*
(6) 14.3.4.2.3 (also Chapter 15) — Describes alternative protection systems in educational occupancies
(7) 18.1.1.2/18.1.1.3/Section 18.7 (also Chapter 19) — Provide methods of evacuation for health care occupancies
(8) Chapters 22 and 23 — Provide methods of evacuation for detention and correctional occupancies, including the five groups of resident user categories
(9) Chapters 32 and 33 — Provide methods of evacuation for residential board and care occupancies

(10) 32.1.5/33.1.5 — For residential board and care occupancies, state that "no means of escape or means of egress shall be considered as complying with the minimum criteria for acceptance, unless emergency evacuation drills are regularly conducted"
(11) 40.2.5.2.2 — For industrial occupancies, states that "ancillary facilities in special-purpose industrial occupancies where delayed evacuation is anticipated shall have not less than a 2-hour fire resistance–rated separation from the predominant industrial occupancy and shall have one means of egress that is separated from the predominant industrial occupancy by 2-hour fire resistance–rated construction"

The method of evacuation should be accomplished in the context of the physical facilities, the type of activities undertaken, and the provisions for the capabilities of occupants (and staff, if available). Therefore, in addition to meeting the requirements of the *Code*, or when establishing an equivalency or a performance-based design, the following recommendations and general guidance information should be taken into account when designing, selecting, executing, and maintaining a method of evacuation:

(1) When choosing a method of evacuation, the available safe egress time (ASET) must always be greater than the required safe egress time (RSET).
(2) The occupants' characteristics will drive the method of evacuation. For example, occupants might be incapable of evacuating themselves because of age, physical or mental disabilities, physical restraint, or a combination thereof. However, some buildings might be staffed with people who could assist in evacuating. Therefore, the method of evacuation is dependent on the ability of occupants to move as a group, with or without assistance. For more information, see the definitions under the term *Evacuation Capability* in Chapter 3.
(3) An alternative method of evacuation might or might not have a faster evacuation time than a total evacuation. However, the priority of evacuation should be such that the occupants in the most danger are given a higher priority. This prioritization will ensure that occupants more intimate with the fire will have a faster evacuation time.
(4) Design, construction, and compartmentation are also variables in choosing a method of evacuation. The design, construction, and compartmentation should limit the development and spread of a fire and smoke and reduce the need for occupant evacuation. The fire should be limited to the room or compartment of fire origin. Therefore, the following factors need to be considered:
   (a) Overall fire resistance rating of the building
   (b) Fire-rated compartmentation provided with the building
   (c) Number and arrangement of the means of egress
(5) Fire safety systems should be installed that complement the method of evacuation and should include consideration of the following:
   (a) Detection of fire
   (b) Control of fire development
   (c) Confinement of the effects of fire
   (d) Extinguishment of fire
   (e) Provision of refuge or evacuation facilities, or both
(6) One of the most important fire safety systems is the fire alarm and communication system, particularly the notification system. The fire alarm system should be in accordance with *NFPA 72, National Fire Alarm and Signaling Code*, and should take into account the following:
   (a) Initial notification of only the occupants in the affected zone(s) (e.g., zone of fire origin and adjacent zones)
   (b) Provisions to notify occupants in other unaffected zones to allow orderly evacuation of the entire building
   (c) Need for live voice communication
   (d) Reliability of the fire alarm and communication system
(7) The capabilities of the staff assisting in the evacuation process should be considered in determining the method of evacuation.
(8) The ability of the fire department to interact with the evacuation should be analyzed. It is important to determine if the fire department can assist in the evacuation or if fire department operations hinder the evacuation efforts.
(9) Evacuation scenarios for hazards that are normally outside of the scope of the *Code* should be considered to the extent practicable. (*See 4.3.1.*)
(10) Consideration should be given to the desire of the occupants to self-evacuate, especially if the nature of the building or the fire warrants evacuation in the minds of the occupants. Self-evacuation might also be initiated by communication between the occupants themselves through face-to-face contact, mobile phones, and so forth.
(11) An investigation period, a delay in the notification of occupants after the first activation of the fire alarm, could help to reduce the number of false alarms and unnecessary evacuations. However, a limit to such a delay should be established before a general alarm is sounded, such as positive alarm sequence, as defined in *NFPA 72, National Fire Alarm and Signaling Code.*
(12) Consideration should be given to the need for an evacuation that might be necessary for a scenario other than a fire (e.g., bomb threat, earthquake).
(13) Contingency plans should be established in the event the fire alarm and communication system fail, which might facilitate the need for total evacuation.
(14) The means of egress systems should be properly maintained to ensure the dependability of the method of evacuation.
(15) Fire prevention policies or procedures, or both, should be implemented that reduce the chance of a fire (e.g., limiting smoking or providing fire-safe trash cans).
(16) The method of evacuation should be properly documented, and written forms of communication should be provided to all of the occupants, which might include sign postings throughout the building. Consideration should be given to the development of documentation for an operation and maintenance manual or a fire emergency action plan, or both.
(17) Emergency egress drills should be performed on a regular basis. For more information, see Section 4.7.
(18) The authority having jurisdiction should also be consulted when developing the method of evacuation.

Measures should be in place and be employed to sequence or control the order of a total evacuation, so that such evacuations proceed in a reasonably safe, efficient manner. Such measures include special attention to the evacuation capabilities and needs of occupants with disabilities, either permanent or temporary. For comprehensive guidance on facilitating life safety for such populations, go to www.nfpa.org. For specific guidance on emergency stair travel devices, see ANSI/RESNA ED-1, *Emergency Stair Travel Devices Used by individuals with Disabilities*.

In larger buildings, especially high-rise buildings, it is recommended that all evacuations — whether partial or total — be managed to sequence or control the order in which certain occupants are evacuated from their origin areas and to make use of available means of egress. In high-rise buildings, the exit stairs, at any level, are designed to accommodate the egress flow of only a very small portion of the occupants — from only one or a few stories, and within a relatively short time period — on the order of a few minutes. In case of a fire, only the immediately affected floor(s) should be given priority use of the means of egress serving that floor(s). Other floors should then be given priority use of the means of egress, depending on the anticipated spread of the fire and its combustion products and for the purpose of clearing certain floors to facilitate eventual fire service operations. Typically, this means that the one or two floors above and below a fire floor will have secondary priority immediately after the fire floor. Depending on where combustion products move — for example, upward through a building with cool-weather stack effect — the next priority floors will be the uppermost occupied floors in the building.

Generally, in order to minimize evacuation time for most or all of a relatively tall building to be evacuated, occupants from upper floors should have priority use of exit stairs. For people descending many stories of stairs, this priority will maximize their opportunity to take rest stops without unduly extending their overall time to evacuate a building. Thus, the precedence behavior of evacuees should be that people already in an exit stair should normally not defer to people attempting to enter the exit stair from lower floors, except for those lower floors most directly impacted by a fire or other imminent danger. Notably, this is contrary to the often observed behavior of evacuees in high-rise building evacuations where lower floor precedence behavior occurs. (Similarly, in the most commonly observed behavior of people normally disembarking a passenger airliner, people within the aisle defer to people entering the aisle, so that the areas closest to the exit typically clear first.) Changing, and generally managing, the sequence or order in which egress occurs will require effectively informing building occupants and evaluating resulting performance in a program of education, training, and drills.

When designing the method of evacuation for a complex building, all forms of egress should be considered. For example, consideration could be given to an elevator evacuation system. An elevator evacuation system involves an elevator design that provides protection from fire effects so that elevators can be used safely for egress. See 7.2.13 and A.7.2.12.2.4 for more information.

For further guidance, see the following publications:

(1) *SFPE Engineering Guide to Human Behavior in Fire*, which provides information on occupant characteristics, response to fire cues, decision making in fire situations, and methods for predicting evacuation times.
(2) NFPA *Fire Protection Handbook*, 20th edition, Section 1, Chapter 9, which provides good methodology for managing exposures and determining the method of evacuation
(3) NFPA *Fire Protection Handbook*, 20th edition, Section 20, which provides further commentary on methods of evacuation for different occupancies
(4) *SFPE Handbook of Fire Protection Engineering*, Section 3, Chapters 11–13, which provide an overview of some of the research on methods of evacuation and methods for predicting evacuation times

A.4.8.2.3 Emergency action plans are a critical component of assuring life safety in buildings. Life safety is the result of an interaction of technical and social systems within the building and in the community. Gathering information to evaluate the performance and effectiveness of emergency action plans is important for verifying system performance and as a basis for improvement. Such reports should be retained by building management and used to inform the process for revision of the building emergency action plan.

Following any drill or actual emergency or reported emergency occurring in the building, an after action report should be prepared by the building owner or designated representative to document the function of the building's life safety hardware, procedures, and occupant emergency organization.

For ordinary drills and reported emergencies, areas of success and areas for improvement should be identified.

For actual emergencies in the building, where there is major occupant movement, damage, or casualties, additional information should be collected. This includes questions concerning the event, as well as performance of life safety systems. It also identifies improvements in areas such as training, maintenance, interaction with local emergency response organizations, or occupant management. The reports from these significant events should be shared with the local emergency response organization.

A.5.1.1 Chapter 5 provides requirements for the evaluation of a performance-based life safety design. The evaluation process is summarized in Figure A.5.1.1.

Code Criteria. On the left side of Figure A.5.1.1 is input from the *Code.* The life safety goals have been stated in Section 4.1. The objectives necessary to achieve these goals are stated in Section 4.2. Section 5.2 specifies the performance criteria that are to be used to determine whether the objectives have been met.

Input. At the top of Figure A.5.1.1 is the input necessary to evaluate a life safety design.

The design specifications are to include certain retained prescriptive requirements, as specified in Section 5.3. All assumptions about the life safety design and the response of the building and its occupants to a fire are to be clearly stated as indicated in Section 5.4. Scenarios are used to assess the adequacy of the design. Eight sets of initiating events are specified for which the ensuing outcomes are to be satisfactory.

Performance Assessment. Appropriate methods for assessing performance are to be used per Section 5.6. Safety factors are to be applied to account for uncertainties in the assessment, as stated in Section 5.7. If the resulting predicted outcome of the scenarios is bounded by the performance criteria, the objectives have been met, and the life safety design is considered to be in compliance with this *Code.* Although not part of this *Code*, a design that fails to comply can be changed and reassessed, as indicated on the right side of Figure A.5.1.1.

Documentation. The approval and acceptance of a life safety design are dependent on the quality of the documentation of the process. Section 5.8 specifies a minimum set of documentation that is to accompany a submission.

The performance option of this *Code* establishes acceptable levels of risk to occupants of buildings and structures as addressed in Section 1.1. While the performance option of this *Code* does contain goals, objectives, and performance criteria necessary to provide an acceptable level of risk to occupants, it does not describe how to meet the goals, objectives, and performance criteria. Design and engineering are needed to develop solutions that meet the provisions of Chapter 5. The *SFPE Engineering Guide to Performance-Based Fire Protection* provides a framework for these assessments. Other useful references include the *Australian Fire*

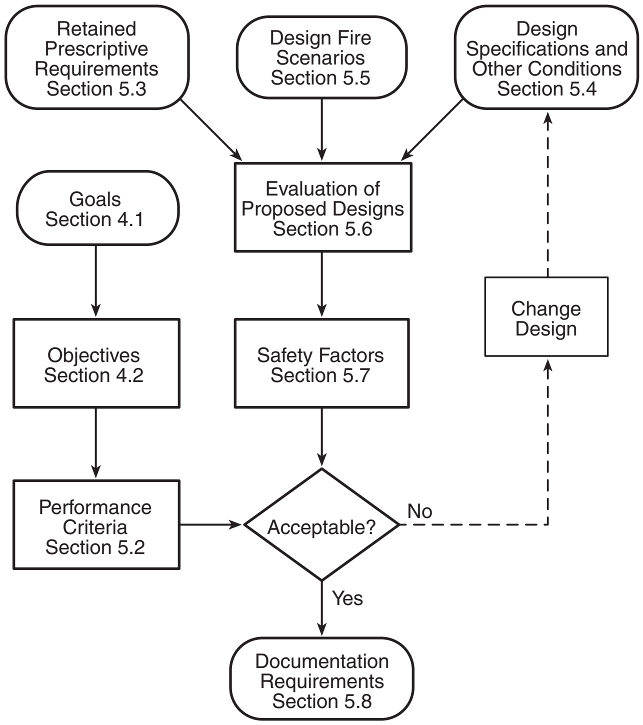


FIGURE A.5.1.1 Performance-Based Life Safety Code Compliance Process.

Engineering Guidelines and the *British Standard Firesafety Engineering in Buildings*.

A.5.1.4 A third-party reviewer is a person or group of persons chosen by the authority having jurisdiction to review proposed performance-based designs. The *SFPE Guidelines for Peer Review in the Fire Protection Design Process* provides a method for the initiation, scope, conduct, and report of a peer review of a fire protection engineering design.

A.5.1.6 For guidance on reviewing performance-based designs, see the *SFPE Code Official's Guide to Performance-Based Design Review*. Additional guidance on reviewing designs in which fire risk assessment is used can be found in NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*.

A.5.1.7 Continued compliance with the goals and objectives of the *Code* involves many factors. The building construction — including openings, interior finish, and fire- and smoke-resistive construction — and the building and fire protection systems need to retain at least the same level of performance as is provided for the original design parameters. The use and occupancy should not change to the degree that assumptions made about the occupant characteristics, combustibility of furnishings, and existence of trained personnel are no longer valid. In addition, actions provided by other personnel, such as emergency responders, should not be diminished below the documented assumed levels. Also, actions needed to maintain reliability of systems at the anticipated level need to meet the initial design criteria.

A.5.2.2 One of the methods that follows can be used to avoid exposing occupants to untenable conditions.

Method 1. The design team can set detailed performance criteria that ensure that occupants are not incapacitated by fire effects. The *SFPE Engineering Guide to Performance-Based Fire Protection* describes a process of establishing tenability limits.

The guide references D. A. Purser, "Assessment of Hazards to Occupants from Smoke, Toxic Gasses, and Heat," Chapter 2/6, *SFPE Handbook of Fire Protection Engineering*, which describes a fractional effective dose (FED) calculation approach, which is also contained in NFPA 269, *Standard Test Method for Developing Toxic Potency Data for Use in Fire Hazard Modeling*. FED addresses the effects of carbon monoxide, hydrogen cyanide, carbon dioxide, hydrogen chloride, hydrogen bromide, and anoxia. It is possible to use the test data, combined with laboratory experience, to estimate the FED value that leads to the survival of virtually all people. This value is about 0.8.

There is a relationship between exposures leading to death and those leading to incapacitation. Kaplan [Kaplan and Hartzell, *Journal of Fire Sciences*, 2:286–305 (1984)] found that rodent susceptibility is similar to that of humans and that for the narcotic gases, CO and HCN, incapacitation is estimated to occur at one-third to one-half of the lethal exposure. A set of very large statistical studies on human lethality associated with carbon monoxide involving almost 5000 fatalities (Hirschler et al., "Carbon monoxide and human lethality: Fire and non-fire studies," Elsevier, 1993) showed that the vast majority of fire deaths are attributable to carbon monoxide poisoning, which results in lethality at levels as low as 25 percent carboxyhemoglobin (much lower than previously believed) without requiring the effect of additional toxicants. This work was also confirmed by Gann [Gann et al., *Fire and Materials*, 18:193 (1994)], who also found that carbon monoxide dominates the lethality of fire smoke, since most fire deaths occur remote from the fire room in fires that have proceeded past flashover. Thus, if an FED value of 0.8 were used for a nonlethal exposure, an FED of 0.3 would be reasonable for a nonincapacitating exposure.

If the authority having jurisdiction or the design professional is concerned with potential toxic fire effects, other than those addressed by the FED procedure as documented, the calculation procedure can be expanded by adding additional terms to the FED equation, with each term expressed as a ratio. The numerator of the ratio is the cumulative exposure to that fire effect, measured as an integral of the product of instantaneous exposure (concentration for toxic products) and time. The denominator of the ratio is the quantity of cumulative exposure for which FED equals the chosen threshold value (i.e., 0.8 or 0.3) based on that fire effect alone. A complete analysis of tenability requires consideration of tenability criteria for thermal effects (convected heat and radiated heat) and smoke obscuration, as well as those for smoke toxicity, and an example of the application of such criteria is shown in ASTM E 2280, *Standard Guide for Fire Hazard Assessment of the Effect of Upholstered Seating Furniture Within Patient Rooms of Health Care Facilities*.

For buildings where an unusually large fraction of the occupants are especially vulnerable, the calculation procedure for the smoke toxicity incapacitating criterion should be modified to use FED values lower than 0.8 or 0.3.

Method 2. For each design fire scenario and the design specifications, conditions, and assumptions, the design team can demonstrate that each room or area will be fully evacuated before the smoke and toxic gas layer in that room descends to a level lower than 6 ft (1830 mm) above the floor. The timing of such an evacuation means that no occupant is exposed to fire effects. Such an evacuation requires calculation of the locations, movement, and behavior of occupants, because fire effects and occupants are separated by moving the occupants. A level of 60 in. (1525 mm) is often used in calculations, but, at that level, a large fraction of the population would not be able to stand, walk, or run normally and still avoid inhalation of toxic gases. They would have to bend over or otherwise move their heads closer to the floor level.

Method 3. For each design fire scenario and the design specifications and assumptions, the design team can demonstrate that the smoke and toxic gas layer will not descend to a level lower than 6 ft (1830 mm) above the floor in any occupied room. The advantage of this procedure is that it conservatively ensures that no occupant is exposed to fire effects, regardless of where occupants are located or where they move. This eliminates the need for calculations regarding occupants, including those for their behavior, movement locations, pre-fire characteristics, and reactions to fire effects. This procedure is even more conservative and simpler than the procedure in Method 2, because it does not allow fire effects in occupied rooms to develop to a point where people could be affected at any time during the fire.

Method 4. For each design fire scenario and the design specifications and assumptions, the design team can demonstrate that no fire effects will reach any occupied room. The advantage of this procedure is that it eliminates the need for calculations regarding occupants, including those for their behavior, movement, locations, pre-fire characteristics, and reactions to fire effects. A further advantage is that it also eliminates the need for some of the modeling of fire effects, because it is not necessary to model the filling of rooms, only the spread of fire effects to those rooms. This procedure is even more conservative and simpler than the procedures in Methods 2 and 3, because it does not allow any fire effects in occupied rooms.

A.5.3.1 This requirement applies both to systems and features required by the *Code* that reference applicable standards and to any additional systems or features included in the design at the discretion of the design team. The referenced standards are hereby expected to state maintenance, testing, and other requirements needed to provide positive assurance of an acceptable level of reliability. The referenced standards themselves might be prescriptive- or performance-based.

A.5.4.1 The design specifications and other conditions form the input to evaluation of proposed designs *(see Section 5.6)*. Where a specification or condition is not known, a reasonable estimation is permitted. However, the design team must take steps to ensure that the estimation is valid during the life of the building. Any estimations need to be documented. *(See Section 5.8.)*

A.5.4.4 Systems addressed by this requirement include automatic fire suppression systems and fire alarm systems. Performance issues that need to be documented might include response time indexes, discharge densities, and distribution patterns. Calculations should not include an unlimited supply of extinguishing agent if only a limited supply will be provided in the actual structure or building.

Emergency procedures addressed by this requirement might be of two types. The design team could include documentation from buildings that are operationally very similar, along with documented operational performance measures tied to the recruitment and training of emergency team personnel. Where such data are unavailable, or where the proposed design differs significantly from other buildings, the design could be based on detailed analyses of the decisions and tasks that need to be performed by emergency personnel, using plausible conservative assumptions about the occupant characteristics and training of those personnel.

A.5.4.5.1 Examples of design features that might be incorporated to modify expected occupant characteristics include training, use of staff to assist with notification and movement, or type of notification appliance used.

A.5.4.5.2 The four basic characteristics — sensibility, reactivity, mobility, and susceptibility — comprise a minimum, exhaustive set of mutually exclusive performance characteristics of people in buildings that can affect a fire safety system's ability to meet life safety objectives. The characteristics are briefly described as follows:

(1) Sensibility to physical cues, which is the ability to sense the sounding of an alarm and can also include discernment and discrimination of visual and olfactory cues in addition to auditory emanations from the fire itself
(2) Reactivity, which is the ability to interpret cues correctly and take appropriate action and can be a function of cognitive capacity, speed of instinctive reaction, or group dynamics; might need to consider reliability or likelihood of a wrong decision, as in situations where familiarity with the premises influences wayfinding
(3) Mobility (speed of movement), which is determined by individual capabilities, as well as crowding phenomena, such as arching at doorways
(4) Susceptibility to products of combustion, which includes metabolism, lung capacity, pulmonary disease, allergies, or other physical limitations that affect survivability in a fire environment

In application, as with the use of computer evacuation models, assumptions can address a larger number of factors that are components of the basic performance characteristics, including the following:

(1) Alertness — condition of being awake/asleep, can depend on time of day
(2) Responsiveness — ability to sense cues and react
(3) Commitment — degree to which occupant is committed to an activity underway before the alarm
(4) Focal point — point at which an occupant's attention is focused (e.g., to front of classroom, stage, or server in business environment)
(5) Physical and mental capabilities — influence on ability to sense, respond, and react to cues; might be related to age or disability
(6) Role — influence on whether occupant will lead or follow others
(7) Familiarity — influence of time spent in building or participation in emergency training
(8) Social affiliation — extent to which an occupant will act/react as an individual or as a member of a group
(9) Condition over the course of the fire — effects, both physiological and psychological, of the fire and its combustion products on each occupant

For a more detailed explanation of occupant characteristics, see the *SFPE Engineering Guide to Human Behavior in Fire*. Occupant characteristics that are discussed in the guide include the following:

(1) Population numbers and density
(2) Condition of being alone or with others
(3) Familiarity with the building

(4) Distribution and activities
(5) Alertness
(6) Physical and cognitive ability
(7) Social affiliation
(8) Role and responsibility
(9) Location
(10) Commitment
(11) Focal point
(12) Occupant condition
(13) Gender
(14) Culture
(15) Age

A.5.4.5.4 The number of people expected to be contained in a room or area should be based on the occupant load factor specified in Table 7.3.1.2 or other approved sources.

A.5.4.5.5 For example, in hospitals, staff characteristics such as number, location, quality, and frequency of training should be considered.

A.5.4.7 Design proposals need to state explicitly any design specifications or estimations regarding building fire safety plans, inspection programs, or other ongoing programs whose performance is necessary for the building, when occupied and operational, to meet the stated goals and objectives. Programs of interest include any maintenance, training, labeling, or certification programs required to ensure operational status or reliability in building systems or features.

A.5.4.9 The design elements required to be excluded by 5.4.9 include those regarding the interrelations between the performance of building elements and systems, occupant behavior, or emergency response actions that conflict with each other. For each fire scenario, care needs to be taken to ensure that conflicts in actions do not occur. Typical conflicts could include the following:

(1) Assuming a fire door will remain closed during the fire to contain smoke while this same door is used by occupants during egress from the area
(2) Assuming fire apparatus will arrive immediately from a distant location to provide water to fire department connections and similar situations

For example, an assumption that compartmentation blocking the passage of fire and smoke will be maintained at the door to a stairwell cannot be paired with an assumption that evacuation through that door will extend over many minutes.

A.5.4.10 The provisions required by 5.4.10 to be documented include those that are in excess of basic requirements covered by referenced codes and standards, typical design requirements, and operating procedures. Such provisions include the following:

(1) More frequent periodic testing and maintenance to increase the reliability of fire protection systems
(2) Redundant systems to increase reliability
(3) On-site guard service to enhance detection of fires and aid in fire response procedures
(4) Staff training
(5) Availability and performance of emergency response personnel
(6) Other factors

A.5.5 Design fire scenarios define the challenge a building is expected to withstand. Design fire scenarios capture and limit value judgments on the type and severity of the fire challenge to which a proposed fire safety system needs to respond. The system includes any and all aspects of the proposed design that are intended to mitigate the effects of a fire, such as egress system, automatic detection and suppression, barriers, staff training, and placement of manual extinguishers.

Design fire scenarios come from two sources: those that are specified in 5.5.3.1 through 5.5.3.8, and those that are developed by the design team based on the unique characteristics of the building as required by 5.5.2. In most, if not all, cases, more than one design fire scenario will be developed to meet the requirements of 5.5.2.

Once the set of design fire scenarios is established, both those specified by 5.5.3.1 through 5.5.3.8 and those that are developed as required by 5.5.2, they need to be quantified into a format that can be used for the evaluation of proposed designs. The *SFPE Engineering Guide to Performance-Based Fire Protection* outlines a process and identifies tools and references that can be used at each step of this process.

A.5.5.2 The protection systems and features used to meet the challenge of the design fire scenario should be typical of, and consistent with, those used for other similar areas of the building. They should not be designed to be more effective in the building area addressed than in similar areas not included and that are, therefore, not explicitly evaluated.

A.5.5.3 It is desirable to consider a wide variety of different fire scenarios to evaluate the complete life safety capabilities of the building or structure. Fire scenarios should not be limited to a single or a couple of worst-case fire scenarios.

The descriptive terms used to indicate the rate of fire growth for the scenarios are intended to be generic. Use of *t*-squared fires is not required for any scenario.

A.5.5.3.1 An example of Design Fire Scenario 1 for a health care occupancy would involve a patient room with two occupied beds with a fire initially involving one bed and the room door open. This is a cursory example in that much of the explicitly required information indicated in 5.5.3.1 can be determined from the information provided in the example. Note that it is usually necessary to consider more than one scenario to capture the features and conditions typical of an occupancy.

A.5.5.3.2 Design Fire Scenario 2 examples include a fire involving ignition of gasoline as an accelerant in a means of egress, clothing racks in corridors, renovation materials, or other fuel configurations that can cause an ultrafast fire. The means of egress chosen is the doorway with the largest egress capacity among doorways normally used in the ordinary operation of the building. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the building.

A.5.5.3.3 An example of Design Fire Scenario 3 is a fire in a storage room adjacent to the largest occupiable room in the building. The contents of the room of fire origin are specified to provide the largest fuel load and the most rapid growth in fire severity consistent with the normal use of the room. The adjacent occupiable room is assumed to be filled to capacity with occupants. Occupants are assumed to be somewhat impaired in whatever form is most consistent with the intended use of the building. At ignition, doors from both rooms are assumed to be open. Depending on the design, doorways connect the two rooms or they connect via a common hallway or corridor.

For purposes of this scenario, an occupiable room is a room that might contain people; that is, a location within a building where people are typically found.

A.5.5.3.4 An example of Design Fire Scenario 4 is a fire originating in a concealed wall or ceiling space adjacent to a large, occupied function room. Ignition involves concealed combustibles, including wire or cable insulation and thermal or acoustical insulation. The adjacent function room is assumed to be occupied to capacity. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be open throughout the building.

A.5.5.3.5 An example of Design Fire Scenario 5 is a cigarette fire in a trash can. The trash can is close enough to room contents to ignite more substantial fuel sources but is not close enough to any occupant to create an intimate-with-ignition situation. If the intended use of the property involves the potential for some occupants to be incapable of movement at any time, the room of origin is chosen as the type of room likely to have such occupants, filled to capacity with occupants in that condition. If the intended use of the property does not involve the potential for some occupants to be incapable of movement, the room of origin is chosen to be an assembly or function area characteristic of the use of the property, and the trash can is placed so that it is shielded by furniture from suppression systems. At ignition, doors are assumed to be open throughout the building.

A.5.5.3.6 An example of Design Fire Scenario 6 is a fire originating in the largest fuel load of combustibles possible in normal operation in a function or assembly room, or in a process/manufacturing area, characteristic of the normal operation of the property. The configuration, type, and geometry of the combustibles are chosen so as to produce the most rapid and severe fire growth or smoke generation consistent with the normal operation of the property. The baseline occupant characteristics for the property are assumed. At ignition, doors are assumed to be closed throughout the building.

This scenario includes everything from a big couch fire in a small dwelling to a rack fire in combustible liquids stock in a big box retail store.

A.5.5.3.7 An example of Design Fire Scenario 7 is an exposure fire. The initiating fire is the closest and most severe fire possible consistent with the placement and type of adjacent properties and the placement of plants and combustible adornments on the property. The baseline occupant characteristics for the property are assumed.

This category includes wildlands/urban interface fires and exterior wood shingle problems, where applicable.

A.5.5.3.8 Design Fire Scenario 8 addresses a set of conditions with a typical fire originating in the building with any one passive or active fire protection system or feature being ineffective. Examples include unprotected openings between floors or between fire walls or fire barrier walls, failure of rated fire doors to close automatically, shutoff of sprinkler system water supply, nonoperative fire alarm system, inoperable smoke management system, or automatic smoke dampers blocked open. This scenario should represent a reasonable challenge to the other building features provided by the design and presumed to be available.

The concept of a fire originating in ordinary combustibles is intentionally selected for this scenario. This fire, although presenting a realistic challenge to the building and the associated building systems, does not represent the worst-case scenario or the most challenging fire for the building. Examples include the following:

(1) Fire originating in ordinary combustibles in the corridor of a patient wing of a hospital under the following conditions:
   (a) Staff is assumed not to close any patient room doors upon detection of fire.
   (b) The baseline occupant characteristics for the property are assumed, and the patient rooms off the corridor are assumed to be filled to capacity.
   (c) At ignition, doors to patient rooms are not equipped with self-closing devices and are assumed to be open throughout the smoke compartment.
(2) Fire originating in ordinary combustibles in a large assembly room or area in the interior of the building under the following conditions:
   (a) The automatic suppression systems are assumed to be out of operation.
   (b) The baseline occupant characteristics for the property are assumed, and the room of origin is assumed to be filled to capacity.
   (c) At ignition, doors are assumed to be closed throughout the building.
(3) Fire originating in ordinary combustibles in an unoccupied small function room adjacent to a large assembly room or area in the interior of the building under the following conditions:
   (a) The automatic detection systems are assumed to be out of operation.
   (b) The baseline occupant characteristics for the property are assumed, the room of origin is assumed to be unoccupied, and the assembly room is assumed to be filled to capacity.
   (c) At ignition, doors are assumed to be closed throughout the building.

A.5.5.3.8(3) The exemption is applied to each active or passive fire protection system individually and requires two different types of information to be developed by analysis and approved by the authority having jurisdiction. System reliability is to be analyzed and accepted. Design performance in the absence of the system is also to be analyzed and accepted, but acceptable performance does not require fully meeting the stated goals and objectives. It might not be possible to meet fully the goals and objectives if a key system is unavailable, and yet no system is totally reliable. The authority having jurisdiction will determine which level of performance, possibly short of the stated goals and objectives, is acceptable, given the very low probability (i.e., the system's unreliability probability) that the system will not be available.

A.5.6 The *SFPE Engineering Guide to Performance-Based Fire Protection* outlines a process for evaluating whether trial designs meet the performance criteria during the design fire scenarios. Additional information on reviewing the evaluation of a performance-based design can be found in the *SFPE Code Official's Guide to Performance-Based Design Review*.

The procedures described in Sections 5.2 and 5.4 identify required design fire scenarios among the design fire scenarios within which a proposed fire safety design is required to perform and the associated untenable conditions that are to be avoided in order to maintain life safety. Section 5.6 discusses methods that form the link from the scenarios and criteria to the goals and objectives.

Assessment methods are used to demonstrate that the proposed design will achieve the stated goals/objectives by providing information indicating that the performance criteria of Section 5.2 can be adequately met. Assessment methods are permitted to be either tests or modeling.

Tests. Test results can be directly used to assess a fire safety design when they accurately represent the scenarios developed by using Section 5.4 and provide output data matching the performance criteria in Section 5.2. Because the performance criteria for this *Code* are stated in terms of human exposure to lethal fire effects, no test will suffice. However, tests will be needed to produce data for use in models and other calculation methods.

Standardized Tests. Standardized tests are conducted on various systems and components to determine whether they meet some predetermined, typically prescriptive criteria. Results are given on a pass/fail basis — the test specimen either does or does not meet the pre-established criteria. The actual performance of the test specimen is not usually recorded.

Scale. Tests can be either small, intermediate, or full scale. Small-scale tests are used to test activation of detection and suppression devices and the flammability and toxicity of materials. Usually, the item to be tested is placed within the testing device or apparatus. Intermediate-scale tests can be used to determine the adequacy of system components — for example, doors and windows — as opposed to entire systems. The difference between small- and intermediate-scale tests is usually one of definition provided by those conducting the test. Full-scale tests are typically used to test building and structural components or entire systems. The difference between intermediate- and large-scale tests is also subject to the definition of those performing the test. Full-scale tests are intended to most closely depict performance of the test subject as installed in the field; that is, most closely represent real world performance.

Full-scale building evacuations can provide information on how the evacuation of a structure is likely to occur for an existing building with a given population without subjecting occupants to the real physical or psychological effects of a fire.

Data Uses. The data obtained from standardized tests have three uses for verification purposes. First, the test results can be used instead of a model. This use is typically the role of full-scale test results. Second, the test results can be used as a basis for validating the model. The model predictions match well with the test results. Therefore, the model can be used in situations similar to the test scenario. Third, the test results can be used as input to models. This is typically the use of small-scale tests, specifically flammability tests.

Start-Up Test. Start-up test results can be used to demonstrate that the fire safety system performs as designed. The system design might be based on modeling. If the start-up test indicates a deficiency, the system needs to be adjusted and retested until it can be demonstrated that the design can meet the performance criteria. Typically, start-up tests apply only to the installation to which they are designed.

Experimental Data. Experimental data from nonstandardized tests can be used when the specified scenario and the experimental setup are similar. Typically, experimental data are applicable to a greater variety of scenarios than are standardized test results.

Human and Organizational Performance Tests. Certain tests determine whether inputs used to determine human performance criteria remain valid during the occupancy of a building. Tests of human and organizational performance might include any of the following:

(1) Measuring evacuation times during fire drills
(2) Querying emergency response team members to determine whether they know required procedures
(3) Conducting field tests to ensure that emergency response team members can execute tasks within predetermined times and accuracy limits

Design proposals should include descriptions of any tests needed to determine whether stated goals, objectives, and performance criteria are being met.

Modeling. Models can be used to predict the performance criteria for a given scenario. Because of the limitations on using only tests for this purpose, models are expected to be used in most, if not all, performance-based design assessments.

The effect of fire and its toxic products on the occupants can be modeled, as can the movement and behavior of occupants during the fire. The term *evacuation model* will be used to describe models that predict the location and movements of occupants, and the term *tenability model* will be used to describe models that predict the effects on occupants of specified levels of exposure to fire effects.

Types of Fire Models. Fire models are used to predict fire-related performance criteria. Fire models can be either probabilistic or deterministic. Several types of deterministic models are available: computational fluid dynamics (CFD or field) models, zone models, purpose-built models, and hand calculations. Probabilistic fire models are also available but are less likely to be used for this purpose.

Probabilistic fire models use the probabilities as well as the severity of various events as the basis of evaluation. Some probabilistic models incorporate deterministic models, but are not required to do so. Probabilistic models attempt to predict the likelihood or probability that events or severity associated with an unwanted fire will occur, or they predict the "expected loss," which can be thought of as the probability-weighted average severity across all possible scenarios. Probabilistic models can be manifested as fault or event trees or other system models that use frequency or probability data as input. These models tend to be manifested as computer software, but are not required to do so. Furthermore, the discussion that follows under "Sources of Models" can also be applied to probabilistic models, although it concentrates on deterministic models.

CFD models can provide more accurate predictions than other deterministic models, because they divide a given space into many smaller-volume spaces. However, since they are still models, they are not absolute in their depiction of reality. In addition, they are much more expensive to use, because they are computationally intensive. Because of their expense, complexity, and intensive computational needs, CFD models require much greater scrutiny than do zone models.

It is much easier to assess the sensitivity of different parameters with zone models, because they generally run much faster and the output is much easier to interpret. Prediction of fire growth and spread has a large number of variables associated with it.

Purpose-built models (also known as stand-alone models) are similar to zone models in their ease of use. However, purpose-built models do not provide a comprehensive model. Instead, they predict the value of one variable of interest. For example, such a model can predict the conditions of a ceiling jet at a specified location under a ceiling, but a zone model would "transport" those conditions throughout the enclosure.

Purpose-built models might or might not be manifested as computer software. Models that are not in the form of software are referred to as hand calculations. Purpose-built models are, therefore, simple enough that the data management capabilities of a computer are not necessary. Many of the calculations are found in the *SFPE Handbook of Fire Protection Engineering*.

Types of Evacuation Models. Four categories of evacuation models can be considered: single-parameter estimation methods, movement models, behavioral simulation models, and tenability models.

Single-parameter estimation methods are generally used for simple estimates of movement time. They are usually based on equations derived from observations of movement in nonemergency situations. They can be hand calculations or simple computer models. Examples include calculation methods for flow times based on widths of exit paths and travel times based on travel distances. Sources for these methods include the *SFPE Handbook of Fire Protection Engineering* and the NFPA *Fire Protection Handbook*.

Movement models generally handle large numbers of people in a network flow similar to water in pipes or ball bearings in chutes. They tend to optimize occupant behavior, resulting in predicted evacuation times that can be unrealistic and far from conservative. However, they can be useful in an overall assessment of a design, especially in early evaluation stages where an unacceptable result with this sort of model indicates that the design has failed to achieve the life safety objectives.

Behavioral simulation models take into consideration more of the variables related to occupant movement and behavior. Occupants are treated as individuals and can have unique characteristics assigned to them, allowing a more realistic simulation of the design under consideration. However, given the limited availability of data for the development of these models, for their verification by their authors, or for input when using them, their predictive reliability is questionable.

Tenability Models. In general, tenability models will be needed only to automate calculations for the time-of-exposure effect equations referenced in A.5.2.2.

Other Models. Models can be used to describe combustion (as noted, most fire models only characterize fire effects), automatic system performance, and other elements of the calculation. There are few models in common use for these purposes, so they are not further described here.

Sources of Models. A compendia of computer fire models are found in the *SFPE Computer Software Directory* and in Olenick, S. and Carpenter, D., "An Updated International Survey of Computer Models for Fire and Smoke," *Journal of Fire Protection Engineering*, 13, 2, 2003, pp. 87–110. Within these references are models that were developed by the Building Fire Research Laboratory of the National Institute of Standards and Technology, which can be downloaded from the Internet at http://www.bfrl.nist.gov/864/fmabs.html. Evacuation models are discussed in the *SFPE Handbook of Fire Protection Engineering* and the NFPA *Fire Protection Handbook*.

Verification and validation. Models should undergo verification and validation to ensure that they are appropriate for their intended use. "Verification" is a check of the math used in the models. "Validation" is a check of the physics used in the model. The *SFPE Guidelines for Substantiating a Fire Model for a Given Application* provides a process for verifying and validating models.

The design professional should present the proposal, and the authority having jurisdiction, when deciding whether to approve a proposal, should consider the strength of the evidence presented for the validity, accuracy, relevance, and precision of the proposed methods. An element in establishing the strength of scientific evidence is the extent of external review and acceptance of the evidence by peers of the authors of that evidence.

Models have limitations. Most are not user friendly, and experienced users are able to construct more reasonable models and better interpret output than are novices. For these reasons, the third-party review and equivalency provisions of 5.1.4 and 5.3.3 are provided. The intent is not to discourage the use of models, only to indicate that they should be used with caution by those who are well versed in their nuances.

Input Data. The first step in using a model is to develop the input data. The heat release rate curve specified by the user is the driving force of a fire effects model. If this curve is incorrectly defined, the subsequent results are not usable. In addition to the smoldering and growth phases that will be specified as part of the scenario definition, two additional phases are needed to complete the input heat release rate curve — steady burning and burnout.

Steady burning is characterized by its duration, which is a function of the total amount of fuel available to be burned. In determining the duration of this phase, the designer needs to consider how much fuel has been assumed to be consumed in the smoldering and growth phases and how much is assumed to be consumed in the burnout phase that follows. Depending on the assumptions made regarding the amount of fuel consumed during burnout, the time at which this phase starts is likely to be easy to determine.

The preceding discussion assumes that the burning objects are solid (e.g., tables and chairs). If liquid or gaseous fuels are involved, the shape of the curve will be different. For example, smoldering is not relevant for burning liquids or gases, and the growth period is very short, typically measured in seconds. Peak heat release rate can depend primarily on the rate of release, on the leak rate (gases and liquid sprays), or on the extent of spill (pooled liquids). The steady burning phase is once again dependent on the amount of fuel available to burn. Like the growth phase, the burnout phase is typically short (e.g., closing a valve), although it is conceivable that longer times might be appropriate, depending on the extinguishment scenario.

Material properties are usually needed for all fuel items, both initial and secondary, and the enclosure surfaces of involved rooms or spaces.

For all fires of consequence, it is reasonable to assume that the fire receives adequate ventilation. If there is insufficient oxygen, the fire will not be sustained. An overabundance of oxygen is only a concern in special cases (e.g., hermetically sealed spaces) where a fire might not occur due to dilution of the fuel (i.e., a flammable mixture is not produced). Therefore, given that the scenarios of interest will occur in nonhermetically sealed enclosures, it is reasonable to assume that adequate ventilation is available and that, if a fire starts, it will continue to burn until it either runs out of fuel or is extinguished by other means. The only variable that might need to be assumed is the total vent width.

Maximum fire extent is affected by two geometric aspects: burning object proximity to walls and overall enclosure dimensions.

The room dimensions affect the time required for a room to flashover. For a given amount and type of fuel, under the same ventilation conditions, a small room will flashover before a large room. In a large room with a small amount of fuel, a fire will behave as if it is burning outside — that is, adequate oxygen for burning and no concentration of heat exist. If the fuel package is unchanged but the dimensions of the room are decreased, the room will begin to have an affect on the fire, assuming adequate ventilation. The presence of the relatively smaller enclosure results in the buildup of a hot layer of smoke and other products of combustion under the ceiling. This buildup, in turn, feeds more heat back to the seat of the fire, which results in an increase in the pyrolysis rate of the fuel and, thus, increases the amount of heat energy released by the fire. The room enclosure surfaces themselves also contribute to this radiation feedback effect.

Probabilistic data are expressed as either a frequency (units of inverse time) or a probability (unitless, but applicable to a stated period of time). An example of the former is the expected number of failures per year, and the range of the latter is between zero and one, inclusive. Probabilities can be either objective or subjective. Subjective probabilities express a degree of belief that an event will occur. Objective probabilities are based on historical data and can be expressed as a reliability of an item, such as a component or a system.

A.5.6.3.3 Procedures used to develop required input data need to preserve the intended conservatism of all scenarios and assumptions. Conservatism is only one means to address the uncertainty inherent in calculations and does not eliminate the need to consider safety factors, sensitivity analysis, and other methods of dealing with uncertainty. The *SFPE Guidelines for Substantiating a Fire Model for a Given Application* outlines a process for identifying and treating uncertainty and other inaccuracies introduced through the use of fire models.

A.5.6.4 An assessment method translates input data, which might include test specifications, parameters, or variables for modeling, or other data, into output data, which are measured against the performance criteria. Computer fire models should be evaluated to ensure that they are appropriate for their intended use in accordance with the *SFPE Guidelines for Substantiating a Fire Model for a Given Application.*

A.5.7 The assessment of precision required in 5.8.2 will require a sensitivity and uncertainty analysis, which can be translated into safety factors.

Sensitivity Analysis. The first run a model user makes should be labeled as the base case, using the nominal values of the various input parameters. However, the model user should not rely on a single run as the basis for any performance-based fire safety system design. Ideally, each variable or parameter that the model user made to develop the nominal input data should have multiple runs associated with it, as should combinations of key variables and parameters. Thus, a sensitivity analysis should be conducted that provides the model user with data that indicate how the effects of a real fire might vary and how the response of the proposed fire safety design might also vary.

The interpretation of a model's predictions can be a difficult exercise if the model user does not have knowledge of fire dynamics or human behavior.

Reasonableness Check. The model user should first try to determine whether the predictions actually make sense; that is, whether they do not upset intuition or preconceived expectations. Most likely, if the results do not pass this test, an input error has been committed.

Sometimes the predictions appear to be reasonable but are, in fact, incorrect. For example, a model can predict higher temperatures farther from the fire than closer to it. The values themselves might be reasonable; for example, they are not hotter than the fire, but they do not "flow" down the energy as expected.

A margin of safety can be developed using the results of the sensitivity analysis in conjunction with the performance criteria to provide the possible range of time during which a condition is estimated to occur.

Safety factors and margin of safety are two concepts used to quantify the amount of uncertainty in engineering analyses. Safety factors are used to provide a margin of safety and represent, or address, the gap in knowledge between the theoretically perfect model — reality — and the engineering models that can only partially represent reality.

Safety factors can be applied either to the predicted level of a physical condition or to the time at which the condition is predicted to occur. Thus, a physical or a temporal safety factor, or both, can be applied to any predicted condition. A predicted condition (i.e., a parameter's value) and the time at which it occurs are best represented as distributions. Ideally, a computer fire model predicts the expected or nominal value of the distribution. Safety factors are intended to represent the spread of the distributions.

Given the uncertainty associated with data acquisition and reduction, and the limitations of computer modeling, any condition predicted by a computer model can be thought of as an expected or nominal value within a broader range. For example, an upper layer temperature of 1110°F (600°C) is predicted at a given time. If the modeled scenario is then tested (i.e., full-scale experiment based on the computer model's input data), the actual temperature at that given time could be 1185°F or 1085°F (640°C or 585°C). Therefore, the temperature should be reported as 1110°F + 75°F/–25°F (600°C + 40°C/–15°C) or as a range of 1085°F to 1185°F (585°C to 640°C).

Ideally, predictions are reported as a nominal value, a percentage, or an absolute value. As an example, an upper layer temperature prediction could be reported as "1110°F (600°C), 55°F (30°C)," or "1110°F (600°C), 5 percent." In this case, the physical safety factor is 0.05 (i.e., the amount by which the nominal value should be degraded and enhanced). Given the state-of-the-art of computer fire modeling, this is a very low safety factor. Physical safety factors tend to be on the order of tens of percent. A safety factor of 50 percent is not unheard of.

Part of the problem in establishing safety factors is that it is difficult to state the percentage or range that is appropriate. These values can be obtained when the computer model predictions are compared to test data. However, using computer fire models in a design mode does not facilitate this comparison, due to the following:

(1) The room being analyzed has not been built yet.
(2) Test scenarios do not necessarily depict the intended design.

A sensitivity analysis should be performed, based on the assumptions that affect the condition of interest. A base case that uses all nominal values for input parameters should be developed. The input parameters should be varied over reasonable ranges, and the variation in predicted output should be noted. This output variation can then become the basis for physical safety factors.

The temporal safety factor addresses the issue of when a condition is predicted and is a function of the rate at which processes are expected to occur. If a condition is predicted to occur

2 minutes after the start of the fire, this prediction can be used as a nominal value. A process similar to that already described for physical safety factors can also be employed to develop temporal safety factors. In such a case, however, the rates (e.g., rates of heat release and toxic product generation) will be varied instead of absolute values (e.g., material properties).

The margin of safety can be thought of as a reflection of societal values and can be imposed by the authority having jurisdiction for that purpose. Because the time for which a condition is predicted will most likely be the focus of the authority having jurisdiction (e.g., the model predicts that occupants will have 5 minutes to safely evacuate), the margin of safety will be characterized by temporal aspects and tacitly applied to the physical margin of safety.

Escaping the harmful effects of fire (or mitigating them) is, effectively, a race against time. When assessing fire safety system designs based on computer model predictions, the choice of an acceptable time is important. When an authority having jurisdiction is faced with the predicted time of untenability, a decision needs to be made regarding whether sufficient time is available to ensure the safety of building occupants. The authority having jurisdiction is assessing the margin of safety. Is there sufficient time to get everyone out safely? If the authority having jurisdiction feels that the predicted egress time is too close to the time of untenability, the authority having jurisdiction can impose an additional period of time that the designer will have to incorporate into the system design. In other words, the authority having jurisdiction can impose a greater margin of safety than that originally proposed by the designer.

A.5.8.1 The *SFPE Engineering Guide to Performance-Based Fire Protection* describes the documentation that should be provided for a performance-based design.

Proper documentation of a performance-based design is critical to design acceptance and construction. Proper documentation will also ensure that all parties involved understand the factors necessary for the implementation, maintenance, and continuity of the fire protection design. If attention to details is maintained in the documentation, there should be little dispute during approval, construction, start-up, and use.

Poor documentation could result in rejection of an otherwise good design, poor implementation of the design, inadequate system maintenance and reliability, and an incomplete record for future changes or for testing the design forensically.

A.5.8.2 The sources, methodologies, and data used in performance-based designs should be based on technical references that are widely accepted and used by the appropriate professions and professional groups. This acceptance is often based on documents that are developed, reviewed, and validated under one of the following processes:

(1) Standards developed under an open consensus process conducted by recognized professional societies, codes or standards organizations, or governmental bodies
(2) Technical references that are subject to a peer review process and published in widely recognized peer-reviewed journals, conference reports, or other publications
(3) Resource publications, such as the *SFPE Handbook of Fire Protection Engineering*, which are widely recognized technical sources of information

The following factors are helpful in determining the acceptability of the individual method or source:

(1) Extent of general acceptance in the relevant professional community, including peer-reviewed publication, widespread citation in the technical literature, and adoption by or within a consensus document
(2) Extent of documentation of the method, including the analytical method itself, assumptions, scope, limitations, data sources, and data reduction methods
(3) Extent of validation and analysis of uncertainties, including comparison of the overall method with experimental data to estimate error rates, as well as analysis of the uncertainties of input data, uncertainties and limitations in the analytical method, and uncertainties in the associated performance criteria
(4) Extent to which the method is based on sound scientific principles
(5) Extent to which the proposed application is within the stated scope and limitations of the supporting information, including the range of applicability for which there is documented validation, and considering factors such as spatial dimensions, occupant characteristics, and ambient conditions, which can limit valid applications

In many cases, a method will be built from, and will include, numerous component analyses. Such component analyses should be evaluated using the same acceptability factors that are applied to the overall method, as outlined in items (1) through (5).

A method to address a specific fire safety issue, within documented limitations or validation regimes, might not exist. In such a case, sources and calculation methods can be used outside of their limitations, provided that the design team recognizes the limitations and addresses the resulting implications.

The technical references and methodologies to be used in a performance-based design should be closely evaluated by the design team and the authority having jurisdiction, and possibly by a third-party reviewer. The strength of the technical justification should be judged using criteria in items (1) through (5). This justification can be strengthened by the presence of data obtained from fire testing.

A.5.8.11 Documentation for modeling should conform to ASTM E 1472, *Standard Guide for Documenting Computer Software for Fire Models*, although most, if not all, models were originally developed before this standard was promulgated. Information regarding the use of the model DETACT-QS can be found in the *SFPE Engineering Guide–the Evaluation of the Computer Fire Model DETACT-QS.*

A.6.1.2.1 Assembly occupancies might include the following:

(1) Armories
(2) Assembly halls
(3) Auditoriums
(4) Bowling lanes
(5) Club rooms
(6) College and university classrooms, 50 persons and over
(7) Conference rooms
(8) Courtrooms
(9) Dance halls
(10) Drinking establishments
(11) Exhibition halls
(12) Gymnasiums
(13) Libraries
(14) Mortuary chapels
(15) Motion picture theaters
(16) Museums
(17) Passenger stations and terminals of air, surface, underground, and marine public transportation facilities
(18) Places of religious worship

(19) Pool rooms
(20) Recreation piers
(21) Restaurants
(22) Skating rinks
(23) Special amusement buildings, regardless of occupant load
(24) Theaters

Assembly occupancies are characterized by the presence or potential presence of crowds with attendant panic hazard in case of fire or other emergency. They are generally or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. Such buildings are ordinarily not used for sleeping purposes. Special conference rooms, snack areas, and other areas incidental to, and under the control of, the management of other occupancies, such as offices, fall under the 50-person limitation.

Restaurants and drinking establishments with an occupant load of fewer than 50 persons should be classified as mercantile occupancies.

Occupancy of any room or space for assembly purposes by fewer than 50 persons in another occupancy, and incidental to such other occupancy, should be classified as part of the other occupancy and should be subject to the provisions applicable thereto.

For special amusement buildings, see 12.4.8 and 13.4.8.

A.6.1.3.1 Educational occupancies include the following:

(1) Academies
(2) Kindergartens
(3) Schools

An educational occupancy is distinguished from an assembly occupancy in that the same occupants are regularly present.

A.6.1.4.1 Day-care occupancies include the following:

(1) Adult day-care occupancies, except where part of a health care occupancy
(2) Child day-care occupancies
(3) Day-care homes
(4) Kindergarten classes that are incidental to a child day-care occupancy
(5) Nursery schools

In areas where public schools offer only half-day kindergarten programs, many child day-care occupancies offer state-approved kindergarten classes for children who need full-day care. As these classes are normally incidental to the day-care occupancy, the requirements of the day-care occupancy should be followed.

A.6.1.5.1 Health care occupancies include the following:

(1) Hospitals
(2) Limited care facilities
(3) Nursing homes

Occupants of health care occupancies typically have physical or mental illness, disease, or infirmity. They also include infants, convalescents, or infirm aged persons.

A.6.1.6.1 It is not the intent that occupants be considered to be incapable of self-preservation just because they are in a wheelchair or use assistive walking devices, such as a cane, a walker, or crutches. Rather, it is the intent to address emergency care centers that receive patients who have been rendered incapable of self-preservation due to the emergency, such as being rendered unconscious as a result of an accident or being unable to move due to sudden illness.

A.6.1.7.1 Detention and correctional occupancies include the following:

(1) Adult and juvenile substance abuse centers
(2) Adult and juvenile work camps
(3) Adult community residential centers
(4) Adult correctional institutions
(5) Adult local detention facilities
(6) Juvenile community residential centers
(7) Juvenile detention facilities
(8) Juvenile training schools

See A.22.1.1.1.6 and A.23.1.1.1.6.

A.6.1.7.2 Chapters 22 and 23 address the residential housing areas of the detention and correctional occupancy as defined in 3.3.190.5. Examples of uses, other than residential housing, include gymnasiums or industries.

A.6.1.8.1.1 The application statement of 24.1.1.1 limits each dwelling unit to being "occupied by members of a single family with not more than three outsiders." The *Code* does not define the term *family*. The definition of family is subject to federal, state, and local regulations and might not be restricted to a person or a couple (two people) and their children. The following examples aid in differentiating between a single-family dwelling and a lodging or rooming house:

(1) An individual or a couple (two people) who rent a house from a landlord and then sublease space for up to three individuals should be considered a family renting to a maximum of three outsiders, and the house should be regulated as a single-family dwelling in accordance with Chapter 24.
(2) A house rented from a landlord by an individual or a couple (two people) in which space is subleased to 4 or more individuals, but not more than 16, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26.
(3) A residential building that is occupied by 4 or more individuals, but not more than 16, each renting from a landlord, without separate cooking facilities, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26.

A.6.1.8.1.3 So-called apartment hotels should be classified as hotels, because they are potentially subject to the same transient occupancy as hotels. Transients are those who occupy accommodations for less than 30 days.

A.6.1.8.1.4 Rooms within dormitories intended for the use of individuals for combined living and sleeping purposes are guest rooms or guest suites. Examples of dormitories include college dormitories, fraternity and sorority houses, and military barracks.

A.6.1.9.1 The following are examples of facilities classified as residential board and care occupancies:

(1) Group housing arrangement for physically or mentally handicapped persons who normally attend school in the community, attend worship in the community, or otherwise use community facilities
(2) Group housing arrangement for physically or mentally handicapped persons who are undergoing training in preparation for independent living, for paid employment, or for other normal community activities

(3) Group housing arrangement for the elderly that provides personal care services but that does not provide nursing care
(4) Facilities for social rehabilitation, alcoholism, drug abuse, or mental health problems that contain a group housing arrangement and that provide personal care services but do not provide acute care
(5) Assisted living facilities
(6) Other group housing arrangements that provide personal care services but not nursing care

A.6.1.10.1 Mercantile occupancies include the following:

(1) Auction rooms
(2) Department stores
(3) Drugstores
(4) Restaurants with fewer than 50 persons
(5) Shopping centers
(6) Supermarkets

Office, storage, and service facilities incidental to the sale of merchandise and located in the same building should be considered part of the mercantile occupancy classification.

A.6.1.11.1 Business occupancies include the following:

(1) Air traffic control towers (ATCTs)
(2) City halls
(3) College and university instructional buildings, classrooms under 50 persons, and instructional laboratories
(4) Courthouses
(5) Dentists' offices
(6) Doctors' offices
(7) General offices
(8) Outpatient clinics (ambulatory)
(9) Town halls

Doctors' and dentists' offices are included, unless of such character as to be classified as ambulatory health care occupancies. *(See 3.3.190.1.)*

Birth centers should be classified as business occupancies if they are occupied by fewer than four patients, not including infants, at any one time; do not provide sleeping facilities for four or more occupants; and do not provide treatment procedures that render four or more patients, not including infants, incapable of self-preservation at any one time. For birth centers occupied by patients not meeting these parameters, see Chapter 18 or Chapter 19, as appropriate.

Service facilities common to city office buildings, such as newsstands, lunch counters serving fewer than 50 persons, barber shops, and beauty parlors are included in the business occupancy group.

City halls, town halls, and courthouses are included in this occupancy group, insofar as their principal function is the transaction of public business and the keeping of books and records. Insofar as they are used for assembly purposes, they are classified as assembly occupancies.

A.6.1.12.1 Industrial occupancies include the following:

(1) Drycleaning plants
(2) Factories of all kinds
(3) Food processing plants
(4) Gas plants
(5) Hangars (for servicing/maintenance)
(6) Laundries
(7) Power plants
(8) Pumping stations
(9) Refineries
(10) Sawmills
(11) Telephone exchanges

In evaluating the appropriate classification of laboratories, the authority having jurisdiction should treat each case individually, based on the extent and nature of the associated hazards. Some laboratories are classified as occupancies other than industrial; for example, a physical therapy laboratory or a computer laboratory.

A.6.1.13.1 Storage occupancies include the following:

(1) Barns
(2) Bulk oil storage
(3) Cold storage
(4) Freight terminals
(5) Grain elevators
(6) Hangars (for storage only)
(7) Parking structures
(8) Truck and marine terminals
(9) Warehouses

Storage occupancies are characterized by the presence of relatively small numbers of persons in proportion to the area.

A.6.1.14.1.3 Examples of uses that might be incidental to another occupancy include the following:

(1) Newsstand (mercantile) in an office building
(2) Giftshop (mercantile) in a hotel
(3) Small storage area (storage) in any occupancy
(4) Minor office space (business) in any occupancy
(5) Maintenance area (industrial) in any occupancy

A.6.1.14.1.3(2) Examples of uses that have occupant loads below the occupancy classification threshold levels include the following:

(1) Assembly use with fewer than 50 persons within a business occupancy
(2) Educational use with fewer than 6 persons within an apartment building.

A.6.1.14.3.2 For example, a common path of travel that occurs wholly in a business tenant space, in a multiple occupancy building containing assembly and business occupancies, should not have to meet the assembly occupancy common path of travel limitation.

A.6.1.14.4.5 Where the *Code* text states that the provision has applicability to the building, rather than just to the occupancy, the provision applies to the entire building, regardless of whether the separated occupancies form of protection is used. For example, the provision of 18.3.5.1 requires that the entire building housing a health care occupancy be sprinklered. Contrast that with the requirement of 20.3.4.1, which requires an ambulatory health care facility, and not the entire building, to be provided with a fire alarm system.

A.6.2.1.3 Under the provision of 6.2.1.3, any violation of the requirements of Chapters 11 through 42 for separation or protection of hazardous operation or storage would inherently involve violation of the other sections of the *Code*, unless additional egress facilities appropriate to high hazard contents were provided.

A.6.2.2.1 These classifications do not apply to the application of sprinkler protection classifications. See NFPA 13, *Standard for the Installation of Sprinkler Systems*. Depending on the use of the space, the area might require special hazard protection in accordance with Section 8.7.

A.6.2.2.2 Chapter 42 recognizes storage of noncombustible materials as low hazard. In other occupancies, it is assumed that, even where the actual contents hazard is normally low, there is sufficient likelihood that some combustible materials or hazardous operations will be introduced in connection with building repair or maintenance, or some psychological factor might create conditions conducive to panic, so that the egress facilities cannot safely be reduced below those specified for ordinary hazard contents.

A.6.2.2.3 Ordinary hazard classification represents the conditions found in most buildings and is the basis for the general requirements of this *Code*.

The fear of poisonous fumes or explosions is necessarily a relative matter to be determined on a judgment basis. All smoke contains some toxic fire gases but, under conditions of ordinary hazard, there should be no unduly dangerous exposure during the period necessary to escape from the fire area, assuming there are proper exits.

A.6.2.2.4 High hazard contents include occupancies where flammable liquids are handled or used or are stored under conditions involving possible release of flammable vapors; where grain dust, wood flour or plastic dust, aluminum or magnesium dust, or other explosive dusts are produced; where hazardous chemicals or explosives are manufactured, stored, or handled; where materials are processed or handled under conditions producing flammable flyings; and other situations of similar hazard.

Chapters 40 and 42 include detailed provisions on high hazard contents.

A.7.1.1 An installation of supplemental evacuation equipment is not recognized as a means of egress. Consequently, such equipment does not satisfy any requirement for minimum number of, capacity of, travel distance to, or remoteness of, means of egress.

A.7.1.3.2.1(1) In existing buildings, existing walls in good repair and consisting of lath and plaster, gypsum wallboard, or masonry units can usually provide satisfactory protection for the purposes of this requirement where a 1-hour fire resistance rating is required. Further evaluation might be needed where a 2-hour fire resistance rating is required. Additional guidelines can be found in Annex O of NFPA 914, *Code for Fire Protection of Historic Structures*, and in the *SFPE Handbook of Fire Protection Engineering*.

A.7.1.3.2.1(3) In existing buildings, existing walls in good repair and consisting of lath and plaster, gypsum wallboard, or masonry units can usually provide satisfactory protection for the purposes of this requirement where a 1-hour fire resistance rating is required. Further evaluation might be needed where a 2-hour fire resistance rating is required. Additional guidelines can be found in Annex O of NFPA 914, *Code for Fire Protection of Historic Structures*, and in the *SFPE Handbook of Fire Protection Engineering*.

A.7.1.3.2.1(6) It is not the intent to require the structural elements supporting outside stairs, or structural elements that penetrate within exterior walls or any other wall not required to have a fire resistance rating, to be protected by fire resistance–rated construction.

A.7.1.3.2.1(9) Means of egress from the level of exit discharge is permitted to pass through an exit stair enclosure or exit passageway serving other floors. Doors for convenience purposes and unrelated to egress also are permitted to provide access to and from exit stair enclosures and exit passageways, provided that such doors are from corridors or normally occupied spaces. It is also the intent of this provision to prohibit exit enclosure windows, other than approved vision panels in doors, that are not mounted in an exterior wall.

A.7.1.3.2.1(10)(b) Penetrations for electrical wiring are permitted where the wiring serves equipment permitted by the authority having jurisdiction to be located within the exit enclosure, such as security systems, public address systems, and fire department emergency communications devices.

A.7.1.3.2.3 This provision prohibits the use of exit enclosures for storage or for installation of equipment not necessary for safety. Occupancy is prohibited other than for egress, refuge, and access. The intent is that the exit enclosure essentially be "sterile" with respect to fire safety hazards.

A.7.1.4.1 See Chapters 12 through 42 for further limitations on interior wall and ceiling finish.

A.7.1.4.2 See Chapters 12 through 42 for further limitations on interior floor finish.

A.7.1.5 For the purpose of this requirement, projections include devices such as lighting equipment, emergency signaling equipment, environmental controls and equipment, security devices, signs, and decorations that are typically limited in area.

A.7.1.6.4 The foreseeable slip conditions are those that are likely to be present at the location of the walking surface during the use of the building or area. Examples of foreseeable conditions include a swimming pool deck and exterior means of egress, generally, that are likely to be wet.

Regarding the slip resistance of treads, it should be recognized that, when walking up or down stairs, a person's foot exerts a smaller horizontal force against treads than is exerted when walking on level floors. Therefore, materials used for floors that are acceptable as slip resistant (as described by ASTM F 1637, *Standard Practice for Safe Walking Surfaces*) provide adequate slip resistance where used for stair treads. Such slip resistance includes the important leading edges of treads, the part of the tread that the foot first contacts during descent, which is the most critical direction of travel. If stair treads are wet, there is an increased danger of slipping, just as there is an increased danger of slipping on wet floors of similar materials. A small wash or drainage slope on exterior stair treads is, therefore, recommended to shed water. (*See Templer, J. A., The Staircase: Studies of Hazards, Falls, and Safer Design, Cambridge, MA: MIT Press, 1992.*)

A.7.1.7.2 Aside from the problems created for persons who are mobility impaired, small changes of elevations in floors are best avoided because of the increased occurrence of missteps where the presence of single steps, a series of steps, or a ramp is not readily apparent. Although small changes of elevation pose significant fall risks in the case of individual movement, they are even more undesirable where crowds traverse the area.

A contrasting marking stripe on each stepping surface can be helpful at the nosing or leading edge so that the location of each step is readily apparent, especially when viewed in descent. Such stripes should be not less than 1 in. (25 mm), but should not exceed 2 in. (51 mm), in width. Other methods could include a relatively higher level of lighting, contrasting colors, contrasting textures, highly prominent handrails, warning signs, a combination thereof, or other similar means. The construction or application of marking stripes should be such that slip resistance is consistent over the walking surface and no tripping hazard is created *(see also A.7.2.2.3.3.2)*. Depending on the distractions of the surroundings, the familiarity of users with a particular small change of level, and especially the number of people that might be in a group traversing the change of level (thereby reducing visibility of the level changes), a strong argument can be made for the elimination of steps and ramps that might pose a risk of missteps.

A.7.1.8 Elements of the means of egress that might require protection with guards include stairs, landings, escalators, moving walks, balconies, corridors, passageways, floor or roof openings, ramps, aisles, porches, and mezzanines.

Escalators and moving walks, other than previously approved existing escalators and moving walks, are prohibited from serving as components of the required means of egress. Building occupants using the escalator at the time of fire or similar emergency must traverse some portion of the escalator to gain access to a required egress route. For those building occupants using the escalator, such travel along the escalator is part of their means of egress. The requirement that guards be provided at the open side of means of egress that exceed 30 in. (760 mm) above the floor or grade below is meant to be applied to escalators and moving walks.

A.7.1.10.1 A proper means of egress allows unobstructed travel at all times. Any type of barrier including, but not limited to, the accumulations of snow and ice in those climates subject to such accumulations is an impediment to free movement in the means of egress. Another example of an obstruction or impediment to full instant use of means of egress is any security device or system that emits any medium that could obscure a means of egress. It is, however, recognized that obstructions occur on a short-duration basis. In these instances, awareness training should be provided to ensure that blockages are kept to a minimum and procedures are established for the control and monitoring of the area affected.

A.7.2.1.2.1 Figure A.7.2.1.2.1(a) and Figure A.7.2.1.2.1(b) illustrate the method of measuring clear width for doors.

In cases where a chapter requires a door width, for example, of not less than 36 in. (915 mm), this requirement can be met by a door leaf of the minimum specified width if the term *clear width* does not appear as part of the minimum width requirement. A pair of cross-corridor doors subject to such a requirement would be judged under the following criteria:

(1) Each door leaf is required to be not less than 36 in. (915 mm) in width.
(2) The pair of doors is required to provide sufficient, clear, unobstructed width (which will be less than the door leaf width measurement) to handle its assigned occupant load, based on a calculation using the appropriate egress capacity factor in Table 7.3.3.1.

Where swinging doors do not open at least 90 degrees, the clear width of the doorway should be measured between the face of the door and the stop.

It is not the intent to regulate projections above the 6 ft 8 in. (2030 mm) height.

A.7.2.1.2.2 Figure A.7.2.1.2.2(a) and Figure A.7.2.1.2.2(b) illustrate the method of measuring egress capacity width for purposes of calculating door egress capacity.

A.7.2.1.2.3.2(2) A example of a room that is "not required to be accessible to persons with severe mobility impairments" is one that is not required to be accessible by *NFPA 5000*, Chapter 10.

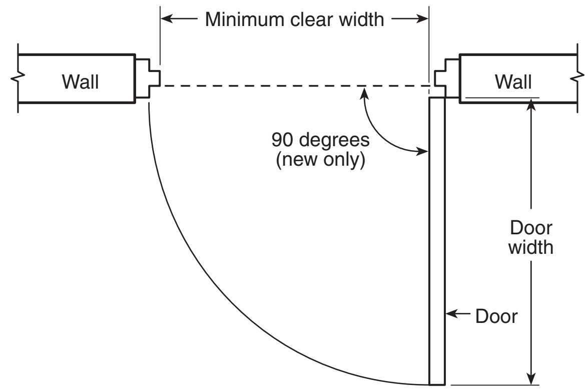


FIGURE A.7.2.1.2.1(a) Minimum Clear Width.

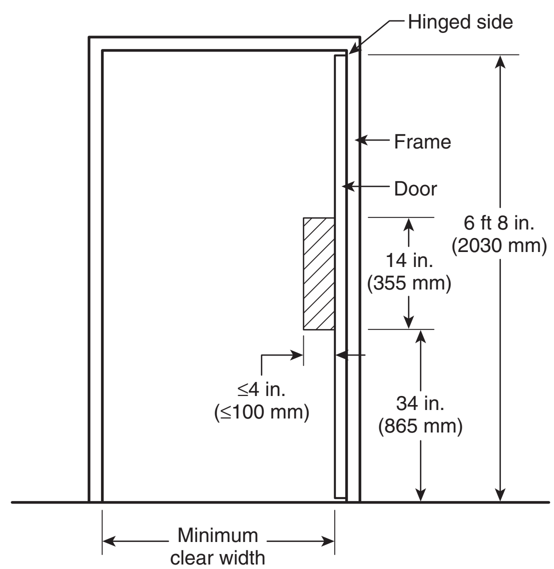


FIGURE A.7.2.1.2.1(b) Minimum Clear Width with Permitted Obstructions.

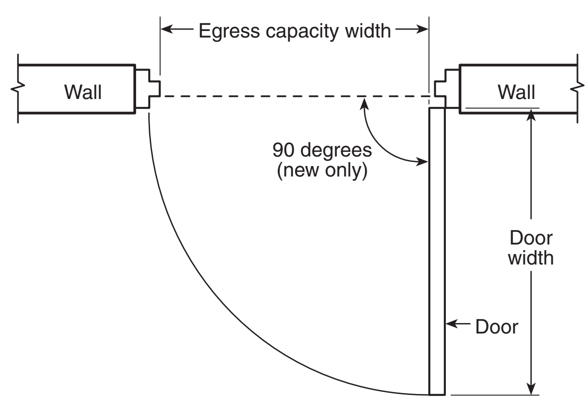


FIGURE A.7.2.1.2.2(a) Door Width — Egress Capacity.

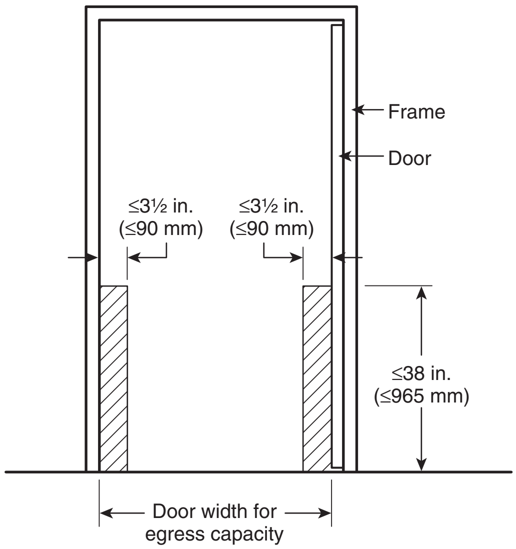


FIGURE A.7.2.1.2.2(b) Door Width — Egress Capacity with Permitted Obstructions.

A.7.2.1.2.3.2(3) A example of a room that is "not required to be accessible to persons with severe mobility impairments" is one that is not required to be accessible by *NFPA 5000*, Chapter 10.

A.7.2.1.2.3.2(9) The relative egress carrying capacity of door openings and stairs is based on the two-to-three ratio used in Table 7.3.3.1 to help balance the capacity of various egress elements and ensure that downstream egress facilities do not form a bottleneck or constriction to flow. For example, a stairway with a nominal width of 56 in. (1420 mm) should be served by an exit discharge door with a minimum width opening of 37 in. (940 mm) if only one discharge door is provided. It might be advantageous for two discharge doors to serve such a stairway, each with a more typical clear opening width of 32 in. (810 mm). This would facilitate access, into the exit, of fire fighters and other emergency responders without causing undue interference to evacuees attempting to transition from the stair to the exit discharge door.

A.7.2.1.4.1 Where doors are subject to two-way traffic, or where their opening can interfere with pedestrian traffic, an appropriately located vision panel can reduce the chance of accidents.

Swinging doors in horizontal- or vertical-rolling partitions should be permitted in a means of egress where the following criteria are met:

(1) The door or doors comply with 7.2.1.4.
(2) The partition in which the doors are mounted complies with the applicable fire protection rating and closes upon smoke detection or power failure at a speed not exceeding 9 in./s (230 mm/s) and not less than 6 in./s (150 mm/s).
(3) The doors mounted in the partition are self-closing or automatic-closing in accordance with 7.2.1.8.

A.7.2.1.4.3 The requirements of 7.2.1.4.3 are not intended to apply to the swing of cross-corridor doors, such as smoke barrier doors and horizontal exits. Neither are the requirements intended to apply to doors from rooms that are typically unoccupied, such as janitor's closets, electrical closets, or telecommunications closets.

A.7.2.1.5.2 Some fire door assemblies are listed for use with fire pins or fusible links that render the door leaf release inoperative upon exposure to elevated temperature during a fire. The door leaf release mechanism is made inoperative where conditions in the vicinity of the door opening become untenable for human occupancy, and such door opening no longer provides a viable egress path.

A.7.2.1.5.5.1 Where the entrance consists of an exterior vestibule, the locking arrangement should be permitted on the egress side of either the interior or exterior door of the vestibule.

A.7.2.1.5.6(5) Separate power supplies might be provided to the electronic lock and the releasing hardware. In this case, it is critical that the lock be arranged to release upon loss of power to the releasing hardware to ensure occupants can egress in the event of a power failure.

A.7.2.1.5.8 It is intended that the re-entry provisions apply only to enclosed exit stairs, not to outside stairs. This arrangement makes it possible to leave the stairway at such floor if the fire renders the lower part of the stair unusable during egress or if the occupants seek refuge on another floor.

A.7.2.1.5.10 Examples of devices that might be arranged to release latches include knobs, levers, and bars. This requirement is permitted to be satisfied by the use of conventional types of hardware, whereby the door is released by turning a lever, knob, or handle or by pushing against a bar, but not by unfamiliar methods of operation, such as a blow to break glass. It is also within the intent of this requirement that switches integral to traditional doorknobs, lever handles, or bars, and that interrupt the power supply to an electromagnetic lock, be permitted, provided that they are affixed to the door leaf. The operating devices should be capable of being operated with one hand and should not require tight grasping, tight pinching, or twisting of the wrist to operate.

A.7.2.1.5.10.3 Examples of devices that, when used with a latch, can be arranged to require not more than one additional releasing operation include night latches, dead bolts, and security chains.

A.7.2.1.5.12 Examples of devices prohibited by this requirement include locks, padlocks, hasps, bars, chains, or combinations thereof.

A.7.2.1.6 None of the special locking arrangements addressed in 7.2.1.6 are intended to allow *credentialed egress, request to exit*, or similar provisions, where an occupant cannot leave the building without swiping a card through a reader. Where such an arrangement is desired to keep track of occupants, the swiping of cards needs to be procedural but not necessary for releasing the door lock or latch. Free egress needs to be available at all times. Another option to free egress is the use of a delayed-egress locking system.

A.7.2.1.6.1.1(3) It is not the intent to require a direct physical or electrical connection between the door release device and the lock. It is the intent to allow door movement initiated by operating the door release device required in 7.2.1.5.10 as one option to initiate the irreversible process.

Several factors need to be considered in approving an increase in delay time from 15 seconds to 30 seconds. Some of the factors include occupancy, occupant density, ceiling height, fire hazards present, fire protection features provided, and the location of the delayed-egress locks. An example of a location where the increase in delay time might not be approved is at an exit stair discharge door.

A.7.2.1.6.1.1(4) In the event that the authority having jurisdiction has permitted increased operation time, the sign should reflect the appropriate time.

A.7.2.1.6.2 It is not the intent to require doors that restrict access but that comply with 7.2.1.5.10 to comply with the access-controlled egress door provisions of 7.2.1.6.2. The term *access-controlled* was chosen when the requirements of 7.2.1.6.2 were first added to the *Code* to describe the function in which a door is electronically locked from the inside in a manner that restricts egress. It is not the *Code's* intent to prohibit methods of securing the door in a locked position from the outside with access control products, provided that the egress requirements of 7.2.1.6.2 are met.

A.7.2.1.6.3(14) It is not the intent to prohibit elevator lobby doors from being equipped with card access systems for gaining access, for example, to tenant spaces. It is the access-controlled egress door system described in 7.2.1.6.2 that is prohibited from being installed on the same door as the lock addressed by 7.2.1.6.3.

A.7.2.1.7.2 The presence of fire exit hardware on a door does not imply the door is required to be a fire protection–rated door.

A.7.2.1.8.1 Examples of doors designed to normally be kept closed include those to a stair enclosure or horizontal exit.

A.7.2.1.9 Special-purpose horizontally sliding accordion or folding door assemblies installed in accordance with 7.2.1.14 should not be considered powered doors subject to the provisions of 7.2.1.9.

Powered doors are divided into two categories — power assisted and power operated. Power-assisted doors that conform to ANSI/BHMA A156.19, *American National Standard for Power Assist and Low Energy Power Operated Doors*, use limited power to operate the door. They require fewer safeguards as compared to full power–operated doors. These door operators are for swinging doors only. Power-operated doors that conform to ANSI/BHMA A156.10, *American National Standard for Power Operated Pedestrian Doors*, require more power to operate the door and require additional safeguards to provide protection against personal injury. Power-operated doors can be swinging, sliding, or folding doors.

A.7.2.1.9.1 An example of the type of door addressed by 7.2.1.9.1 is one actuated by a motion-sensing device upon the approach of a person.

A.7.2.1.9.1.5 Although a single power-operated door leaf located within a two-leaf opening might alone not provide more than 30 in. (760 mm) of clear width in the emergency breakout mode, where both leaves are broken out to become side hinged, the required egress width is permitted to be provided by the width of the entire opening.

A.7.2.1.11.1.3 Security access turnstiles are designed to control security access into and out of buildings. Security access turnstiles might utilize physical barriers consisting of arms, wings, gates, or panels. The subject physical barriers come in various heights and function by retracting or opening in the direction of travel.

A.7.2.1.15.1 Door assemblies within the required means of egress (e.g., door assemblies that discharge from exit enclosures) require a higher level of care and maintenance throughout the life of their installations to ensure they perform as intended by the *Code*. Annual inspection and functional testing of these door assemblies is necessary to verify that they are maintained in proper working condition. Panic hardware and fire exit hardware devices are specifically required to be used in assembly and educational occupancies. However, door leaves that are equipped with panic hardware or fire exit hardware, in areas not specifically required by the *Code* (e.g., stairwell entry doors and double-egress cross-corridor door assemblies not serving an assembly occupancy), should be subject to annual inspection and functional testing to ensure that the operating hardware functions correctly in accordance with 7.2.1.7, since the presence of panic hardware and fire exit hardware implies it is required by the *Code*.

Additionally, door assemblies that are electrically controlled egress doors in accordance with 7.2.1.5.5 and door assemblies that are equipped with special locking arrangements in accordance with 7.2.1.6 are outfitted with electrified hardware and access control devices that are susceptible to wear and abuse. Consequently, these door assemblies need to be inspected and tested on an annual basis, regardless of the occupant load being served.

In cases where the authority having jurisdiction determines there is a distinct hazard to building occupant safety, the inspection requirements of 7.2.1.15 should be applied to other exit access, exit, and exit discharge door assemblies.

A.7.2.1.15.2 See NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, Annex J, for information pertaining to performance-based inspection, testing, and maintenance of door assemblies.

A.7.2.1.15.7 Performing corrective action work on door assemblies frequently requires ordering replacement components that might take time to produce, ship, and install. Consideration of the time it takes to procure and install components should be included in the timeline for restoring the door assemblies to normal working condition.

A.7.2.2.2.1.1(2) It is the intent of 7.2.2.2.1.1(2) to permit the use of Table 7.2.2.2.1.1(b) in existing buildings, even where there is a change in occupancy per 4.6.11. Safety improvements should be made that are reasonable and feasible at minimal cost. Improvements include removal, repair, or replacement of step coverings, as described in A.7.2.2.3.5, particularly Figure A.7.2.2.3.5(e), and addition of functional handrails and guardrails in place of, or in conjunction with, other rails, as described in 7.2.2.4.

A.7.2.2.2.1.2 In some cases, the egress capacity provisions of 7.3.3 will require a stair to have a greater width than the minimum specified in 7.2.2.2.1.2(B).

A.7.2.2.2.1.2(B) The stair width requirement of 7.2.2.2.1.2(B) is based on accumulating the occupant load on each story the stair serves.

The accumulating of occupant load is done for the purposes of the requirements of 7.2.2.2.1.2 only. The egress capacity requirements of Section 7.3 are NOT cumulative on a story-by-story basis.

If additional exits provide egress capacity, the occupant load served by such additional exits, up to the limit permitted for the egress capacity of such additional exits, is not added to the total occupant load considered for the minimum stair width requirements of 7.2.2.2.1.2.

If horizontal exits are provided on any of the stories, the total occupant load of all compartments on the story with the horizontal exits is used in the calculation of the minimum stair width requirements of 7.2.2.2.1.2. The number of stairs permitted through application of horizontal exit requirements in

7.2.4 is not affected by the minimum stair width requirements of 7.2.2.2.1.2.

The examples that follow illustrate applications of the minimum stair width requirement.

A stair in a building two stories in height above grade plane that has 2000 persons on the second story, among 10 equally sized stairs that serve the second story, would be considered to have an occupant load of 200 persons for the purposes of applying Table 7.2.2.2.1.2(B). The minimum width of such a stair would be 44 in. (1120 mm).

For a building with a relatively large floor area, a typical 44 in. (1120 mm) stair would not be required to be increased in width until it serves a building approximately 14 stories in height above grade plane, calculated as follows:

[A.7.2.2.2.1.2(B)]

$$\frac{2000 \text{ persons}}{\text{147 persons per floor for a 44 in. (1120 mm) width stair}} \approx 14 \text{ stories}$$

For egress in the descending direction, only the stair width below the 14 stories with the total occupant load of 2000 persons per stair, or 4000 persons if served by two equally sized stairs, would need to be increased to 56 in. (1420 mm). If the building is 20 stories in height above grade plane, only the stairs on the lowest 7 stories would be required to have the 56 in. (1420 mm) width.

For a building 41 stories in height above grade plane with 200 persons on each story (or 8000 persons overall, not including the level of exit discharge), with two equally sized stairs, each stair would be considered to have an occupant load of 4000 persons for the purposes of applying Table 7.2.2.2.1.2(B). Only the portion of the stair serving 2000 persons would be required to have the wider width. If each story provides the same floor area for occupancy, the upper 20 stories would have 44 in. (1120 mm) stairs, and the lowest 20 stories would have the 56 in. (1420 mm) stairs, as a minimum.

A.7.2.2.2.4 If properly designed and constructed, stairs with winders are not necessarily more dangerous than other stairs. Attention to the factors that follow helps to make winders generally more effective for egress and safety. Handrails should be continuous, without breaks at newel posts, from story to story. Handrails located at a greater than normal distance from the inner turn of winders can improve safety by constraining stair users to walk on the portion of the treads providing deeper treads, which should have not less than 11 in. (280 mm) of depth. Combinations of straight flights and winders are best arranged with winders located only below the straight flight. This arrangement is best because the winders provide larger tread dimensions over much of their width than do typical treads on straight flights. A descending person will, thus, be unlikely to experience a reduction of tread depth during descent, a condition of nonuniformity that is best avoided.

A.7.2.2.3.3.2 The tripping hazard referred to in 7.2.2.3.3.2 occurs especially during descent, where the tread walking surface has projections such as strips of high-friction materials or lips from metal pan stairs that are not completely filled with concrete or other material. In addition, the installation of a retrofit, surface-mounted stair nosing or a strip of high-friction material onto an existing stair tread might produce a projection that creates a tripping hazard. For example, the slight elevation difference between the new stair tread nosing and the stair tread might create enough of an elevation change to trip the stair user. Tread nosings that project over adjacent treads can also be a tripping hazard. ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, illustrates projecting nosing configurations that minimize the hazard.

A.7.2.2.3.3.3 "Consistent surface traction" means that slip resistance is reasonably uniform and adequate to minimize risk of slipping across the treads where users' feet contact the tread surface.

For the front-to-back direction, particular attention should be given to consistency of slip resistance in the front two-thirds of the tread, but preferably the entire tread surface. For descent, initial foot contact occurs at the nosing; for ascent, it occurs in the middle of the tread.

For the side-to-side direction, particular attention should be given to consistency of slip resistance within the clear width of the stair between handrails, especially on the portion contacted by users' feet. For most users, this will extend to within about 6 in. (150 mm), measured horizontally, of the handrails; however, some vulnerable stair users might place the front portions of their feet below the handrails.

Consistency is important because misleading user expectation of underfoot conditions is a major factor in missteps and falls involving slipping.

Regarding the slip resistance of treads, it should be recognized that, when walking up or down stairs, a person's foot exerts a smaller horizontal force against treads than is exerted when walking on level floors, including on landings. Therefore, materials used for floors that are acceptable as slip resistant (as described by ASTM F 1637, *Standard Practice for Safe Walking Surfaces* and standards specifically addressing tribology, including ANSI/ASSE A1264.2, *Standard for the Provision of Slip Resistance on Walking/Working Surfaces*) provide adequate slip resistance where used for stair treads. Such slip resistance includes the important leading edges of treads, the part of the tread that the foot first contacts during descent, which is the most critical direction of travel. If stair treads are wet, there is an increased danger of slipping, just as there is an increased danger of slipping on wet floors of similar materials. A small wash or drainage slope on exterior stair treads is, therefore, recommended to shed water. *(See Templer, J. A., The Staircase: Studies of Hazards, Falls, and Safer Design, Cambridge, MA: MIT Press, 1992.)*

A.7.2.2.3.4 A small drainage slope for stair treads subject to wetting can improve tread slip resistance *(see also A.7.2.2.3.3.2)*. A consistent slope to a side of the stair, where drainage is possible, might be preferable to a front-to-back slope of the treads. Providing a pitch of ⅛ in./ft to ¼ in./ft (10 mm/m to 21 mm/m) aids the shedding of water from a nominally horizontal surface.

A.7.2.2.3.5 Figure A.7.2.2.3.5(a), Figure A.7.2.2.3.5(b), Figure A.7.2.2.3.5(c), and Figure A.7.2.2.3.5(d) illustrate the method for measuring riser height and tread depth. Stairs that are covered with resilient floor coverings might need additional tread depth beyond the minimum specified in the *Code*. Any horizontal projection of resilient covering materials beyond the tread nosing and riser, such as carpet and underlayment, can interfere with users' feet and thereby reduce usable tread depth. At the tread nosing, such resilient covering materials might not be capable of providing stable support for users' feet. Generally, effective tread depth is reduced by the uncompressed thickness of such resilient coverings, and might be further reduced over time if coverings are not well secured, and, consequently, might move forward at the nosings. *[See Figure A.7.2.2.3.5(e).]*

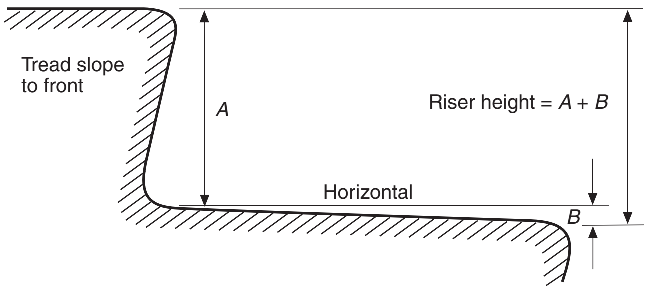


FIGURE A.7.2.2.3.5(a) Riser Measurement with Tread Slope to Front.

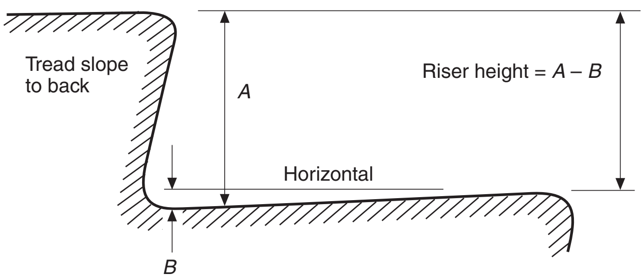


FIGURE A.7.2.2.3.5(b) Riser Measurement with Tread Slope to Back.

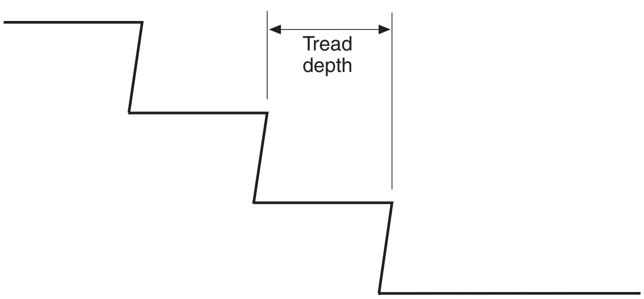


FIGURE A.7.2.2.3.5(c) Tread Depth.

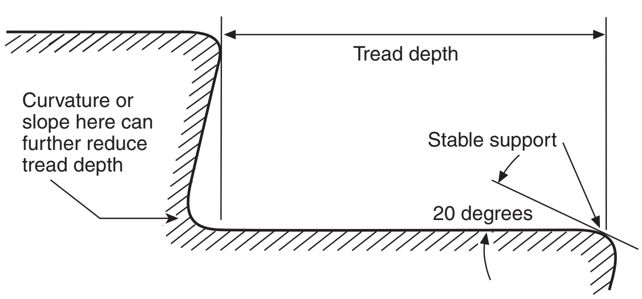


FIGURE A.7.2.2.3.5(d) Tread Measurement with Stable Support at Leading Edge.

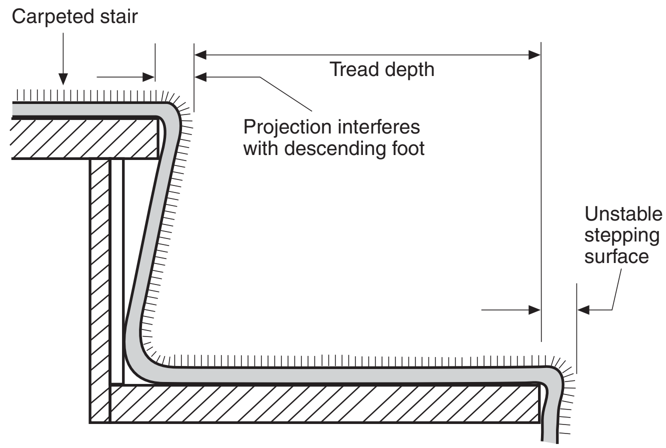


FIGURE A.7.2.2.3.5(e) Tread Measurement with Unstable Stepping Surface at Leading Edge.

A.7.2.2.3.6 A relatively common error in much of home stair construction and, more rarely, in other stair construction is a failure to make the landing nosing projection consistent with the projection of all other nosings in the stair flight. Such an error can easily occur if the stair flight is installed as a prefabricated unit where the top landing does not have a comparable nosing and the unit includes nosing projections. This heightens the risk of an overstepping misstep, at the second or third step down, by a person who is descending.

A fairly reliable test of step dimension uniformity is the crouch and sight test, in which the inspector crouches on the landing above a flight of stairs to confirm that all of the nosings, including the landing nosing, line up. Unless there is a rare matched variation in the height of a step riser and in the tread depth, both proportionally larger or smaller than other steps in the flight, such that the internosing slope or pitch is maintained consistent in the flight, the visual alignment of the nosings in the crouch and sight test will indicate dimensional uniformity. Thus, as a first task in any stair inspection, the crouch and sight test should be routinely performed. If the stair does not pass this visual test, careful measurements performed in accordance with 7.2.2.3.5 are essential. If the stair appears to pass this test, indicating that the internosing slope or pitch is consistent, a prudent second, quick test is to measure the internosing distances for each step to confirm their consistency.

Step dimensions or their uniformity should not be measured by simply laying a measuring tape or stick on the tread or against the riser. Such measurements could be misleading and erroneous relative to the criteria set out in 7.2.2.3.5, particularly if nosing projections are not uniform (as addressed in 7.2.2.3.6.5), if treads slope, or if the slopes vary within a stair flight.

A.7.2.2.3.6.5 "Safety yellow" is the widely used, standard color (described in ANSI/NEMA Z535.1, *Standard for Safety Colors*) to be used for a "caution" function, as a solid color or in alternating, angled yellow-black bars or other geometric combination that draws attention beyond merely designating a nosing. Other nosings, not located above nonuniform risers, need only contrast with the remainder of the step and can be of any color providing contrast relative to the remainder of the tread. Note that similar specification of distinctive and contrasting nosing markings is called for in assembly seating aisle stairs *(see, respectively, 12.2.5.6.6(7) and 12.2.5.6.10.1).* The safety problems of exterior stairs in assembly aisles and adjacent to a sloping public way are similar, as each individual step has to be visually detected in a reliable fashion. In addition, the presence and location of steps with unavoidably nonuniform risers must be effectively communicated, especially when viewed in the descent direction. Widely varying light conditions further heighten the need for such markings.

A.7.2.2.4.1.4 The intent of this provision is to place handrails for the required egress width only, regardless of the actual width. The required egress width is provided along the natural path of travel to and from the building. Examples of this requirement are shown in Figure A.7.2.2.4.1.4. The reduced intermediate handrail spacing of 60 in. (1525 mm), along with a handrail height within the permissible height limits, allows users to reach and grasp one handrail. Except as noted in 7.2.2.4.2 and 7.2.2.4.4, handrails are not required on stair landings.

A.7.2.2.4.5 Figure A.7.2.2.4.5 illustrates some of the requirements of 7.2.2.4.4.

A.7.2.2.4.5.4 Additional handrails, beyond those required by the *Code*, are permitted at heights other than those stipulated. For example, where children under the age of five are major users of a facility, an additional handrail at a height in the range of 28 in. to 32 in. (710 mm to 810 mm) might be useful. Generally, children prefer to use, and can effectively use, handrails that are located at shoulder to head height due to their developmental characteristics and their less developed balance and walking abilities. At age 3, head height ranges from 35 in. to 40 in. (890 mm to 1015 mm); shoulder height averages 29 in. (735 mm). At age 5, head height ranges from 39 in. to 46 in. (990 mm to 1170 mm); shoulder height ranges from 31 in. to 37 in. (785 mm to 940 mm).

A.7.2.2.4.5.6(2) Handrails should be designed so they can be grasped firmly with a comfortable grip and so the hand can be slid along the rail without encountering obstructions. The profile of the rail should comfortably match the hand grips. For example, a round profile, such as is provided by the simplest round tubing or pipe having an outside diameter of 1½ in. to 2 in. (38 mm to 51 mm), provides good graspability for adults. Factors such as the use of a handrail by small children and the wall-fixing details should be taken into account in assessing handrail graspability. The most functional, as well as the most preferred, handrail shape and size is circular with a 1½ in. (38 mm) outside diameter (according to research conducted using adults). Handrails used predominantly by children should be designed at the lower end of the permitted dimensional range.

Handrails are one of the most important components of a stair; therefore, design excesses such as oversized wood handrail sections should be avoided, unless there is a readily perceived and easily grasped handhold provided. In handrail design, it is useful to remember at all times the effectiveness of a simple round profile that allows some locking action by fingers as they curl around and under the handrail.

Perimeter dimension, referred to in 7.2.2.4.5.6(2), is the length of the shortest loop that wraps completely around the railing.

A.7.2.2.4.6.2(3) This reduction in required height applies only to the stair, not to the landings.

A.7.2.2.4.6.3 Vertical intermediate rails are preferred to reduce climbability.

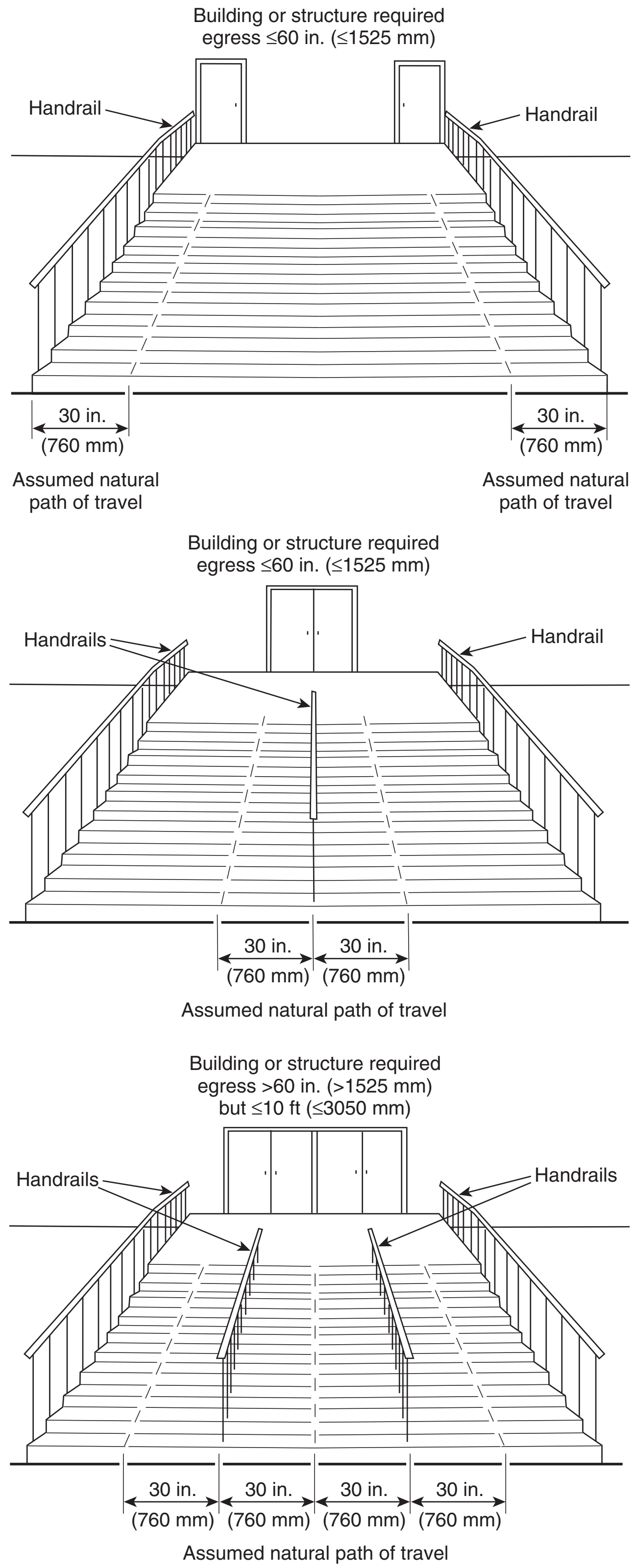


FIGURE A.7.2.2.4.1.4 Assumed Natural Paths of Travel on Monumental Stairs with Various Handrail Locations.

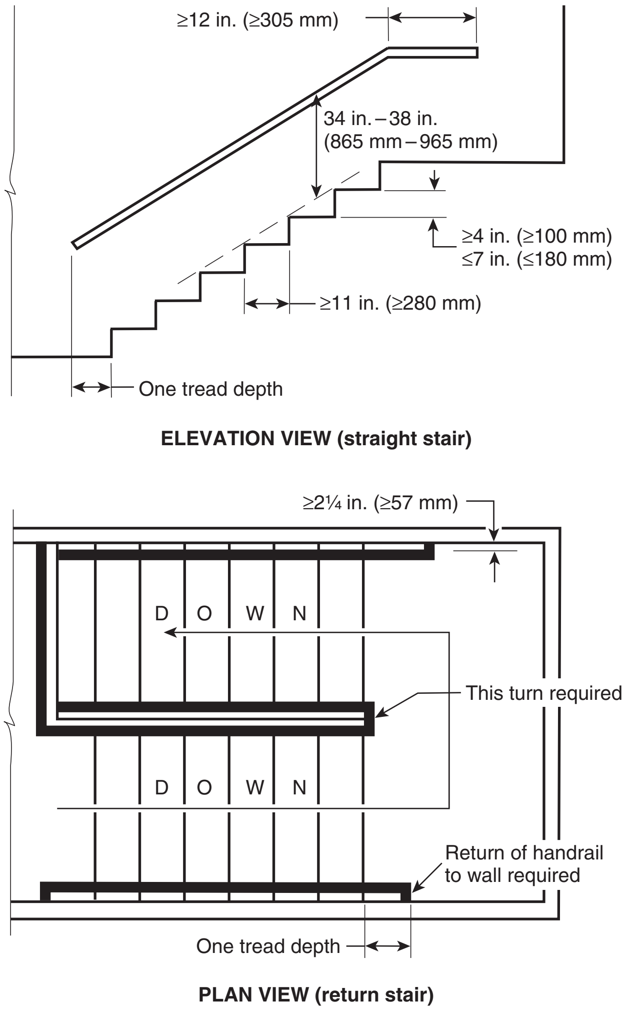


FIGURE A.7.2.2.4.5 Handrail Details.

A.7.2.2.5.2 The purpose of this provision is to protect the exterior wall of a stairway from fires in other portions of the building. If the exterior wall of the stair is flush with the building exterior wall, the fire would need to travel around 180 degrees in order to impact the stair. This has not been a problem in existing buildings, so no protection is required. However, if the angle of exposure is less than 180 degrees, protection of either the stair wall or building wall is required.

Figure A.7.2.2.5.2(a), Figure A.7.2.2.5.2(b), and Figure A.7.2.2.5.2(c) illustrate the requirement, assuming nonrated glass on the exterior wall of the stair is used.

A.7.2.2.5.3 An example of a use with the potential to interfere with egress is storage.

A.7.2.2.5.4 Figure A.7.2.2.5.4 shows an example of a stairway marking sign.

A.7.2.2.5.4.1(M) It is not the intent to require a sign that reads ROOF ACCESS, as such message might be misinterpreted by building occupants as an alternative egress route. However signs that read ROOF ACCESS are not prohibited, as many such signs have been installed in existing buildings so as to make a requirement for removal impractical. Historically, the ROOF ACCESS sign has provided information for the fire

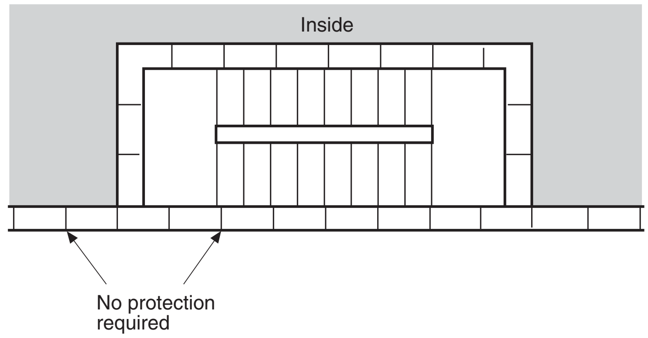


FIGURE A.7.2.2.5.2(a) Stairway with Nonrated Exterior Wall in Same Plane as Building Exterior Wall.

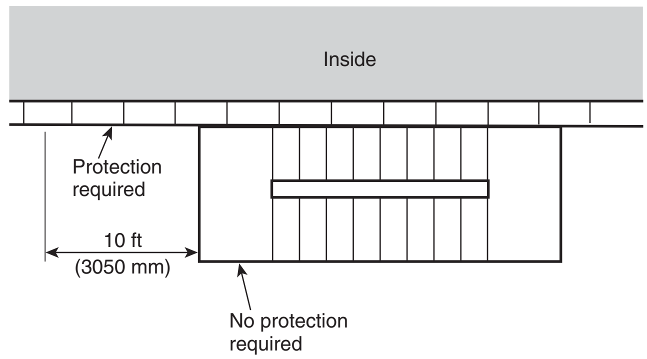


FIGURE A.7.2.2.5.2(b) Stairway with Unprotected Exterior Perimeter Protruding Past Building Exterior Wall.

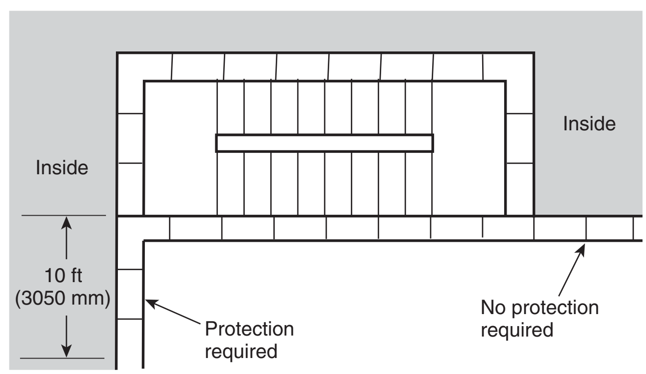


FIGURE A.7.2.2.5.2(c) Stairway with Nonrated Exterior Wall Exposed by Adjacent Exterior Wall of Building.

department. Where there is no roof access, such information will be posted via a NO ROOF ACCESS sign. The absence of the NO ROOF ACCESS sign should be understood by the fire department to mean that roof access is possible.

A.7.2.2.5.4.3 Where environmental conditions (such as illumination levels and directionality or a complex visual field that draws a person's attention away from stair treads) lead to a hazardous reduction in one's ability to perceive stair treads, they should be made of a material that allows ready discrimination of the number and position of treads. In all cases, the

FIGURE A.7.2.2.5.4 Example of a Stairway Marking Sign.

leading edges of all treads should be readily visible during both ascent and descent. A major factor in injury-producing stair accidents, and in the ability to use stairs efficiently in conditions such as egress, is the clarity of the stair treads as separate stepping surfaces.

For stair nosing marking, surface-applied material, such as adhesive-backed tape and magnetic strips, should not be used, as it is not durable under the scuffing from users' feet and, in coming loose, it creates a tripping hazard. While a carefully applied and consistently maintained coating is acceptable, contrasting color or photoluminescent material integral with the nosings is preferable because of its permanence. It is also the intent of 7.2.2.5.4.3 to require the contrasting stairway tread marking to be a material integral with the stair tread and not a material integral with a stair nosing product that is installed on the stair tread. See also 7.1.6.4 and 7.2.2.3.6 for slip resistance uniformity requirements, as well as prohibition of projections on the treads.

Guidance on the use of photoluminescent marking is provided by ASTM E 2030, Standard *Guide for Recommended Uses of Photoluminescent (Phosphorescent) Safety Markings*. Additional marking, for example, at the side boundaries of the stair, should be applied in accordance with the guidance provided therein.

A.7.2.2.5.4.4 Coatings and other applied markings, if used, should be durable for the expected usage, especially at end terminations of the marking and at changes in stair direction where usage is more extensive and hand forces are larger.

A.7.2.2.5.5.1 Exit stair treads are required to incorporate a marking stripe that is applied as a paint/coating or be a material that is integral with the nosing of each step. It is the intent of this provision to require the contrasting stairway tread marking to be a material integral with the stair tread and not a material integral with a stair nosing product that is installed on the stair tread. See also 7.1.6.4 and 7.2.2.3.6 for slip resistance requirements, as well as 7.2.2.3.3.2, which prohibits tread projections.

A.7.2.2.5.5.5 Examples of obstacles addressed by 7.2.2.5.5.5 are standpipes, hose cabinets, and wall projections.

A.7.2.2.5.5.7(B)(1) The marking stripe for door hardware should be of sufficient size to adequately mark the door hardware. This marking could be located behind, immediately adjacent to, or on the door handle or escutcheon.

A.7.2.2.6.2 The guards that are required by 7.1.8 and detailed in 7.2.2.4.5 will usually meet this requirement where the stair is not more than 36 ft (11 m) above the finished ground level. Special architectural treatment, including application of such devices as metal or masonry screens and grilles, will usually be necessary to comply with the intent of this requirement for stairs over 36 ft (11 m) above the finished ground level.

A.7.2.2.6.3.1 Where outside stairs are not required to be separated from interior portions of the building in accordance with 7.2.2.6.3.1(1) through (5), such stairs are considered exits and not exit access.

A.7.2.2.6.5 See A.7.2.2.3.4.

A.7.2.3.9.1 The design pressure differences required by 7.2.3.9.1 are based on specific gas temperatures and ceiling heights. The system is required to be approved, because anticipated conditions might be different from those on which the design pressure differences were calculated and, thus, different design pressure differences might be needed. For additional information on necessary minimum design pressure differences, including calculational techniques, or maximum pressure differences across doors to ensure reasonable operating forces, see NFPA 92, *Standard for Smoke Control Systems.*

A.7.2.4.1.2 An example of one way to provide the required egress capacity from the upper floor of a department store building measuring 350 ft × 200 ft (107 m × 61 m), with an occupant load of 1166 per floor, would be to furnish eight 44 in. (1120 mm) stairs. *[See Figure A.7.2.4.1.2(a).]*

The building is assumed to be divided into two sections by a fire barrier meeting the requirements for a horizontal exit, one 130 ft × 200 ft (40 m × 61 m), and the other 220 ft × 200 ft (67 m × 61 m), with two pairs of 46 in. (1170 mm) double egress doors, with each door providing 44 in. (1120 mm) of clear egress width *[see Figure A.7.2.4.1.2(b)]*. The smaller section, considered separately, will require the equivalent of three 44 in. (1120 mm) exit stairs, and the larger section will require five such exits. The horizontal exits will serve as one of the three exits required for the smaller section and two of the five exits required for the larger section. Therefore, only two 44 in. (1120 mm) exit stairs from the smaller section and three 44 in. (1120 mm) exit stairs from the larger section will be required if the exits can be arranged to meet the requirements for the 150 ft (46 m) travel distance permitted from any point in a nonsprinklered building. Thus, the total number of exit stairs required for the building will be five, as compared to eight if no horizontal exit had been provided.

Another option would be the use of two 56 in. (1420 mm) exit stairs from the larger section, which would reduce the total number of stairways required from the floor to four *[see Figure A.7.2.4.1.2(c)]*. However, if the building were further subdivided by a second fire wall meeting the requirements for a horizontal exit, no further reduction in stairways would be permitted in order to comply with the requirement that horizontal exits provide a maximum of one-half of egress capacity.

It is not the intent of 7.2.4.1.2 to limit the number of doors in the fire barrier forming the horizontal exit. Where doors other than those serving as horizontal exits are provided, such doors are permitted to be considered as part of the exit access and not as exits.

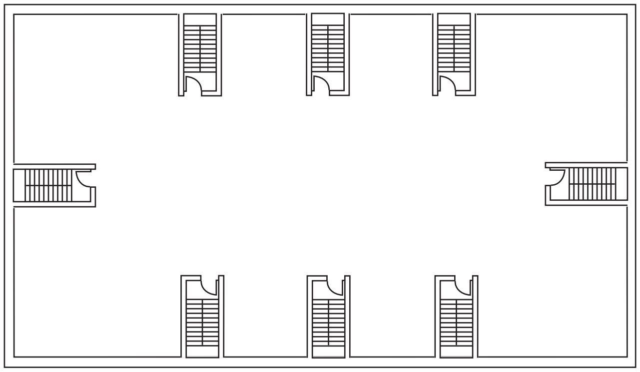


FIGURE A.7.2.4.1.2(a) Eight Exits, Required to Provide Necessary Egress Capacity, with None via Horizontal Exit.

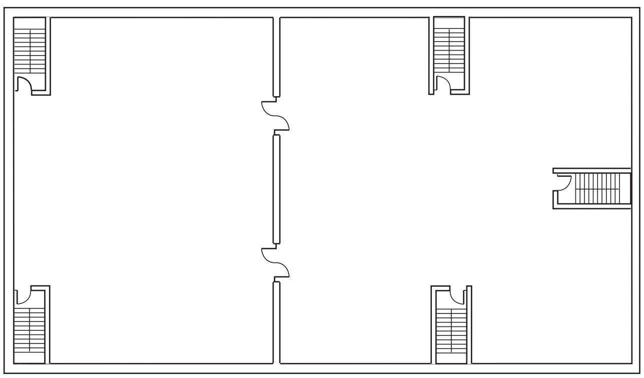


FIGURE A.7.2.4.1.2(b) Number of Stairs Reduced by Three Through Use of Two Horizontal Exits; Egress Capacity Not Reduced.

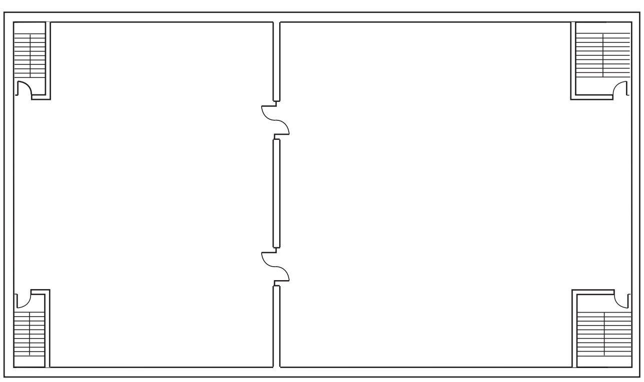


FIGURE A.7.2.4.1.2(c) Number of Stairs Further Reduced by Widening Stairs in Larger Compartment, But Not to Less than One-Half the Required Number and Capacity of Exits from That Compartment.

A.7.2.4.3.1 The continuity requirement of 7.2.4.3.1 does not prohibit the horizontal exit fire barrier from being offset on various floors. Where the floor assembly has a minimum 2-hour fire resistance rating and horizontal exit fire barrier walls are provided on all floors to the finished ground level, the continuity provision might be achieved by a combination of horizontal and vertical assemblies. For requirements regarding the alignment of fire barriers separating buildings of differing construction types, see 8.2.1.3.

A.7.2.4.3.2 Figure A.7.2.4.3.2 depicts an example of the use of the exemption provided by 7.2.4.3.2.

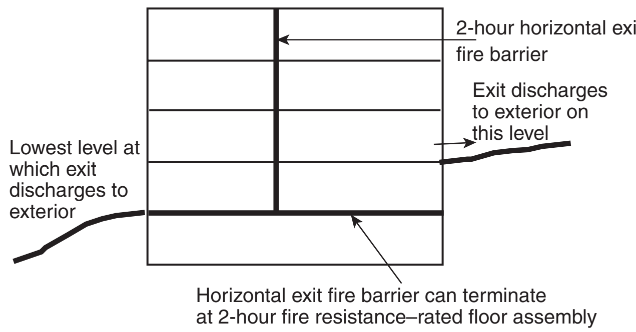


FIGURE A.7.2.4.3.2 Example of Horizontal Exit Termination.

A.7.2.4.3.5 The requirements of 7.2.4.3.5 are meant to apply to the horizontal and vertical portions of the fire barrier forming the horizontal exit.

A.7.2.4.3.10 Fusible link–actuated automatic-closing doors do not qualify for use in horizontal exits under these provisions, because smoke might pass through the opening before there is sufficient heat to release the hold-open device. Such doors are also objectionable because, once closed, they are difficult to open and would inhibit orderly egress.

A.7.2.5.7.1 The guards required by 7.1.8 and detailed in 7.2.2.4.5 for the unenclosed sides of ramps will usually meet this requirement where the ramp is not more than 36 ft (11 m) above the finished ground level. Special architectural treatment, including application of such devices as metal or masonry screens and grilles, will usually be necessary to comply with the intent of the requirements for ramps over 36 ft (11 m) above the finished ground level.

A.7.2.5.7.2 Providing a pitch of ⅛ in./ft to ¼ in./ft (10 mm/m to 21 mm/m) will aid the shedding of water from a nominally horizontal surface.

A.7.2.6 An exit passageway serves as a horizontal means of exit travel that is protected from fire in a manner similar to an enclosed interior exit stair. Where it is desired to offset exit stairs in a multistory building, an exit passageway can be used to preserve the continuity of the protected exit by connecting the bottom of one stair to the top of the stair that continues to the street floor. Probably the most important use of an exit passageway is to satisfy the requirement that at least 50 percent of the exit stairs discharge directly outside from multistory buildings *(see 7.7.2)*. Thus, if it is impractical to locate the stair on an exterior wall, an exit passageway can be connected to the bottom of the stair to convey the occupants safely to an outside exit door. In buildings of extremely large area, such as shopping malls and some factories, the exit passageway can be used to advantage where the travel distance to reach an exit would otherwise be excessive.

A.7.2.6.1 Examples of building elements that might be arranged as exit passageways include hallways, corridors, passages, tunnels, underfloor passageways, or overhead passageways.

A.7.2.6.4.1(1) Where an exit passageway serves occupants on the level of exit discharge as well as other floors, it should not be required that the occupant loads be added, thus increasing the width of the exit passageway. The situation is the same as that in which occupants from the level of exit discharge join occupants from upper floors for a few feet of horizontal travel through a stair enclosure.

A.7.2.8.7 Swinging stairs, although superior to fire escape ladders, are generally unsatisfactory, even for emergency use. Although such stairs are permitted by this *Code*, they should not be used where it is reasonably possible to terminate the fire escape stair at the finished ground level.

A.7.2.8.7.9 A latch is desirable for holding swinging stairs down after they have swung to the finished ground level.

A.7.2.11 Special consideration should be given prior to the application of such devices where children, the elderly, or physically disabled persons use such devices. These devices present obstacles in ascent and descent that differ from those for stairs and ladders.

A.7.2.12.2.3 A clear width of not less than 48 in. (1220 mm) is needed for a three-person carry of an occupied wheelchair up or down a stair. This procedure, as well as the more difficult two-person wheelchair carry or roll, requires training and experience. Safer alternative stair descent measures for transporting a person who normally requires a wheelchair, or otherwise cannot use stairs, include emergency stair travel devices designed, constructed, and operated in accordance with ANSI/RESNA ED-1, *Emergency Stair Travel Devices Used by Individuals with Disabilities*. In addition to having such devices available where needed, and having persons trained and experienced in their use, it is important to have people trained and experienced in wheelchair transfer techniques.

In view of the logistical difficulties, as well as the dangers inherent in carrying occupied wheelchairs or otherwise transferring and transporting their occupants on stairs, the preferred means of egress from an area of refuge consists of facilities normally employed for ingress and egress by people using wheelchairs. Foremost among these options are elevators meeting the fire fighters' emergency operations requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*.

A.7.2.12.2.4 The use of elevators for egress, especially during an emergency such as a fire, is not an approach to be taken without considerable planning, ongoing effort, and a high degree of understanding by everyone involved with the evacuation of persons with mobility impairments. Due in part to the limited capacity of elevators, as well as to the conflicting demands for elevator use for fire-fighting activities, even elevators in accordance with 7.2.12.2.4 cannot be considered as satisfying any of the *Code*'s requirements for egress capacity, number of means of egress, or travel distance to an exit.

A.7.2.12.2.6 The instructions should include the following:

(1) Directions to find other means of egress
(2) Advice that persons able to use exit stairs do so as soon as possible, unless they are assisting others
(3) Information on planned availability of assistance in the use of stairs or supervised operation of elevators and how to summon such assistance
(4) Directions for use of the emergency communications system

To facilitate an adequate degree of understanding of the use of areas of refuge and of the associated assisted egress procedures, information should be provided to those using the facilities. The exact content of the information, its organization (e.g., as a set of instructions), and its format (e.g., either posted instructions in the area of refuge or information otherwise transmitted to facility users) should be determined on a case-by-case basis. The information should be tailored to the specific facility, its emergency action plan, the intended audience, and the intended presentation format. Suggested information content addressing two situations follows.

Refuge with Elevator Use. An area of refuge provided in the elevator lobby serves as a staging area for persons unable to use stairs and needing assistance for their evacuation during an emergency. The elevator(s) will be taken out of automatic service and operated by emergency service personnel. Persons unable to evacuate down the exit stairs without assistance and needing transportation by elevator should make certain the elevator lobby doors are closed while they wait in the elevator lobby for assistance. The two-way communication system should be used if there is a delay of more than several minutes in the arrival of an elevator that will provide transportation to the level of exit discharge. Alternatively, another refuge area, and assistance with evacuation, is available in the designated exit stair.

Refuge with Stair Use. An area of refuge within the designated exit stair serves as a staging area for persons needing assistance for their evacuation during an emergency. Persons unable to use the stairs unassisted, or who wish to move down the stairs at a slower pace, should wait on the stair landing. The two-way communication system should be used if assistance is needed.

A.7.2.12.3.1 Figure A.7.2.12.3.1 illustrates the application of the minimum space requirement to an area of refuge located within an exit stair enclosure. Note that each of the two required spaces is sufficient to allow the parking of a standard wheelchair. Preferably, such spaces should be provided adjacent to each other in a location where the presence of people taking temporary shelter in an area of refuge will be immediately apparent to rescue personnel and other evacuees.

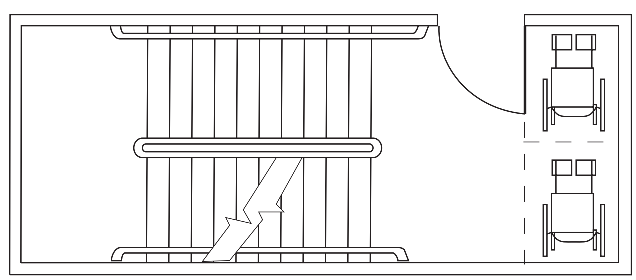


FIGURE A.7.2.12.3.1 Exit Stair Used as an Area of Refuge.

A.7.2.12.3.2 The method of meeting the tenability performance criteria required of an area of refuge of less than 1000 ft^2 (93 m^2) can involve controlling the exposing fire (e.g., via automatic sprinkler protection), installing smoke-resisting doors in the smoke-resisting barriers *(see* NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives),* providing smoke control to prevent or limit smoke migration through cracks or other leakage paths *(see* NFPA 92, *Standard* *for Smoke Control Systems),* or providing other means or a combination of these means.

Calculations, if used, need to be based on established engineering relationships and equations. Such calculational procedures are described in NFPA 92 and the *SFPE Handbook of Fire Protection Engineering*. Tenable conditions are those that maintain the temperature of any smoke in the area of refuge at less than 200°F (93°C) if the smoke is more than 60 in. (1525 mm) above the floor, and at less than 120°F (49°C) if the smoke descends below the 60 in. (1525 mm) level in the area of refuge. Also, if the smoke descends below the 60 in. (1525 mm) level, tenable conditions require not less than 16 percent oxygen and not more than 30,000 ppm/min exposure to carbon monoxide. The exposing conditions used in the calculations should be in accordance with the following:

(1) The exposing space is sprinkler protected, and the following conditions also exist:
    (a) The temperature of the exposing smoke is 200°F (93°C).
    (b) The smoke layer extends to the floor.
    (c) The oxygen content is 16 percent.
    (d) The carbon monoxide concentration is 2000 ppm (0.2 percent).
(2) The exposing space is a nonsprinklered corridor finished with Class A interior wall and ceiling finish, and the following conditions also exist:
    (a) The temperature of the exposing smoke is 600°F (316°C).
    (b) The smoke layer extends to a level 24 in. (610 mm) above the floor.
    (c) The oxygen content is 3 percent.
    (d) The carbon monoxide concentration is 50,000 ppm (5 percent).
(3) The exposing space is either not a corridor or, if a corridor, the corridor is not finished with a Class A interior wall and ceiling finish, and the following conditions also exist:
    (a) The temperature of the exposing smoke is 1500°F (815°C).
    (b) The smoke layer extends to a level 24 in. (610 mm) above the floor.
    (c) The oxygen content is 3 percent.
    (d) The carbon monoxide concentration is 50,000 ppm (5 percent).

A.7.2.12.3.4 Requirements for fire resistance ratings in excess of 1 hour, fire protection ratings in excess of 20 minutes, and prohibitions on duct penetrations appear in other *Code* sections. For example, if the barrier creating the area of refuge is also part of an exit stair enclosure that connects two or more stories, or is a horizontal exit, a minimum 2-hour fire resistance rating for the barrier and a minimum 1½-hour fire protection rating for opening protectives, such as doors, would be required for most occupancies.

For further information on door openings in smoke-resisting barriers, see NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*.

Generally, by providing one barrier that subdivides a floor area, two areas of refuge can be created. This subdivision method and the possibility of creating areas of refuge within compartmented elevator lobbies or on enlarged stair landings of exit stair enclosures make less onerous any requirement for a story to have more than one accessible means of egress.

A.7.2.13.1 It is the intent of 7.2.13.1 that elevators serving as a means of egress serve only independent towers or the tower portion of any integral structure. For elevators that are used as a component in the means of egress, the elevator lobbies, elevator shaft, and machine room need to be protected from the effects of fire.

A.7.2.13.6 One or more of the following approaches can be used to restrict exposure of elevator equipment to water:

(1) A combination of sealed elevator lobby doors, sloped floors, floor drains, and sealed elevator shaft walls is used.
(2) The elevator is mounted on the building exterior that normally operates in the elements, and seals are used on the elevator lobby doors.
(3) The elevator shaft is separated from the building at each floor by an exterior elevator lobby designed to prevent water entry into the elevator shaft.

Information gained from ongoing research concerning waterflow and elevators could lead to the development of water-resistive or water-protected elevator equipment specifically for fire applications. Such equipment should be used only with the building elements (e.g., sealed elevator lobby doors, sloped floors, floor drains) for which it is developed. Further information is available from the NIST publication, *Feasibility of Fire Evacuation by Elevators at FAA Control Towers*.

A.7.2.13.7 Cooling equipment dedicated to the elevator machine room can be used to minimize requirements for standby power.

A.7.2.13.8 Communication between elevator lobbies and a central control point can be by telephone or intercom. Auditory alarms should be designed so that they do not interfere with people talking on communications systems.

A.7.2.13.9 Smoke detection in the elevator lobby will result in a Phase I recall of the elevators. The elevators will then be automatically taken out of normal service and will be available to be operated by emergency service personnel.

A.7.3.1.2 The normal occupant load is not necessarily a suitable criterion, because the greatest hazard can occur when an unusually large crowd is present, which is a condition often difficult for authorities having jurisdiction to control by regulatory measures. The principle of this *Code* is to provide means of egress for the maximum probable number of occupants, rather than to attempt to limit occupants to a number commensurate with available means of egress. However, limits of occupancy are specified in certain special cases for other reasons.

Suggested occupant load factors for components of large airport terminal buildings are given in Table A.7.3.1.2. However, the authority having jurisdiction might elect to use different occupant load factors, provided that egress requirements are satisfied.

Table A.7.3.1.2 Airport Terminal Occupant Load Factors

Airport Terminal Area	ft^2 (gross)	m^2 (gross)
Concourse	100	9.3
Waiting areas	15	1.4
Baggage claim	20	1.9
Baggage handling	300	27.9

The figure used in determining the occupancy load for mall shopping centers of varying sizes was arrived at empirically by surveying over 270 mall shopping centers, by studying mercantile occupancy parking requirements, and by observing the number of occupants per vehicle during peak seasons.

These studies show that, with an increase in shopping center size, there is a decrease in the number of occupants per square foot of gross leasable area.

This phenomenon is explained when one considers that, above a certain shopping center gross leasable area [approximately 600,000 ft^2 (56,000 m^2)], there exists a multiplicity of the same types of stores. The purpose of duplicate types of stores is to increase the choices available to a customer for any given type of merchandise. Therefore, when shopping center size increases, the occupant load increases as well, but at a declining rate. In using Figure 7.3.1.2(a) or Figure 7.3.1.2(b), the occupant load factor is applied only to the gross leasable area that uses the mall as a means of egress.

The value for concentrated business use is intended to address business use spaces with a higher density of occupants than would normally be expected in a general business occupancy. Where furnishings and floor layouts are arranged to maximize the number of occupants in the space, the value for concentrated business use should be applied. Examples of concentrated business use areas are call centers, trading floors, and data processing centers.

A.7.3.3 In egress capacity calculations, standard rounding should be used.

A.7.3.3.2 The effective capacity of stairways has been shown by research to be proportional to the effective width of the stairway, which is the nominal width minus 12 in. (305 mm). This phenomenon, and the supporting research, were described in the chapter, “Movement of People,” in the first, second, and third editions of the *SFPE Handbook of Fire Protection Engineering* and was also addressed in Appendix D of the 1985 edition of NFPA 101, among several other publications. In 1988, this appendix was moved to form Chapter 2 of the 1988 edition of NFPA 101M, *Alternative Approaches to Life Safety*. (This document was later designated as NFPA 101A, *Guide on Alternative Approaches to Life Safety*, and this chapter remained in the document through the 1998 edition.) In essence, the effective width phenomenon recognizes that there is an edge or boundary effect at the sides of a circulation path. It has been best examined in relation to stairway width, where the edge effect was estimated to be 6 in. (150 mm) on each side, but a similar phenomenon occurs with other paths, such as corridors and doors, although quantitative estimates of their edge effect are not as well established as they have been for stairways, at least those stairways studied in Canada during the late 1960s through the 1970s in office building evacuation drills and in crowd movement in a variety of buildings with assembly occupancy.

More recent studies have not been performed to determine how the edge effect might be changing (or has changed) with demographic changes to larger, heavier occupants moving more slowly, and thus swaying laterally, to maintain balance when walking. The impact of such demographic changes, which are significant and influential for evacuation flow and speed of movement on stairs, for example, has the effect of increasing the time of evacuation in a way that affects all stair widths, but will be most pronounced for nominal widths less than 56 in. (1422 mm).

Without taking into account occupant demographic changes in the last few decades that affect evacuation performance, especially on stairs, the formula for enhanced capacity of stairways wider than 44 in. (1120 mm) assumes that any portion of the nominal width greater than 44 in. (1120 mm) is as effective proportionally as the effective width of a nominal 44 in. (1120 mm) stair, that is, 32 in. (810 mm). Thus, the denominator (0.218) in the equation is simply the effective width of 32 in. (810 mm) divided by the capacity of 147 persons that is credited, by the 0.3 in. (7.6 mm) capacity factor in Table 7.3.3.1, to the corresponding nominal width, 44 in. (1120 mm).

The resulting permitted stairway capacities, based on occupant load of single stories (in accordance with 7.3.1.4), for several stairway widths are shown in Table A.7.3.3.2.

Table A.7.3.3.2 Stairway Capacities

Permitted Capacity (no. of persons)	Nominal Width		Clear Width Between Handrails[a]		Effective Width	
	in.	mm	in.	mm	in.	mm
120[b]	36	915	28	710	24	610
147	44	1120	36	915	32	810
202	56	1420	48	1220	44	1120
257	68	1725	60	1525[c]	56	1420

[a]A reasonable handrail incursion of only 4 in. (100 mm), into the nominal width, is assumed on each side of the stair, although 7.3.3.2 permits a maximum incursion of 4½ in. (114 mm) on each side.

[b]Other *Code* sections limit the occupant load for such stairs more severely, (e.g., 50 persons in 7.2.2.2.1.2). Such lower limits are partly justified by the relatively small effective width of such stairs, which, if taken into account by Table 7.3.3.1, would result in a correspondingly low effective capacity of only 110 persons (24 divided by 0.218), or a more realistic capacity factor of 0.327, applicable to nominal width.

[c]A clear width of 60 in. (1525 mm) is the maximum permitted by the handrail reachability criteria of 7.2.2.4.1.2. Although some prior editions of the *Code* permitted wider portions of stairs [up to 88 in. (2240 mm), between handrails], such wider portions are less effective for reasonably safe crowd flow and generally should not be used for major crowd movement. To achieve the maximum possible, reasonably safe egress capacity for such stairs, retrofit of an intermediate — not necessarily central — handrail is recommended; for example, with an intermediate handrail located 36 in. (915 mm) from the closest side handrail. In this case, the effective capacity would be 358 persons for the formerly permitted, now retrofitted, stair. This is based on a retrofitted, effective width of about 78 in. (1980 mm) [subtracting 2 in. (51 mm) from each usable side of a handrail and assuming a 2 in. (51 mm) wide, retrofitted intermediate handrail].

A.7.3.4.1.1 The criteria of 7.3.4.1.1, as initially written, were intended to provide for minimum widths for small spaces such as individual offices. The intent is that these reductions in required width apply to spaces formed by furniture and movable walls, so that accommodations can easily be made for mobility-impaired individuals. One side of a path could be a fixed wall, provided that the other side is movable. This does not exempt the door widths or widths of fixed-wall corridors, regardless of the number of people or length. The allowance for reduction in width has been expanded to include all exit accesses serving not more than six people where the travel length along the reduced-width path does not exceed 50 ft (15 m), regardless of occupancy or use of the space.

Figure A.7.3.4.1.1(a) and Figure A.7.3.4.1.1(b) present selected anthropometric data for adults. The male and female figures depicted in the figures are average, 50th percentile, in size. Some dimensions apply to very large, 97.5 percentile, adults (noted as 97.5 P).

A.7.4 Section 7.4 requires a minimum number of means of egress, unless otherwise specified by an occupancy chapter in subsection ____.2.4, which addresses number of means of egress. Several occupancy chapters establish not only the minimum number of means of egress but also the minimum number of actual exits that must be provided on each floor. For example, for new educational occupancies, 14.2.4 requires access to two exits and further requires that both of the exits be provided on the floor. In contrast, for industrial occupancies, 40.2.4.1.1 requires access to two exits and further requires that at least one of the exits be located on the floor. Access to the other exit can involve traveling to another floor via an egress component such as an open stair, provided that such open stair is permitted by the occupancy chapter's provisions for the protection of vertical openings.

In most occupancy chapters, meeting the requirements for egress capacities and travel distances means the required minimum number of means of egress will automatically be met. However, in occupancies characterized by high occupant

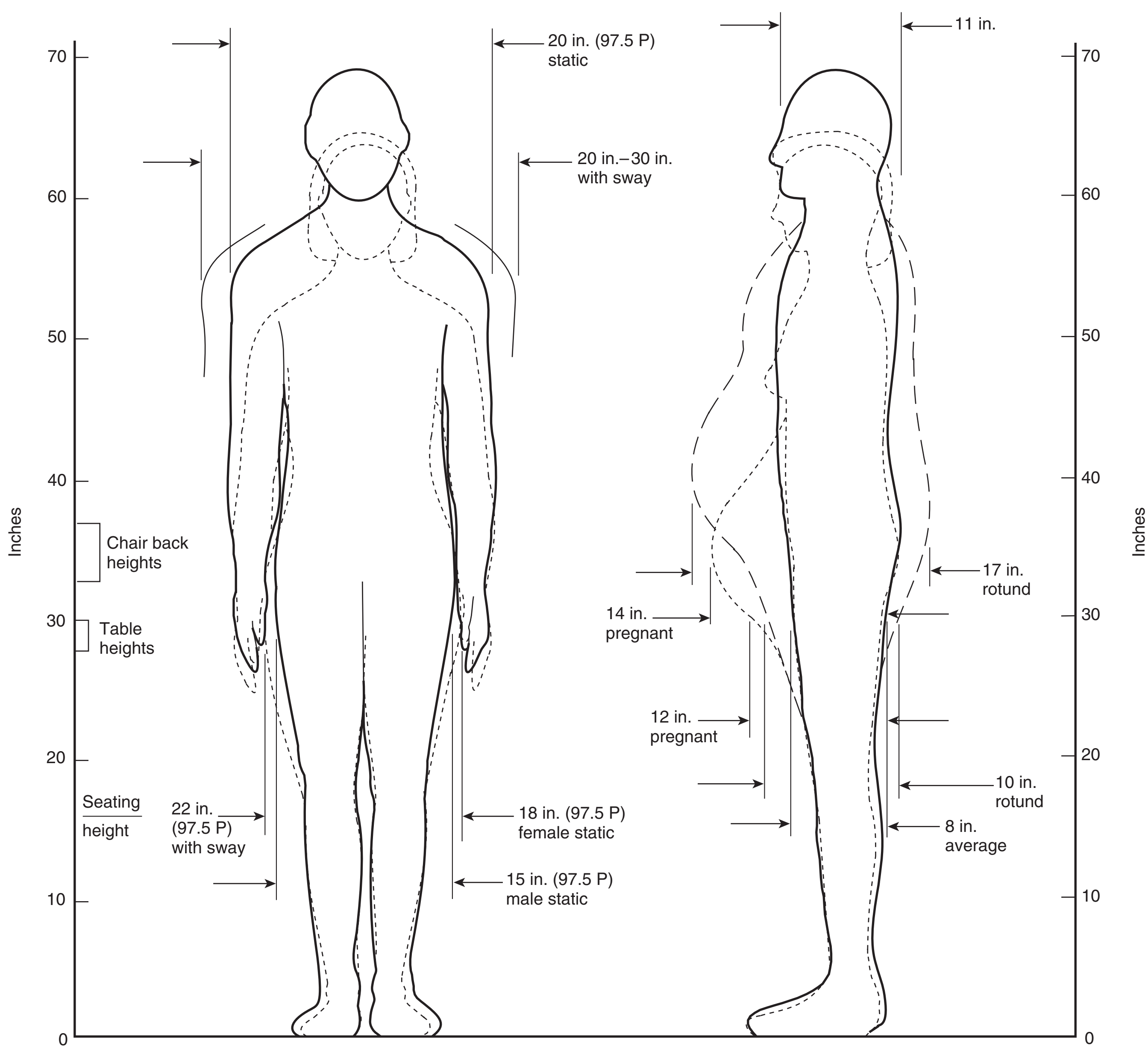


FIGURE A.7.3.4.1.1(a) Anthropometric Data (in in.) for Adults; Males and Females of Average, 50th Percentile, Size; Some Dimensions Apply to Very Large, 97.5 Percentile (97.5 P), Adults.

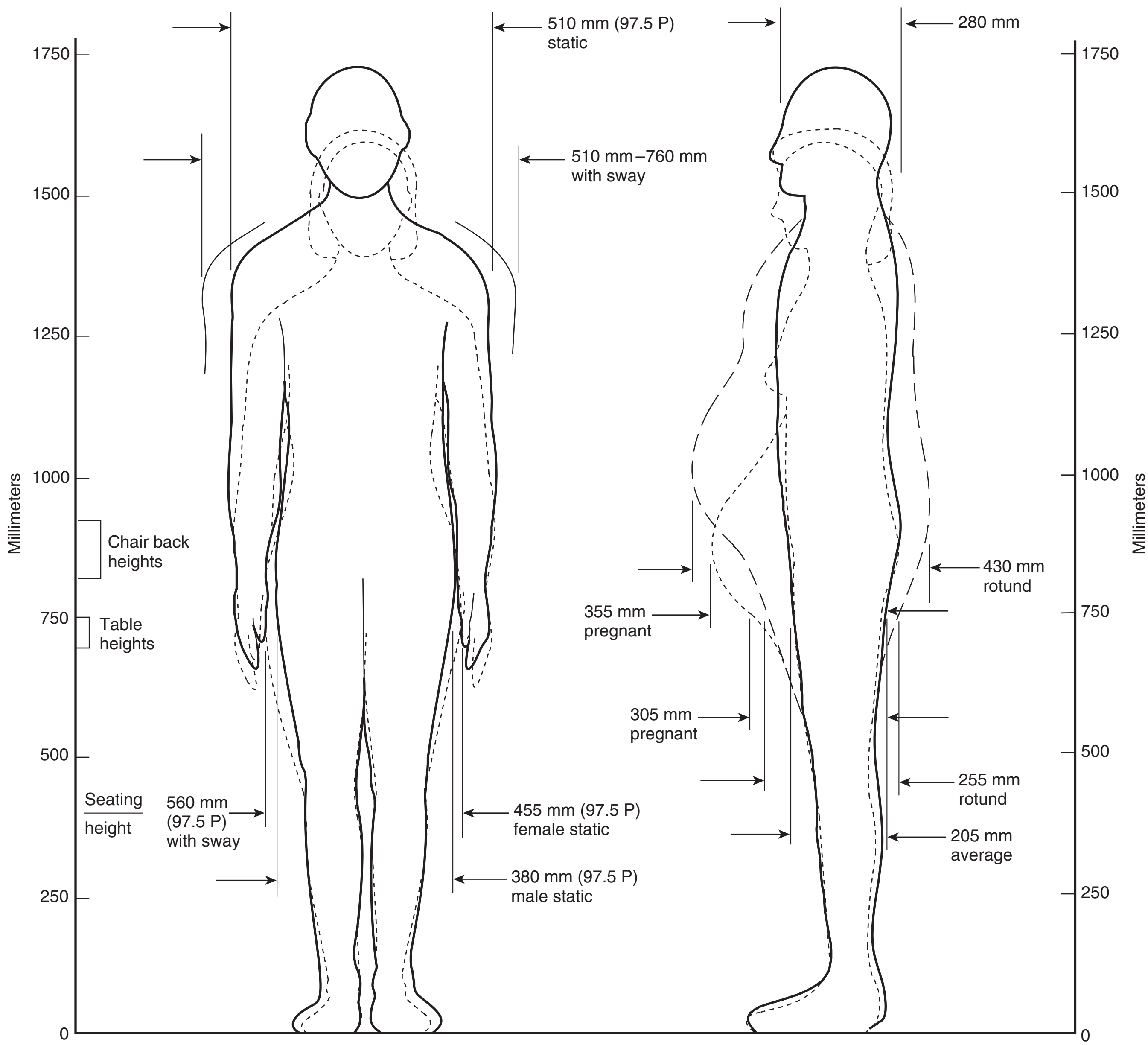


FIGURE A.7.3.4.1.1(b) Anthropometric Data (in mm) for Adults; Males and Females of Average, 50th Percentile, Size; Some Dimensions Apply to Very Large, 97.5 Percentile (97.5 P), Adults.

loads, such as assembly and mercantile occupancies, compliance with requirements for more than two exits per floor might require specific attention.

A.7.5.1.1.1 See A.7.5.1.5.

A.7.5.1.3.2 Figure A.7.5.1.3.2(a) through Figure A.7.5.1.3.2(e) illustrate the method of measurement intended by 7.5.1.3.2.

A.7.5.1.3.4 Figure A.7.5.1.3.4 illustrates the method of measuring exit separation distance along the line of travel within a minimum 1-hour fire resistance–rated corridor.

A.7.5.1.4.2 It is difficult in actual practice to construct scissor stairs so that products of combustion that have entered one stairway do not penetrate into the other. Their use as separate required exits is discouraged. The term *limited-combustible* is intentionally not included in 7.5.1.4.2. The user's attention is directed to the provisions for limited-combustible and noncombustible in 4.6.13 and 4.6.14, respectively.

A.7.5.1.5 The terms *dead end* and *common path of travel* are commonly used interchangeably. Although the concepts of each are similar in practice, they are two different concepts.

A common path of travel exists where a space is arranged so that occupants within that space are able to travel in only one direction to reach any of the exits or to reach the point at which the occupants have the choice of two paths of travel to

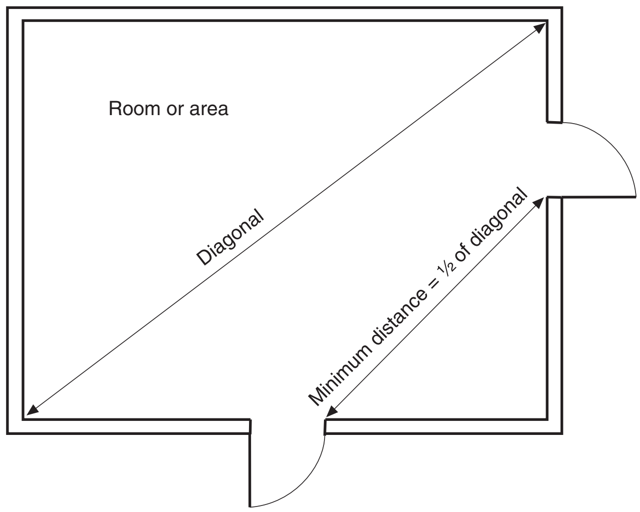


FIGURE A.7.5.1.3.2(a) **Diagonal Rule for Exit Remoteness.**

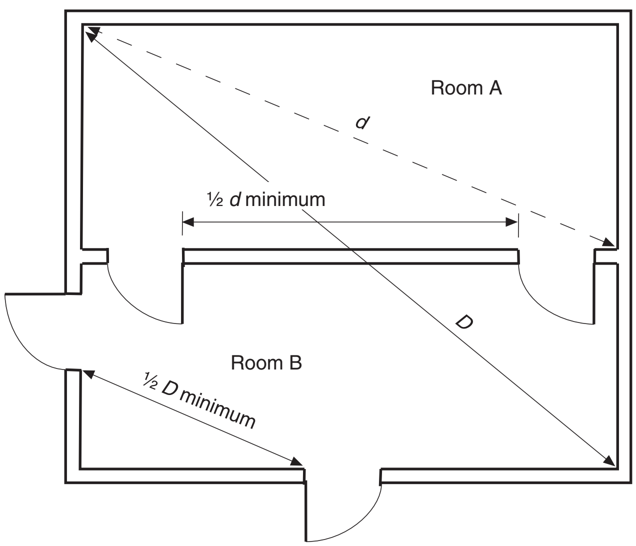


FIGURE A.7.5.1.3.2(b) Diagonal Rule for Exit and Exit Access Door Remoteness.

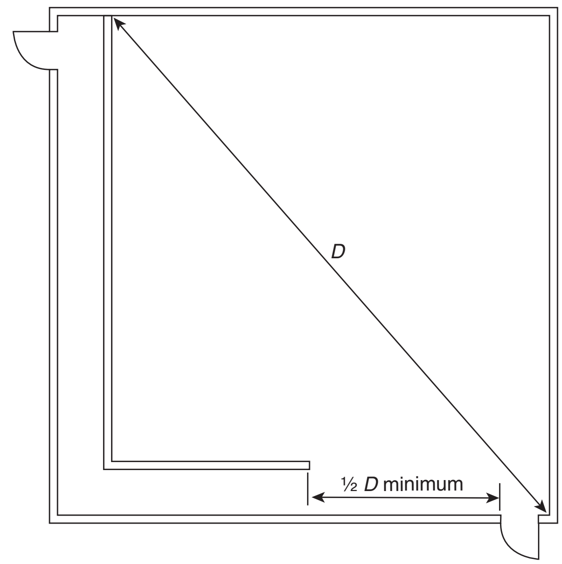


FIGURE A.7.5.1.3.2(c) Diagonal Rule for Exit and Access Remoteness.

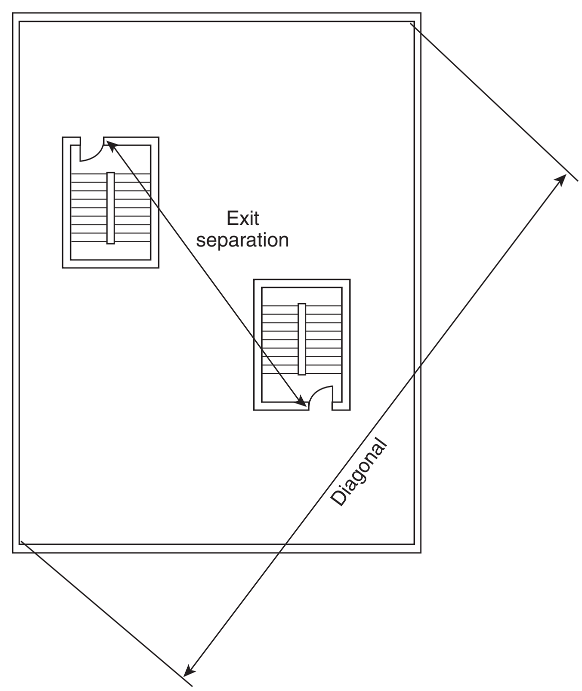


FIGURE A.7.5.1.3.2(d) Exit Separation and Diagonal Measurement of Area Served.

remote exits. Part (a) of Figure A.7.5.1.5 is an example of a common path of travel.

While a dead end is similar to a common path of travel, a dead end can exist where there is no path of travel from an occupied space but can also exist where an occupant enters a corridor thinking there is an exit at the end and, finding none, is forced to retrace his or her path to reach a choice of exits. Part (b) of Figure A.7.5.1.5 is an example of such a dead-end arrangement.

Combining the two concepts, part (c) of Figure A.7.5.1.5 is an example of a combined dead-end/common path of travel problem.

Common paths of travel and dead-end travel are measured using the same principles used to measure travel distance as described in Section 7.6. Starting in the room shown in part (d) of Figure A.7.5.1.5, measurement is made from the most remote point in the room, A, along the natural path of travel and through the doorway along the centerline of the corridor to point C, located at the centerline of the corridor, which then provides the choice of two different paths to remote exits; this is common path of travel. The space between point B and point C is a dead end. *(See 3.3.47 for the definition of common path of travel.)*

A.7.5.2.1 It is not the intent that an area with equipment such as a beverage brewpot, microwave oven, and a toaster be considered a kitchen.

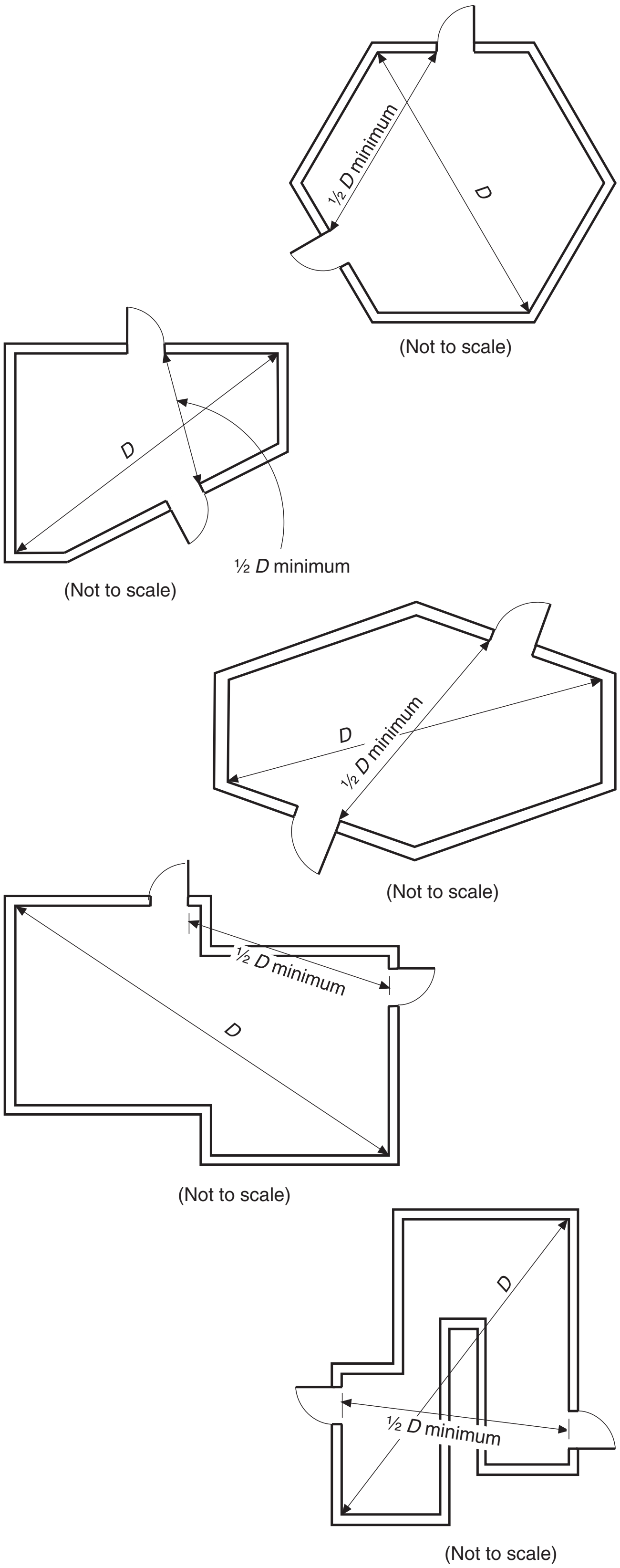


FIGURE A.7.5.1.3.2(e) Diagonal Measurement for Unusually Shaped Areas.

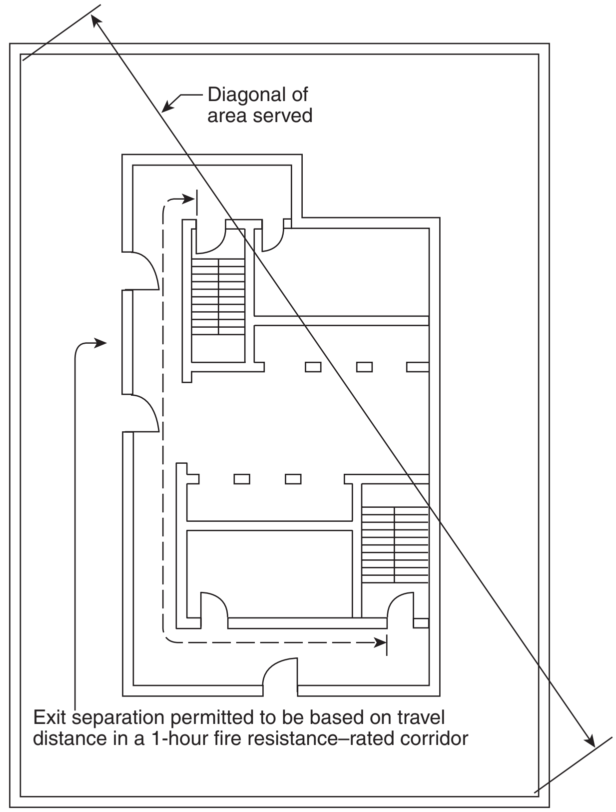


FIGURE A.7.5.1.3.4 Exit Separation Measured Along Corridor Path.

A.7.5.2.2 Doors that lead through wall paneling, and that harmonize in appearance with the rest of the wall to avoid detracting from some desired aesthetic or decorative effect, are not acceptable, because casual occupants might not be aware of such means of egress even though it is visible.

A.7.5.4.1 An accessible means of egress should comply with the accessible route requirements of ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities.*

A.7.6 Table A.7.6 is a compilation of the requirements of the individual occupancy chapters (Chapters 12 through 42) for permissible length of common path of travel, dead-end corridors, and travel distance to not less than one of the required exits.

A dead end exists where an occupant enters a corridor thinking there is an exit at the end and, finding none, is forced to retrace the path traveled to reach a choice of egress travel paths. Although relatively short dead ends are permitted by this *Code*, it is better practice to eliminate them wherever possible, as they increase the danger of persons being trapped in case of fire. Compliance with the dead-end limits does not necessarily mean that the requirements for remoteness of exits have been met. Such lack of compliance is particularly true in small buildings or buildings with short public hallways. Adequate remoteness can be obtained in such cases by further reducing the length of dead ends. *(See also A.7.5.1.5.)*

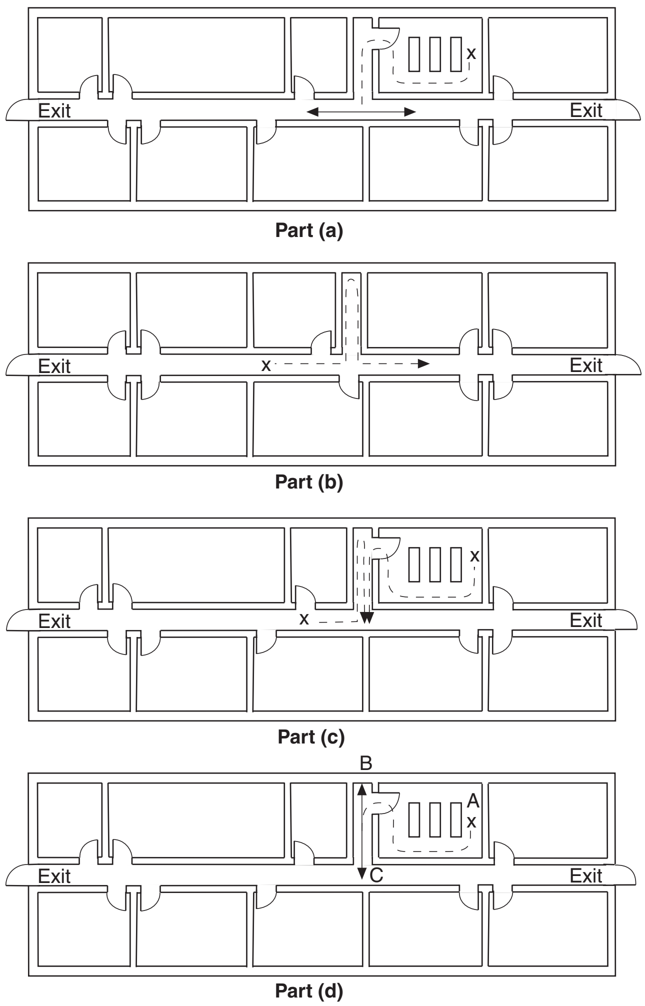


FIGURE A.7.5.1.5 Common Paths of Travel and Dead-End Corridors.

A.7.6.1 The natural exit access (path of travel) is influenced by the contents and occupancy of the building. Furniture, fixtures, machinery, or storage can serve to increase the length of travel. It is good practice in building design to recognize the influence of contents and occupancy by spacing exits for a completely open floor area at closer intervals than are required, thus reducing the hazard of excessive travel distances due to the introduction of furniture, fixtures, machinery, or storage and minimizing the possibility of violating the travel distance requirements of this *Code*.

A.7.6.3 Examples of locations where open stairways might exist include between mezzanines or balconies and the floor below.

A.7.7.1 An exit from the upper stories in which the direction of egress travel is generally downward should not be arranged so that it is necessary to change to travel in an upward direction at any point before discharging to the outside. A similar prohibition of reversal of the vertical component of travel should be applied to exits from stories below the floor of exit discharge. However, an exception is permitted in the case of stairs used in connection with overhead or underfloor exit passageways that serve the street floor only.

It is important that ample roadways be available from buildings in which there are large numbers of occupants so that exits will not be blocked by persons already outside. Two or more avenues of departure should be available for all but very small places. Location of a larger theater — for example, on a narrow dead-end street — might be prohibited by the authority having jurisdiction under this rule, unless some alternate way of travel to another street is available.

Exterior walking surfaces within the exit discharge are not required to be paved and often are provided by grass or similar surfaces. Where discharging exits into yards, across lawns, or onto similar surfaces, in addition to providing the required width to allow all occupants safe access to a public way, such access also is required to meet the following:

(1) Provisions of 7.1.7 with respect to changes in elevation
(2) Provisions of 7.2.2 for stairs, as applicable
(3) Provisions of 7.2.5 for ramps, as applicable
(4) Provisions of 7.1.10 with respect to maintaining the means of egress free of obstructions that would prevent its use, such as snow and the need for its removal in some climates

A.7.7.3.3 Examples include partitions and gates. The design should not obstruct the normal movement of occupants to the exit discharge. Signs, graphics, or pictograms, including tactile types, might be permitted for existing exit enclosures where partitions or gates would obstruct the normal movement of occupants to the exit discharge.

A.7.8.1.1 Illumination provided outside the building should be to either a public way or a distance away from the building that is considered safe, whichever is closest to the building being evacuated.

A.7.8.1.2.2 Photoluminescent materials and battery-powered luminaires require some period of time to restore themselves to full operational capacity after being de-energized.

Photoluminescent products rely on nearby luminaires to maintain their full capacity. When those luminaires are de-energized, the photoluminescent product will gradually deplete its capacity. Listed photoluminescent exit signs and path markers are restored to full rated capacity within one hour, and there is no known limit to the number of times they can be discharged and recharged, nor any known degradation of overall capacity or lifetime as a result of discharge/charge cycles.

De-energizing the normal (utility) power source will automatically begin the battery discharge cycle of emergency luminaires, unit equipment, and exit signs provided with battery backup. Once drained, these batteries will typically require between 24 and 72 hours, depending on the battery technology and charging circuitry design, to regain full capacity. Frequent discharge/charge cycles can reduce overall battery lifetime and, depending on battery technology, might also prematurely reduce overall battery capacity.

A.7.8.1.2.3 A consideration for the approval of automatic, motion sensor–type lighting switches, controls, timers, or controllers is whether the equipment is listed as a fail-safe device for use in the means of egress.

A.7.8.1.3(4) Some processes, such as manufacturing or handling of photosensitive materials, cannot be performed in areas provided with the minimum specified lighting levels. The use of spaces with lighting levels below 1 ft-candle (10.8 lux) might necessitate additional safety measures, such as written emergency action plans, training of new employees in emergency evacuation procedures, and periodic fire drills.

Table A.7.6 Common Path, Dead-End, and Travel Distance Limits (by occupancy)

	Common Path Limit				Dead-End Limit				Travel Distance Limit			
	Unsprinklered		Sprinklered		Unsprinklered		Sprinklered		Unsprinklered		Sprinklered	
Type of Occupancy	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**	**ft**	**m**
Assembly												
New	20/75	6.1/23[a]	20/75	6.1/23[a]	20	6.1[b]	20	6.1[b]	200	61[c]	250	76[c]
Existing	20/75	6.1/23[a]	20/75	6.1/23[a]	20	6.1[b]	20	6.1[b]	200	61[c]	250	76[c]
Educational												
New	75	23	100	30	20	6.1	50	15	150	46	200	61
Existing	75	23	100	30	20	6.1	50	15	150	46	200	61
Day Care												
New	75	23	100	30	20	6.1	50	15	150	46[d]	200	61[d]
Existing	75	23	100	30	20	6.1	50	15	150	46[d]	200	61[d]
Health Care												
New	NA	NA	100	30	NA	NA	30	9.1	NA	NA	200	61[d]
Existing	NR	NR	NR	NR	NR[e]	NR[e]	NR[e]	NR[e]	150	46[d]	200	61[d]
Ambulatory Health Care												
New	75	23[f]	100	30[f]	20	6.1	50	15	150	46	200	61
Existing	75	23[f]	100	30[f]	50	15	50	15	150	46	200	61
Detention and Correctional												
New — Use Condition II, III, IV	50	15	100	30	50	15	50	15	150	46[d]	200	61[d]
New — Use Condition V	50	15	100	30	20	6.1	20	6.1	150	46[d]	200	61[d]
Existing — Use Condition II, III, IV, V	50	15[g]	100	30[g]	NR	NR	NR	NR	150	46[d]	200	61[d]
Residential												
One- and two-family dwellings	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Lodging or rooming houses	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Hotels and dormitories												
New	35	10.7[h,i]	50	15[h,i]	35	10.7	50	15	175	53[d,j]	325	99[d,j]
Existing	35	10.7[h]	50	15[h]	50	15	50	15	175	53[d,i]	325	99[d,i]
Apartment buildings												
New	35	10.7[h]	50	15[h]	35	10.7	50	15	175	53[d,j]	325	99[d,j]
Existing	35	10.7[h]	50	15[h]	50	15	50	15	175	53[d,j]	325	99[d,j]
Board and care												
Small, new and existing	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Large, new	NA	NA	75	23[i]	NA	NA	30	9.1	NA	NA	250	76[d,j]
Large, existing	110	33	160	49	50	15	50	15	175	53[d,j]	325	99[d,j]
Mercantile												
Class A, B, C												
New	75	23	100	30	20	6.1	50	15	150	46	250	76
Existing	75	23	100	30	50	15	50	15	150	46	250	76
Open air, new and existing	NR	NR	NR	NR	0	0	0	0	NR	NR	NR	NR
Mall												
New	75	23	100	30	20	6.1	50	15	150	46	400	120[k]
Existing	75	23	100	30	50	15	50	15	150	46	400	120[k]
Business												
New	75	23[l]	100	30[l]	20	6.1	50	15	200	61	300	91
Existing	75	23[l]	100	30[l]	50	15	50	15	200	61	300	91

Table A.7.6 *Continued*

Type of Occupancy	Common Path Limit				Dead-End Limit				Travel Distance Limit			
	Unsprinklered		Sprinklered		Unsprinklered		Sprinklered		Unsprinklered		Sprinklered	
	ft	m	ft	m	ft	m	ft	m	ft	m	ft	m
Industrial												
General	50	15	100	30	50	15	50	15	200	61[m]	250	75[n]
Special purpose	50	15	100	30	50	15	50	15	300	91	400	122
High hazard	0	0	0	0	0	0	0	0	0	0	75	23
Aircraft servicing hangars, finished ground level floor	50	15[o]	100	30[o]	50	15[o]	50	15[o]	footnote m	footnote m	footnote m	footnote m
Aircraft servicing hangars, mezzanine floor	50	15[o]	75	23[o]	50	15[o]	50	15[o]	75	23	75	23
Storage												
Low hazard	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR	NR
Ordinary hazard	50	15	100	30	50	15	100	30	200	61	400	122
High hazard	0	0	0	0	0	0	0	0	75	23	100	30
Parking structures, open[p]	50	15	50	15	50	15	50	15	300	91	400	122
Parking structures, enclosed	50	15	50	15	50	15	50	15	150	46	200	60
Aircraft storage hangars, finished ground level floor	50	15[o]	100	30[o]	50	15[o]	50	15[o]	footnote m	footnote m	footnote m	footnote m
Aircraft servicing hangars, mezzanine floor	50	15[o]	75	23[o]	50	15[o]	50	15[o]	75	23	75	23
Underground spaces in grain elevators	50	15[o]	100	30[o]	50	15[o]	100	30[o]	200	61	400	122

NR: No requirement. NA: Not applicable.

[a]For common path serving >50 persons, 20 ft (6.1 m); for common path serving ≤50 persons, 75 ft (23 m).

[b]Dead-end corridors of 20 ft (6.1 m) permitted; dead-end aisles of 20 ft (6.1 m) permitted.

[c]See Chapters 12 and 13 for special considerations for smoke-protected assembly seating in arenas and stadia.

[d]This dimension is for the total travel distance, assuming incremental portions have fully utilized their permitted maximums. For travel distance within the room, and from the room exit access door to the exit, see the appropriate occupancy chapter.

[e]See 19.2.5.2.

[f]See business occupancies, Chapters 38 and 39.

[g]See Chapter 23 for special considerations for existing common paths.

[h]This dimension is from the room/corridor or suite/corridor exit access door to the exit; thus, it applies to corridor common path.

[i]See the appropriate occupancy chapter for requirements for second exit access based on room area.

[j]See the appropriate occupancy chapter for special travel distance considerations for exterior ways of exit access.

[k]See 36.4.4 and 37.4.4 for special travel distance considerations in covered malls considered to be pedestrian ways.

[l]See Chapters 38 and 39 for special common path considerations for single-tenant spaces.

[m]See Chapters 40 and 42 for special requirements on spacing of doors in aircraft hangars.

[n]See Chapter 40 for industrial occupancy special travel distance considerations.

[o]See Chapters 40 and 42 for special requirements if high hazard conditions exist.

[p]See 42.8.2.6.2 for special travel distance considerations in open parking structures.

A.7.8.1.4 Failure of a lighting unit is deemed to have occurred when the light output drops below 70 percent of its original level.

A.7.9.1.1 Emergency lighting outside the building should provide illumination to either a public way or a distance away from the building that is considered safe, whichever is closest to the building being evacuated.

A.7.9.2.3 Where emergency lighting is provided by automatic transfer between normal power service and an emergency generator, it is the intent to prohibit the installation, for any reason, of a single switch that can interrupt both energy sources.

A.7.9.3.1.1(2) Technical justification for extending test intervals past 30 days should be based on recorded event history (data) and should include evaluation of the following criteria:

(1) Number of egress lighting units
(2) Number of 30-second tests for analysis
(3) Re-evaluation period (confirm or adjust intervals)
(4) Number of fixtures found obstructed
(5) Number of fixtures found misaligned
(6) Fixtures found to be missing
(7) Fixtures found damaged
(8) Battery design
(9) Type of light source
(10) Fixture design (manufacturer)
(11) Number of light fixtures per exit path
(12) Existence of fire, smoke, and thermal barriers
(13) Evacuation capability
(14) Maximum egress time
(15) Hours of occupancy
(16) Number of recorded bulb failures
(17) Number of recorded fixture failures
(18) Single fixture reliability
(19) Repairs — mean time to repair
(20) Lighted egress path probability of success or failure — monthly upper tolerance limit
(21) Lighted egress path probability of success or failure — quarterly upper tolerance limit (estimated)

A.7.10.1.2.1 Where a main entrance also serves as an exit, it will usually be sufficiently obvious to occupants so that no exit sign is needed.

The character of the occupancy has a practical effect on the need for signs. In any assembly occupancy, hotel, department store, or other building subject to transient occupancy, the need for signs will be greater than in a building subject to permanent or semipermanent occupancy by the same people, such as an apartment house where the residents are presumed to be familiar with exit facilities by reason of regular use thereof. Even in a permanent residence–type building, however, there is a need for signs to identify exit facilities, such as outside stairs that are not subject to regular use during the normal occupancy of the building.

The requirement for the locations of exit signs visible from any direction of exit access is illustrated in Figure A.7.10.1.2.1.

A.7.10.1.2.2 The direction of travel to the exit discharge within a stair enclosure with horizontal components in excess of the typical landings might need additional signage to be readily visible or obvious. Exit signs should be installed above doors through which the egress path leads. Directional exit signs should be installed where the horizontal egress path changes directions. The stairway marking signs required by 7.2.2.5.4, provided within the stair enclosure at each floor landing, indicate the vertical direction to exit discharge.

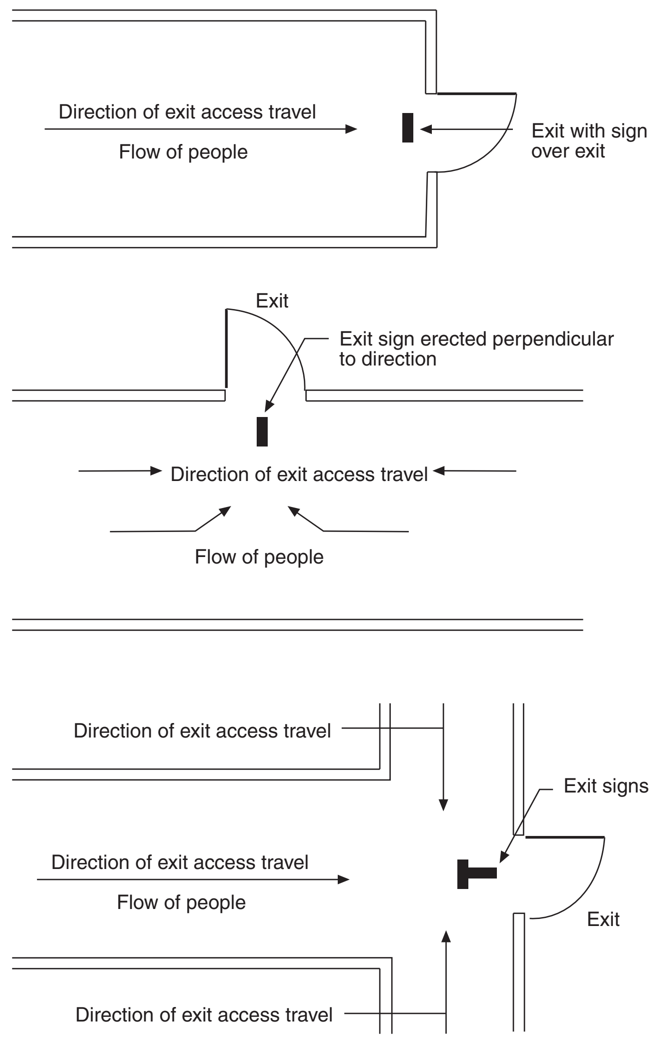


FIGURE A.7.10.1.2.1 Location of Exit Signs.

A.7.10.1.5.2 For externally illuminated signs in accordance with 7.10.6 and internally illuminated signs listed without a marked viewing distance, the rated viewing distance should be considered to be 100 ft (30 m). Where placing signs at their rated viewing distance requires them to be placed above the line of sight, consideration should be given to proportionally increasing the size of the exit legend to compensate for the additional straight-line distance between the viewer and the sign.

A.7.10.1.6 See A.7.10.3.

A.7.10.1.7 See 3.3.146.2 for the definition of the term *internally illuminated.*

A.7.10.1.8 In stores, for example, an otherwise adequate exit sign could be rendered inconspicuous by a high-intensity illuminated advertising sign located in the immediate vicinity.

Red is the traditional color for exit signs and is required by law in many places. However, at an early stage in the development of the *Code*, a provision made green the color for exit signs, following the concept of traffic lights in which green indicates safety and red is the signal to stop. During the period when green signs were specified by the *Code*, many such signs were installed, but the traditional red signs also remained. In 1949, the Fire Marshals Association of North America voted to request that red be restored as the required exit sign color, because it was found that the provision for green involved difficulties in law enactment that were out of proportion to the importance of safety. Accordingly, the 10th edition of the *Code* specified red where not otherwise required by law. The present text avoids any specific requirement for color, based on the assumption that either red or green will be used in most cases and that there are some situations in which a color other than red or green could actually provide better visibility.

A.7.10.3 Where graphics are used, the symbols provided in NFPA 170, *Standard for Fire Safety and Emergency Symbols*, should be used. Such signs need to provide equal visibility and illumination and are to comply with the other requirements of Section 7.10.

A.7.10.3.2 Pictograms are permitted to be used in lieu of, or in addition to, signs with text.

A.7.10.4 It is not the intent of this paragraph to require emergency lighting but only to have the sign illuminated by emergency lighting if emergency lighting is required and provided.

It is not the intent to require that the entire stroke width and entire stroke height of all letters comprising the word EXIT be visible per the requirements of 7.10.6.3 under normal or emergency lighting operation, provided that the sign is visible and legible at a 100 ft (30 m) distance under all room illumination conditions.

A.7.10.5.1 See A.7.8.1.3(4).

A.7.10.5.2 It is the intent to prohibit the use of a freely accessible light switch to control the illumination of either an internally or externally illuminated exit sign.

A.7.10.5.2.2 The flashing repetition rate should be approximately one cycle per second, and the duration of the off-time should not exceed ¼ second per cycle. During on-time, the illumination levels need to be provided in accordance with 7.10.6.3. Flashing signs, when activated with the fire alarm system, might be of assistance.

A.7.10.6.1 Experience has shown that the word EXIT, or other appropriate wording, is plainly legible at 100 ft (30 m) if the letters are as large as specified in 7.10.6.1.

A.7.10.6.2 Figure A.7.10.6.2 shows examples of acceptable locations of directional indicators with regard to left and right orientation. Directional indicators are permitted to be placed under the horizontal stroke of the letter T, provided that spacing of not less than ⅜ in. (10 mm) is maintained from the horizontal and vertical strokes of the letter T.

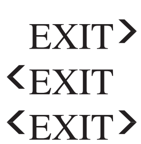


FIGURE A.7.10.6.2 Directional Indicators.

A.7.10.6.3 Colors providing a good contrast are red or green letters on matte white background. Glossy background and glossy letter colors should be avoided.

The average luminance of the letters and background is measured in footlamberts or candela per square meter. The contrast ratio is computed from these measurements by the following formula:

$$\text{Contrast} = \frac{L_g - L_e}{L_g} \qquad \textbf{[A.7.10.6.3]}$$

Where L_g is the greater luminance and L_e is the lesser luminance, either the variable L_g or L_e is permitted to represent the letters, and the remaining variable will represent the background. The average luminance of the letters and background can be computed by measuring the luminance at the positions indicated in Figure A.7.10.6.3 by numbered circles.

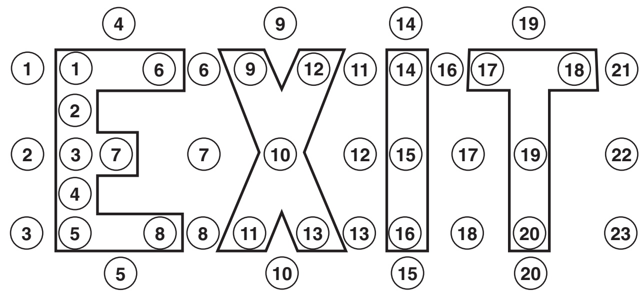


FIGURE A.7.10.6.3 Measurement of Exit Sign Luminance.

A.7.10.7.2 Photoluminescent signs need a specific minimum level of light on the face of the sign to ensure that the sign is charged for emergency operation and legibility in both the normal and emergency modes. Additionally, the type of light source (e.g., incandescent, fluorescent, halogen, metal halide) is important. Each light source produces different types of visible and invisible light (e.g., UV) that might affect the ability of some photoluminescent signs to charge and might also affect the amount of light output available during emergency mode. This type of sign would not be suitable where the illumination levels are permitted to decline. The charging light source should not be connected to automatic timers, because continuous illumination of the sign is needed; otherwise, the sign illumination would not be available, because it would be discharged.

A.7.10.8.1.1 Special signs require sufficient illumination in order for them to be readable at close proximity. They are not expected to be of a size or illumination level necessary to be readable from a distance, as is the case for an exit sign.

A.7.10.8.3 The likelihood of occupants mistaking passageways or stairways that lead to dead-end spaces for exit doors and becoming trapped governs the need for exit signs. Thus, such areas should be marked with a sign that reads as follows:

NO EXIT

Supplementary identification indicating the character of the area, such as TO BASEMENT, STOREROOM, LINEN CLOSET, or the like, is permitted to be provided.

A.7.10.8.4(1) These signs are to be used in place of signs that indicate that elevators are not to be used during fires. Examples of these signs include the following:

In the Event of Fire, This Elevator Will Be Used

by the Fire Department for Evacuation of People.

PROTECTED ELEVATOR —

USABLE IN EMERGENCIES

A.7.10.8.4(2) The wording of these signs should reflect human behavior in fires and the control specifics of the elevator system. Subparagraph 7.10.8.4 addresses signs, but provisions for notification of the vision impaired need to be considered. For information about human behavior with respect to elevator evacuation, see Groner and Levin, "Human Factor Considerations in the Potential for Using Elevators in Building Emergency Evacuation Plans"; Levin and Groner, "Human Behavior Aspects of Staging Areas for Fire Safety in GSA Buildings"; and Levin and Groner, "Human Factor Considerations for the Potential Use of Elevators for Fire Evacuation of FAA Air Traffic Control Towers." Some examples of messages on signs that could be displayed are shown in Table A.7.10.8.4(2).

Table A.7.10.8.4(2) Elevator Status Messages

Elevator Status	Message
Normal use	Elevator in Service
Elevators recalled and waiting for fire service	Please Wait for Fire Department or Use Stairs
Elevator out of service	Elevator Out of Service

A.7.10.8.5 Egress paths with multiple turns can often be confusing with respect to which exit route will lead to the closest exit door. Floor evacuation diagrams can eliminate the guesswork by giving the occupant a point of reference by the YOU ARE HERE symbol. The entire floor plan should be shown with the primary and secondary exit routes, exit stairs, and elevators clearly identified. For further information, see ASTM E 2238, *Standard Guide for Evacuation Route Diagrams*.

A.7.11.1 Seventy-five feet (23 m) can be traversed in approximately 10 seconds to 15 seconds, even when allowing for a momentary delay to decide which way to go, during which it can be assumed that the average individual can hold his or her breath.

A.7.13.1 29 CFR 1910.146 of the OSHA regulations describes the aspects of normally unoccupied areas. For example, hazardous atmosphere criteria are presented, and asphyxiation risk due to an entrance becoming engulfed are addressed. The areas described by 29 CFR 1910.146, "Permitted Required Confined Spaces," would be considered hazardous if located within a building or structure regulated by NFPA 101.

A.7.13.2.1 Egress from normally unoccupied building service equipment support areas not exceeding 45,000 ft^2 (4180 m^2) is permitted to be by access panels or other hardware not complying with the door requirements of 7.2.1.

A.7.14.1.1 The Phase I emergency recall operation mandated by the fire fighters' emergency operation provisions of ASME A17.1/CSA B 44, *Safety Code for Elevators and Escalators*, recalls elevators upon detection of smoke by smoke detectors installed in the following locations:

(1) At each floor served by the elevator in the lobby (landing) adjacent to the hoistway doors
(2) In the associated elevator machine/control room or machinery/control space
(3) In the elevator hoistway where sprinklers are located in the hoistway

Where smoke from a fire remote from the elevator lobby (landing), elevator machine/control room or machinery/control space, and elevator hoistway can be kept from reaching the elevator lobby (landing), elevator machine/control room or machinery/control space, and elevator hoistway, the associated elevators can continue to operate in a fire emergency. The provisions of Section 7.14 address the features that need to be provided to make such elevator operation safe for evacuation.

A.7.14.1.3 The occupant evacuation operation requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* address the elevator-related features for occupant evacuation elevators — features for which an elevator code has jurisdiction. The requirements were written assuming that necessary and complementary provisions that are not within the purview of an elevator code would be addressed in building, life safety, and fire codes. ASME A17.1/CSA B44 Annex T, titled "Building Features for Elevator Occupant Evacuation Operation (OEO)," lists the building construction features assumed to be present for coordinated use with its provisions for OEO.

A.7.14.3.1 Building occupants have traditionally been taught not to use elevators in fire or similar emergencies. The emergency action plan should include more than notification that the elevators can be used for emergency evacuation. The plan should include training to make occupants aware that the elevators will be available only for the period of time prior to elevator recall via smoke detection in the elevator lobby, elevator machine/control room or machinery/control space, or elevator hoistway. Occupants should be prepared to use the exit stairs, which are required to be directly accessible from the elevator lobby by 7.14.9.3, where the elevator has been called out of service.

A.7.14.4.2 The emergency voice/alarm communication system with the ability to provide voice directions on a selective basis to any building floor might be used to instruct occupants of the fire floor who are able to use stairs to relocate to a floor level below. The selective voice notification feature might be used to provide occupants of a given elevator lobby with a status report or supplemental instructions.

A.7.14.4.3 An audible notification appliance will need to be positioned in the elevator lobby in order to meet the requirement of 7.14.3.4. The continued use of the occupant evacuation elevator system is predicated on elevator lobby doors that are closed to keep smoke from reaching the elevator lobby smoke detector that is arranged to initiate the Phase I emergency recall operation.

A.7.14.5.2 The presence of sprinklers in the elevator machine/control room or machinery/control space would necessitate the installation of a shunt trip for automatically disconnecting the main line power for compliance with ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* as it is unsafe to operate elevators while sprinkler water is being discharged in the elevator machine/control room or machinery/control space. The presence of a shunt trip conflicts with the needs of the occupant evacuation elevator, as it disconnects the power without ensuring that the elevator is first returned to a safe floor so as to prevent trapping occupants.

A.7.14.5.3 NFPA 13, *Standard for the Installation of Sprinkler Systems*, permits sprinklers to be omitted from the top of the elevator hoistway where the hoistway for passenger elevators is noncombustible and the car enclosure materials meet the requirements of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. The provision of 7.14.5.3 restricts occupant evacuation elevators to passenger elevators that are in noncombustible hoistways and for which the car enclosure materials meet the requirements of ASME A17.1/CSA B 44.

A.7.14.6.2 Elevator shunt breakers are intended to disconnect the electric power to an elevator prior to sprinkler system waterflow impairing the functioning of the elevator. The provision of 7.14.5.2 prohibits the installation of sprinklers in the elevator machine/control room or machinery/control space and at the top of the elevator hoistway, obviating the need for shunt breakers. The provision of 7.14.6.2 is not actually an exemption to the provisions of ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, as ASME A17.1/CSA B44 requires the automatic main line power disconnect (shunt trip) only where sprinklers are located in the elevator machine/control room or machinery/control space or in the hoistway where it could cause unsafe elevator operation. The provision of 7.14.5.2 prohibits sprinklers in the elevator machine/control room and machinery/control space. The provision of 7.14.5.3 prohibits sprinklers at the top of the hoistway and at other points in the hoistway more than 24 in. (610 mm) above the pit floor in recognition of the limitations on combustibility established by 7.14.6.3.

A.7.14.7.1 The minimum 2-hour fire resistance–rated separation is based on the omission of sprinklers from the elevator machine room in accordance with 7.14.5.3.

A.7.14.7.2 The requirement of 7.14.7.2 is consistent with that in ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, which permits only machinery and equipment used in conjunction with the function or use of the elevator to be in the elevator machine/control room or machinery/control space. An inspection program should be implemented to ensure that the elevator machine/control room or machinery/control space is kept free of storage.

A.7.14.8.3 Wiring or cables that provide control signals are exempt from the protection requirements of 7.14.8.2, provided that such wiring or cables, where exposed to fire, will not disable Phase II emergency in-car operation once such emergency operation has been activated.

A.7.14.9.2 Elevator lobbies provide a safe place for building occupants to await the elevators and extend the time available for such use by providing a barrier to smoke and heat that might threaten the elevator car or hoistway. Smoke detectors within the elevator lobbies are arranged to initiate a Phase I emergency recall operation if the lobby is breached by smoke.

A.7.14.9.6 The performance-based language of 7.14.9.6 permits alternate design options to prevent water from an operating sprinkler system from infiltrating the hoistway enclosure. For example, such approved means might include drains and sloping the floor. The objective of the water protection requirement is to limit water discharged from sprinklers operating on the floor of fire origin from entering the hoistway, as it might by flowing into the lobby and under the landing doors, interfering with safety controls normally located on the front of the elevator car. A small flow of water (of the order of the flow from a single sprinkler) should be able to be diverted by the landing doorway nose plate to the sides of the opening, where it can do little harm. The requirement is intended to protect from water from sprinklers outside the elevator lobby, since the activation of sprinklers in the lobby would be expected to be preceded by activation of the lobby smoke detector that recalls the elevators.

Water protection can be achieved in any of several ways. Mitigation features that should be effective in keeping the waterflow from a sprinkler out of the hoistway include the following:

(1) Raised lip in accordance with 7.1.6.2 and a floor drain
(2) Sloped floor and a floor drain
(3) Sealed sill plates and baseboards on both sides of the lobby partitions and along the perimeter of the hoistway shaft

A.8.2.1.2 Table A.8.2.1.2 is from *NFPA 5000*, *Building Construction and Safety Code*, and is reproduced in this annex for the convenience of users of this *Code*.

It is not the intent to require exterior walls to be protected against exterior fire exposure except where specifically required by NFPA 220 or *NFPA 5000*. Other building codes might also require protection from the exterior in some circumstances. The presence of fire sprinklers or an occupiable exterior space, such as a porch or balcony, does not require protection against exterior fire exposure unless specifically required elsewhere.

A.8.2.3.1 ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, and ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, are considered nationally recognized methods of determining fire resistance and have been found to yield equivalent test results.

A.8.2.4.2 The intent of this provision is to allow the provisions of either ASCE/SFPE 29, *Standard Calculation Methods for Structural Fire Protection*, or ACI 216.1/TMS 0216.1 *Code Requirements for Determining Fire Resistance of Concrete and Masonry Construction Assemblies,* for the calculation for fire resistance of concrete or masonry elements or assemblies.

A.8.3.1.1(4) Walls in good condition with lath and plaster, or gypsum board of not less than ½ in. (13 mm) on each side, can be considered as providing a minimum ½-hour fire resistance rating. Additional information on archaic material assemblies can be found in Annex O of NFPA 914, *Code for Fire Protection of Historic Structures*.

A.8.3.1.2 To ensure that a fire barrier is continuous, it is necessary to seal completely all openings where the fire barrier abuts other fire barriers, the exterior walls, the floor below, and the floor or ceiling above. In 8.3.1.2(2), the fire resistance rating of the bottom of the interstitial space is provided by that membrane alone. Ceilings of rated floor/ceiling and roof/ceiling assemblies do not necessarily provide the required fire resistance.

A.8.3.2.1.1 Fire resistance–rated glazing complying with 8.3.2, where not installed in a door, is considered a wall, not an opening protective.

A.8.3.3.2 Some door assemblies have been tested to meet the conditions of acceptance of ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*. Where such assemblies are used, the provisions of 8.3.2 should be applied instead of those of 8.3.3.2.

A.8.3.3.2.3 In existing installations, it is important to be able to determine the fire protection rating of the fire door. However, steel door frames that are well set in the wall might be judged as acceptable even if the frame label is not legible.

A.8.3.3.6 Some window assemblies have been tested to meet the conditions of acceptance of ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or ANSI/UL 263, *Standard for Fire Tests of Building Construction and*

Table A.8.2.1.2 Fire Resistance Ratings for Type I Through Type V Construction (hours)

	Type I		Type II			Type III		Type IV	Type V	
Construction Element	**442**	**332**	**222**	**111**	**000**	**211**	**200**	**2HH**	**111**	**000**
Exterior Bearing Walls [a]										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting one floor only	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting a roof only	4	3	1	1	0[b]	2	2	2	1	0[b]
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses, and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor-Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof-Ceiling Assemblies	2	1½	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls [c]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]

H: Heavy timber members *(see NFPA 5000 for requirements).*
[a]See 7.3.2.1 of *NFPA 5000.*
[b]See Section 7.3 of *NFPA 5000.*
[c]See 7.2.3.2.12, 7.2.4.2.3, and 7.2.5.6.8 of *NFPA 5000.*
[***5000:*** Table 7.2.1.1]

Materials. Where such assemblies are used, the provisions of 8.3.2 should be applied instead of those of 8.3.3.6.

A.8.3.4.2 Longer ratings might be required where opening protectives are provided for property protection as well as life safety. NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* should be consulted for standard practice in the selection and installation of fire door assemblies and fire window assemblies.

Table 8.3.4.2. A vision panel in a fire door is not a fire window, and, thus, it is not the intent of the "NP" notations in the "Fire Window Assemblies" column of Table 8.3.4.2 to prohibit vision panels in fire doors.

A.8.3.5.1 Firestop materials become systems when installed to the listed firestop system design from an accredited testing laboratory. Installation of firestop materials to the listed system should meet all limitations of the system.

There are management system–based contractor approval or qualification programs offered by third-party, independent companies that quantifiably qualify a company to install firestop materials that become systems after proper installation. In each program, there is an industry firestop exam that gives the company a basis to appoint a "Designated Responsible Individual."

Then, the third-party firm audits the firestop company's product and systems documentation records in conjunction with the company's management system operational policies and procedures to verify company compliance. An audit also takes place on a project site to verify that the management system is working.

Where the configuration of a penetrating item or group of items is such that a listed system is determined to be nonexistent and reconfiguration of the penetrations or fire resistance–rated assembly is determined to be impractical or impossible, alternative methods for maintaining the integrity of the required fire resistance rating of the assembly should be permitted to be established using an engineering analysis based on a comparison of listed systems prepared by a manufacturer's technical representative of the systems specified, by the laboratory that conducted the original test, or by a professional engineer.

ASTM E 2174, *Standard Practice for On-Site Inspection of Installed Fire Stops,* provides guidance for the inspection of through-penetration firestop systems tested in accordance with ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, and ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*.

Independent inspection paid for by the owner is in many specifications and referenced in this appendix using ASTM E 2174 and ASTM E 2393, *Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers*. As a result, there is an accreditation program available for firestop special inspection agencies.

A.8.3.5.6.3(1)(c) Criteria associated with fireblocking can be found in 8.14.2 of *NFPA 5000, Building Construction and Safety Code*.

A.8.3.6.5 Materials used to protect joints become systems when installed to the listed joint system design from an accredited testing laboratory. Installation of joint materials to the listed system should meet all limitations of the system.

There are management system–based contractor approval or qualification programs offered by third-party, independent companies that quantifiably qualify a company to install firestop materials that become systems after proper installation. In each program, there is an industry firestop exam that gives the company a basis to appoint a "Designated Responsible Individual."

Then, the third-party firm audits the firestop company's product and systems documentation records in conjunction with the company's management system operational policies and procedures to verify company compliance. An audit also takes place on a project site to verify that the management system is working.

Where the configuration of a joint is such that a listed system is determined to be nonexistent and reconfiguration of the joint or fire resistance–rated assembly is determined to be impractical or impossible, alternative methods for maintaining the integrity of the required fire resistance rating of the assembly should be permitted to be established using an engineering analysis based on a comparison of listed systems prepared by a manufacturer's technical representative of the systems specified, by the laboratory that conducted the original test, or by a professional engineer.

On-site inspection of firestopping is important in maintaining the integrity of any vertical or horizontal fire barrier. Two standard practice documents were developed with the ASTM process to allow inspections of through-penetration firestops, joints, and perimeter fire barrier systems. ASTM E 2393, *Standard Practice for On-Site Inspection of Installed Fire Resistive Joint Systems and Perimeter Fire Barriers*, provides guidance for the inspection of fire-resistive joints and perimeter fire barrier joint systems tested in accordance with the requirements of ASTM E 1966, *Standard Test Method for Fire-Resistive Joint Systems*, or with ANSI/UL 2079, *Standard for Tests for Fire Resistance of Building Joint Systems*. ASTM E 2393 contains a standardized report format, which would lead to greater consistency for inspections.

Independent inspection paid for by the owner is in many specifications and referenced in this appendix using ASTM E 2393. As a result, there is an accreditation program available for firestop special inspection agencies.

A.8.3.6.7 The provisions of 8.3.6.7 are intended to restrict the interior vertical passage of flame and hot gases from one floor to another at the location where the floor intersects the exterior wall assembly. The requirements of 8.3.6.7 mandate sealing the opening between a floor and an exterior wall assembly to provide the same fire performance as that required for the floor. ASTM E 2307, *Standard Test Method for Determining Fire Resistance of Perimeter Fire Barrier Systems Using Intermediate-Scale, Multi-Story Test Apparatus*, is a test method for evaluating the performance of perimeter fire barrier systems. Some laboratories have tested and listed perimeter fire barrier systems essentially in accordance with the ASTM method. The ASTM test method evaluates the performance of perimeter fire barrier systems in terms of heat transfer and fire spread inside a building through the floor/exterior wall intersection. The current test method does not assess the ability of perimeter fire barrier systems to prevent the spread of fire from story to story via the exterior. However, some laboratories have included additional temperature measurement criteria in their evaluation of the exterior wall, and also evaluate vision glass breakage, as additional pass/fail criteria in an attempt to at least partially address this leapfrog effect.

A.8.4.1 Although a smoke partition is intended to limit the free movement of smoke, it is not intended to provide an area that would be free of smoke.

A.8.4.2(2) An architectural, exposed, suspended-grid acoustical tile ceiling with penetrations for sprinklers, ducted HVAC supply and return-air diffusers, speakers, and recessed light fixtures is capable of limiting the transfer of smoke.

A.8.4.3.4 Gasketing of doors should not be necessary, as the clearances in NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, effectively achieve resistance to the passage of smoke if the door is relatively tight-fitting.

A.8.4.6.2 An air-transfer opening, as defined in NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, is an opening designed to allow the movement of environmental air between two contiguous spaces.

A.8.5.1 Wherever smoke barriers and doors therein require a degree of fire resistance, as specified by requirements in the various occupancy chapters (Chapters 12 through 42), the construction should be a fire barrier that has been specified to limit the spread of fire and restrict the movement of smoke.

Although a smoke barrier is intended to restrict the movement of smoke, it might not result in tenability throughout the adjacent smoke compartment. The adjacent smoke compartment should be safer than the area on the fire side, thus allowing building occupants to move to that area. Eventually, evacuation from the adjacent smoke compartment might be required.

A.8.5.2 To ensure that a smoke barrier is continuous, it is necessary to seal completely all openings where the smoke barrier abuts other smoke barriers, fire barriers, exterior walls, the floor below, and the floor or ceiling above. It is not the intent to prohibit a smoke barrier from stopping at a fire barrier if the fire barrier meets the requirements of a smoke barrier (i.e., the fire barrier is a combination smoke barrier/fire barrier).

A.8.5.4.1 For additional information on the installation of smoke control door assemblies, see NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*.

A.8.5.4.4 Where, because of operational necessity, it is desired to have smoke barrier doors that are usually open, such doors should be provided with hold-open devices that are activated to close the doors by means of the operation of smoke detectors and other alarm functions.

A.8.6.2 Openings might include items such as stairways; hoistways for elevators, dumbwaiters, and inclined and vertical conveyors; shaftways used for light, ventilation, or building services; or expansion joints and seismic joints used to allow structural movements.

A.8.6.5 The application of the 2-hour rule in buildings not divided into stories is permitted to be based on the number of levels of platforms or walkways served by the stairs.

A.8.6.6(7) Given that a mezzanine meeting the maximum one-third area criterion of 8.6.10.2.1 is not considered a story, it is permitted, therefore, to have 100 percent of its exit access within the communicating area run back through the story below.

A.8.6.7 Where atriums are used, there is an added degree of safety to occupants because of the large volume of space into which smoke can be dissipated. However, there is a need to ensure that dangerous concentrations of smoke are promptly removed from the atrium, and the exhaust system needs careful design. For information about systems that can be used to provide smoke protection in these spaces, see the following:

(1) NFPA 92, *Standard for Smoke Control Systems*
(2) *Principles of Smoke Management*

A.8.6.7(1)(c) The intent of the requirement for closely spaced sprinklers is to wet the atrium glass wall to ensure that the surface of the glass is wet upon operation of the sprinklers, with a maximum spacing of sprinklers of 6 ft (1830 mm) on centers. Provided that it can be shown that the glass can be wet by the sprinklers using a given discharge rate, and that the 6 ft (1830 mm) spacing is not exceeded, the intent of the requirement is met. It is important that the entire glass area surface is wet. Due consideration should be given to the height of the glass panels and any horizontal members that might interfere with sprinkler wetting action.

A.8.6.7(5) See NFPA 92, *Standard for Smoke Control Systems*. The engineering analysis should include the following elements:

(1) Fire dynamics, including the following:
    (a) Fire size and location
    (b) Materials likely to be burning
    (c) Fire plume geometry
    (d) Fire plume or smoke layer impact on means of egress
    (e) Tenability conditions during the period of occupant egress
(2) Response and performance of building systems, including passive barriers, automatic detection and extinguishing, and smoke control
(3) Response time required for building occupants to reach building exits, including any time required to exit through the atrium as permitted by 8.6.7

A.8.6.7(6) Activation of the ventilation system by manual fire alarms, extinguishing systems, and detection systems can cause unwanted operation of the system, and it is suggested that consideration be given to zoning of the activation functions so the ventilation system operates only when actually needed.

A.8.6.9.1(4) The intent of this requirement is to prohibit a communication of two compartments on the same floor via two convenience openings. This is represented in Figure A.8.6.9.1(4).

A.8.6.9.1(6) This requirement prohibits means of egress down or up the convenience opening. It does not prohibit means of escape from running down or up the convenience opening within residential dwelling units.

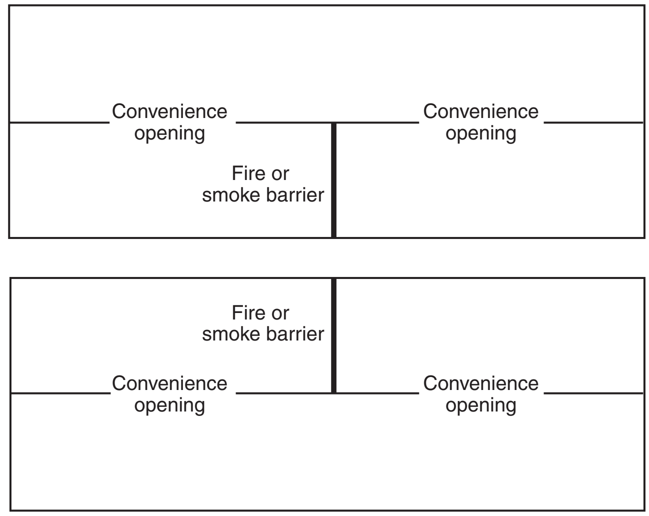


FIGURE A.8.6.9.1(4) Examples of Convenience Openings That Communicate with Two Compartments on Same Floor in Violation of 8.6.9.1(4).

A.8.6.9.2(3) Draftstops protecting vertical openings that are defined in the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, are curtain style descending from the ceiling surface or plane.

A.8.6.9.7(2) The intent is to place a limitation on the size of the opening to which the protection applies. The total floor opening should not exceed twice the projected area of the escalator or moving walk at the floor. Also, the arrangement of the opening is not intended to circumvent the requirements of 8.6.7.

As with any opening through a floor, the openings around the outer perimeter of the escalators should be considered as vertical openings.

A.8.6.11.2(2) See NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

A.8.6.11.3 A wood structural panel is a panel manufactured from veneers, or wood strands or wafer, or a combination of veneer and wood strands or wafers bonded together with waterproof synthetic resins or other suitable bonding systems, including composite panels, oriented strand board, and plywood.

A.8.7.1.1 Areas requiring special hazard protection include, but are not limited to, areas such as those used for storage of combustibles or flammables, areas housing heat-producing appliances, or areas used for maintenance purposes.

A.8.7.2 For details, see NFPA 68, *Standard on Explosion Protection by Deflagration Venting*.

A.8.7.3.2 NFPA 58, *Liquefied Petroleum Gas Code*, permits portable butane-fueled appliances in restaurants and in attended commercial food catering operations where fueled by not in excess of two 10 oz (0.28 kg) LP-Gas capacity, nonrefillable butane containers having a water capacity not in excess of 1.08 lb (0.4 kg) per container. Containers are required to be directly connected to the appliance, and manifolding of containers is not permitted. Storage of cylinders is also limited to 24 containers, with an additional 24 permitted where protected by a 2-hour fire resistance–rated barrier.

A.8.7.3.3 The total quantities of flammable liquids in any area should comply with the provisions of other recognized codes, including NFPA 1, *Fire Code*, and NFPA 30, *Flammable and Combustible Liquids Code*. In addition, special consideration should be given to the following:

(1) Obstructions created by the installation of hand-rub solution dispensers
(2) Location of dispensers with regard to adjacent combustible materials and potential sources of ignition, especially where dispensers are mounted on walls of combustible construction
(3) Requirements for other fire protection features, including complete automatic sprinkler protection, to be installed throughout the compartment
(4) Amount and location of the flammable solutions, both in use and in storage, particularly with respect to potential for leakage or failure of the dispenser

A.8.7.5 While the scope of NFPA 99, *Health Care Facilities Code*, is limited to health care occupancies, it is the intent that this requirement be applied to hyperbaric facilities used in all occupancies.

A.8.8 Doors covered by this section include smoke barrier doors, doors in smoke partitions, and doors serving hazardous areas. Paragraph 7.2.1.15 addresses inspection and testing of means of egress doors. Paragraph 8.2.2.4 addresses maintenance of doors required to be smoke leakage. Paragraph 8.3.3.13 addresses the inspection and testing of fire doors.

A.9.4.1 Under certain conditions, elevators are recognized as means of egress.

The use of elevators for emergency evacuation purposes, where operated by trained emergency service personnel (e.g., building personnel, fire personnel), should be incorporated into the building evacuation program. Elevators are normally capable of manual, in-car fire fighter operation (Phase II) after elevator recall (Phase I). In addition, there usually are two or more shafts wherever there are more than three elevators, which further enhances the possibilities for elevator use during an emergency evacuation where operated by trained personnel.

In high-rise buildings, in towers, or in deep underground spaces where travel over considerable vertical distance on stairs can cause persons incapable of such physical effort to collapse before they reach the street exit, stairways are permitted to be used for initial escape from the immediate area of danger, and elevators are permitted to be used to complete the travel to the street.

It can be reasonably assumed that, in all buildings of sufficient height to indicate the need for elevators, elevators will be provided for normal use; for this reason, no requirements for mandatory installation of elevators are included in the *Code*.

For additional information on elevators, see ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators,* and ASME A17.3, *Safety Code for Existing Elevators and Escalators*.

A.9.4.5 Continued operation of solid-state elevator equipment is contingent on maintaining the ambient temperature in the range specified by the elevator manufacturer. If the machine room ventilation/air-conditioning is connected to the general building system, and that system is shut down during a fire, the fire department might lose the use of elevators due to excessive heat in the elevator machine room.

A.9.6.1 The provisions of Section 9.6 cover the basic functions of a complete fire alarm system, including fire detection, alarm, and communications. These systems are primarily intended to provide the indication and warning of abnormal conditions, the summoning of appropriate aid, and the control of occupancy facilities to enhance protection of life.

Some of the provisions of Section 9.6 originated with *NFPA 72, National Fire Alarm and Signaling Code*. For purposes of this *Code*, some provisions of Section 9.6 are more stringent than those of *NFPA 72*, which should be consulted for additional details.

A.9.6.1.4 Records of conducted maintenance and testing and a copy of the certificate of compliance should be maintained.

A.9.6.1.5 A fire watch should at least involve some special action beyond normal staffing, such as assigning an additional security guard(s) to walk the areas affected. Such individuals should be specially trained in fire prevention and in occupant and fire department notification techniques, and they should understand the particular fire safety situation for public education purposes. *(Also see NFPA 601, Standard for Security Services in Fire Loss Prevention.)*

The term *out of service* in 9.6.1.5 is intended to imply that a significant portion of the fire alarm system is not in operation, such as an entire initiating device, signaling line, or notification appliance circuit. It is not the intent of the *Code* to require notification of the authority having jurisdiction, or evacuation of the portion of the building affected, for a single nonoperating device or appliance.

A.9.6.2.5 It is not the intent of 9.6.2.5 to require manual fire alarm boxes to be attached to movable partitions or to equipment, nor is it the intent to require the installation of permanent structures for mounting purposes only.

A.9.6.2.6 The manual fire alarm box required by 9.6.2.6 is intended to provide a means to manually activate the fire alarm system when the automatic fire detection system or waterflow devices are out of service due to maintenance or testing, or where human discovery of the fire precedes automatic sprinkler system or automatic detection system activation. Where the fire alarm system is connected to a monitoring facility, the manual fire alarm box required by 9.6.2.6 should be connected to a separate circuit that is not placed "on test" when the detection or sprinkler system is placed on test. The manual fire alarm box should be located in an area that is accessible to occupants of the building and should not be locked.

A.9.6.2.7 Manual fire alarm boxes can include those with key-operated locks for detention areas or psychiatric hospitals, manual fire alarm boxes in areas where explosive vapors or dusts might be a hazard, or manual fire alarm boxes in areas with corrosive atmospheres. The appearance of manual fire alarm boxes for special uses often differs from those used in areas of normal occupancy. Manual fire alarm boxes, such as those with locks, that are located in areas where the general public has limited access might need to have signage advising persons to seek assistance from staff in the event a fire is noted.

A.9.6.2.10.3 *NFPA 72, National Fire Alarm and Signaling Code*, mandates smoke alarms in all sleeping rooms, and interconnection of smoke alarms is required for both new and existing installations. Per 9.6.2.10.1, the residential occupancy chapters determine whether smoke alarms are needed within sleeping rooms. Paragraph 9.6.2.10.3 limits the requirement for interconnection of smoke alarms to those in new construction. This *Code* does not intend to require compliant, existing smoke alarm installations to be interconnected. This *Code* is periodically revised to add retrospective requirements only where the need is clearly substantiated.

A.9.6.2.10.4 As per annex material located in A.29.5.1 of *NFPA 72*, it is not normally recommended that smoke alarms or smoke detectors be placed in kitchen spaces. This section of the code provides guidelines for safe installation if a need exists to install a smoke alarm or smoke detector in a residential kitchen space or cooking area.

Within this *Code* section, a fixed cooking appliance is any appliance that is intended to be permanently connected electrically to the wiring system or the fuel source. A stationary cooking appliance is any appliance that is intended to be fastened in place or located in a dedicated space and is connected to the supply circuit or fuel source.

Smoke alarms and smoke detectors that are currently available to consumers are susceptible to particles released into the air during normal cooking procedures. If smoke alarms and smoke detectors are placed too close to the area where the cooking source originates, a high level of nuisance alarms can occur. Frequent nuisance alarms can result in an occupant disabling the smoke alarm or smoke detector.

Nuisance alarm studies show that commercially available residential smoke alarms and smoke detectors are susceptible to nuisance alarms when installed too close to cooking appliances. As the horizontal distance between the smoke alarm or smoke detectors and the cooking appliance increases, the frequency of nuisance alarms decreases. Smoke alarms or smoke detectors that use ionization smoke detection have been shown to be more susceptible to cooking nuisance alarms than those that use photoelectric smoke detection when the alarms or detectors are installed within 10 ft (3.0 m) along a horizontal smoke travel path from a cooking appliance. Smoke alarms or smoke detectors that use photoelectric smoke detection produce nuisance alarms when installed less than 10 ft (3.0 m) from a cooking appliance, though to a lesser degree.

The occurrence of the higher frequency of nuisance alarms observed in smoke alarms or smoke detectors that use ionization detection have been documented in the fire research data. Due to the differences in technology between ionization detection and photoelectric detection, the sensitivity typically used for ionization detection is much higher than that used for photoelectric detection. This sensitivity difference is a result of each type of the detection being required to satisfy UL 217, *Single and Multiple Station Smoke Alarms*, performance tests. Removing detection technology from consideration, the frequency of nuisance alarms is solely due to the sensitivity of the detection method used. Thus, both ionization and photoelectric detector technologies will produce nuisance alarms due to cooking, but currently available smoke alarms and smoke detectors that use ionization detection typically produce more cooking related nuisance alarms.

The higher sensitivities of currently available smoke alarms and smoke detectors that use ionization detection do provide a benefit at the expense of a potentially higher rate of cooking-related nuisance alarms. Research has demonstrated that ionization detection will typically respond faster than photoelectric detection to flaming fires, providing earlier warning to occupants that might allow for quicker intervention or faster egress. In general, the installation of smoke alarms or smoke detectors that use ionization detection will result in increased fire safety at the risk of a higher frequency of nuisance alarms. The installation of smoke alarms or smoke detectors that use photoelectric detection will result in reduced fire safety for flaming fires and a reduced risk of nuisance alarms. Based on the trade-off between faster response to fires and the frequency of nuisance alarms, detectors that utilize both technologies (i.e., ionization, photoelectric, and a combination) are allowed to be installed between 10 ft (3.0 m) and 20 ft (6.1 m) along a horizontal flow path from a standard or fixed cooking appliance if the specific detector is equipped with an alarm silencing means or is of the photoelectric type. Nuisance alarm studies provide data on cooking nuisances that emanate from both fixed cooking appliances and stationary cooking appliances (e.g., stove, oven) as well as portable cooking appliances (e.g., toaster). Based on these studies, which demonstrate the potential of all cooking appliances to generate nuisance sources, a zone of exclusion has been specified surrounding each stationary or fixed cooking appliance. The purpose of this zone is to limit the installation of smoke alarms and detectors in areas where stationary, fixed, or portable cooking appliances will be located within the residential kitchen space such that potential nuisance alarms are minimized. The size of the zone of exclusion is specified to attempt to take into account the unknown and transitory locations of portable cooking appliances. This zone of exclusion is determined by measuring a 10 ft (3.0 m) radial distance from the closest edge of a stationary or fixed cooking appliance. The zone of exclusion is not intended to pass through walls or doorways. Figure A.9.6.2.10.4(a) provides an example of the zone of exclusion in a generalized residential kitchen. If other areas of this *Code* require that a smoke alarm or smoke detector be placed within a horizontal flow path distance between 10 ft (3.0 m) and 20 ft (6.1 m) from a stationary or fixed cooking appliance, the following method should be used to determine the distance, and only photoelectric detection or smoke alarms/detectors with alarm silencing means can be installed in this area.

To install a smoke alarm or detector between 10 ft (3.0 m) and 20 ft (6.1 m) from the cooking appliance, an installer must first determine the 10 ft (3.0 m) area of exclusion. Once the area of exclusion is determined, an installer must then determine the horizontal flow distance. This is the horizontal distance along the ceiling from the closest edge of the cooking appliance to the smoke alarm or detector. The horizontal distance can consist of line segments due to impediments, such as interior partitions.

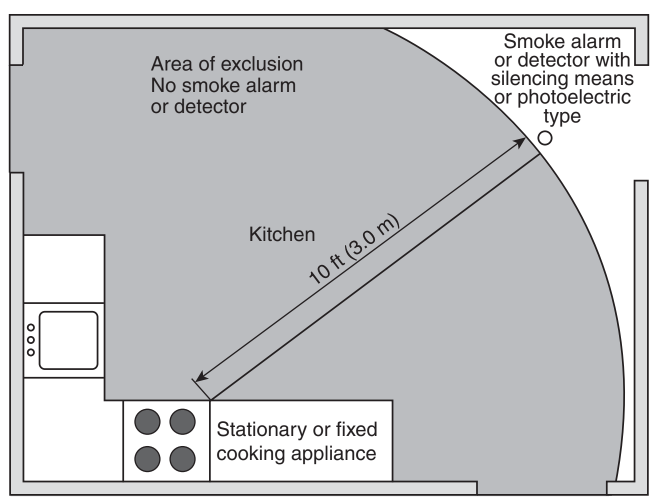


FIGURE A.9.6.2.10.4(a) Example of Zone of Exclusion (gray area) Within Typical Residential Kitchen. [72: Figure A.29.8.3.4(4)(a)]

Once an impediment is met, the measurement of the distance will then continue along the new horizontal path segment until the distance requirement is met or another impediment is encountered. Figure A.9.6.2.10.4(b) provides an example for placement outside a kitchen in a nearby hallway. Figure A.9.6.2.10.4(c) provides another example of appropriate placement outside of a kitchen in an adjacent room. At a horizontal flow path distance of greater than 20 ft (6.1 m), any type of smoke alarm or smoke detector can be installed. In rare cases, a residential dwelling can be of such size and configuration that an area of exclusion of 10 ft (3.0 m) from a stationary or fixed cooking appliance excludes the placement of a smoke alarm or smoke detector required by other areas of this *Code*. In these cases, a smoke alarm or smoke detector using photoelectric detection can be installed at least 72 in. (1.83 m) from the fixed or stationary cooking appliance. Figure A.9.6.2.10.4(d) provides an example of this situation in practice where a smoke alarm or smoke detector is required outside of the sleeping area but the space is in close proximity to the kitchen space. [**72:** A.29.8.3.4(4)]

A.9.6.2.10.5 Studies indicate that smoke alarms and smoke detectors that use ionization detection, photoelectric detection, or a combination of ionization and photoelectric detection are susceptible to nuisance alarms caused by steam. Little research has been done on the comparative response of these types of detection to steam. Steam particles, in general, are visible, reflect light easily, and are typically produced in a size range that would be more likely to activate a photoelectric sensor. Thus, it is required that smoke alarms and smoke detectors be installed greater than 36 in. (910 mm) from the bathroom door where possible. Increasing the distance between the smoke alarm or smoke detector and the bathroom door can reduce the frequency of nuisance alarms from bathroom steam. Frequent nuisance alarms can result in the occupant disabling the smoke alarm. Each incremental increase in separation, up to 10 ft (3.0 m), between the bathroom door and the smoke alarm or smoke detector is expected to reduce the frequency of nuisance alarms. [**72:** A.29.8.3.4(5)]

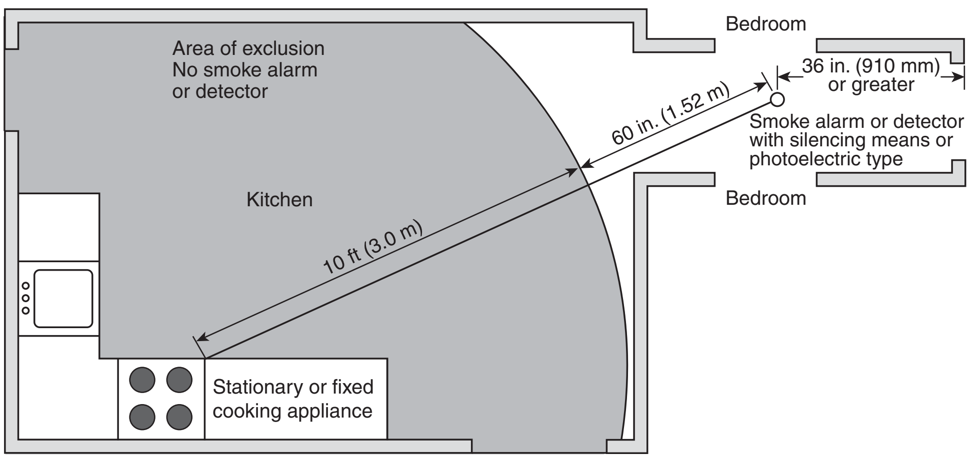


FIGURE A.9.6.2.10.4(b) Example of Smoke Alarm or Smoke Detector Placement Between 10 ft (3.0 m) and 20 ft (6.1 m) Away in Hallway from Center of Stationary or Fixed Cooking Appliance. [72: Figure A.29.8.3.4(4)(b)]

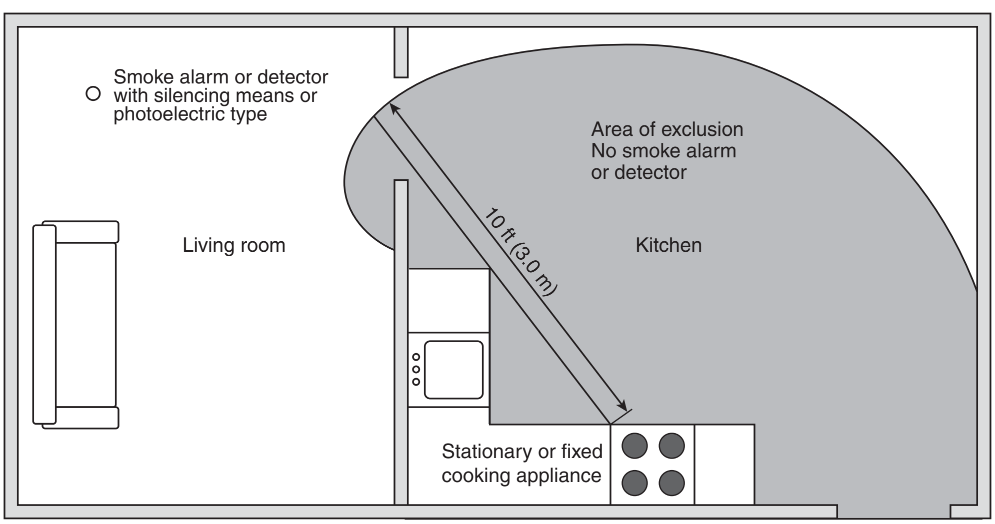


FIGURE A.9.6.2.10.4(c) Example of Smoke Alarm or Smoke Detector Placement Between 10 ft (3.0 m) and 20 ft (6.1 m) Away in Hallway from Center of Stationary or Fixed Cooking Appliance. [72: Figure A.29.8.3.4(4)(c)]

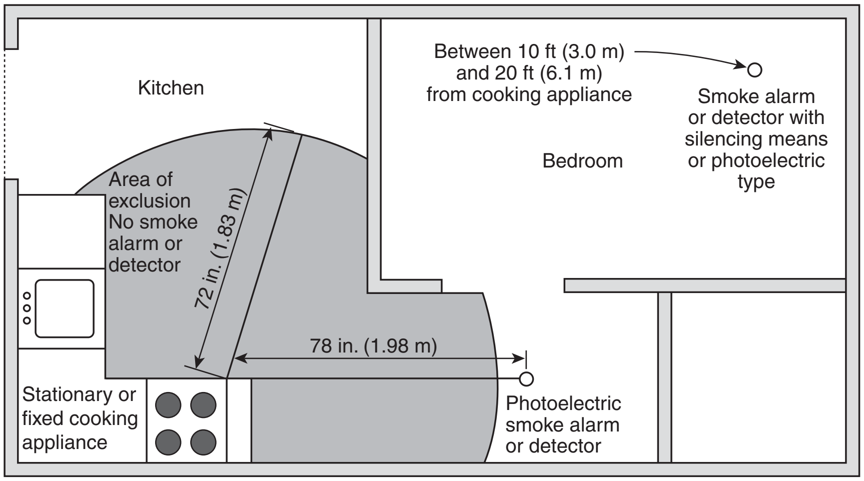


FIGURE A.9.6.2.10.4(d) Example of Exception Placement of Photoelectric Smoke Alarm or Smoke Detector at 72 in. (1.83 m) from Stationary or Fixed Cooking Appliance. [72: Figure A.29.8.3.4(4)(d)]

A.9.6.2.10.8 A dwelling unit is that structure, area, room, or combination of rooms, including hotel rooms/suites, in which a family or individual lives. A dwelling unit includes living areas only and not common usage areas in multifamily buildings, such as corridors, lobbies, and basements.

A.9.6.3.2.1 Elevator lobbies have been considered areas subject to unwanted alarms due to factors such as low ceilings and smoking. In the past several years, new features have become available to reduce this problem. These features are, however, not necessarily included in any specific installation.

A.9.6.3.2.2 The concept addressed is that detectors used for releasing service, such as door or damper closing and fan shutdown, are not required to sound the building alarm.

A.9.6.3.2.3 The concept addressed is that detectors used for releasing service, such as door or damper closing and fan shutdown, are not required to sound the building alarm.

A.9.6.3.5.7 Visual notification appliances installed in large-volume spaces, such as arenas, stadiums, malls, and atriums, can be alternative devices that are not listed as visible notification appliances for fire alarm systems, provided that the notification objective of the visual signal is reasonably achieved. Examples of alternative devices include, but are not limited to, scoreboards, message boards, and other electronic devices that meet the performance objectives of visible fire alarm appliances in large-volume spaces.

It is the intent to permit the omission of visible notification appliances as identified in 9.6.3.5.7, provided that the adjacent areas that have not been specifically designated as exempt are provided with visible notification as required by 9.6.3.5.

A.9.6.3.5.8 Documentation should be maintained with the as-built drawings so that inspection and testing personnel understand that the visible appliances have been exempted from certain areas and, therefore, can note the deviation on the acceptance test documentation and ongoing inspection reports. This will provide inspection and testing personnel with necessary details regarding the omission of visible notification appliances.

A.9.6.3.6.2 To approve an evacuation plan to selectively notify building occupants, the authority having jurisdiction should consider several building parameters, including building compartmentation, detection and suppression system zones, occupant loads, and the number and arrangement of the means of egress.

In high-rise buildings, it is typical to evacuate the fire floor, the floor(s) above, and the floor immediately below. Other areas are then evacuated as the fire develops.

A.9.6.3.9.2 The provisions of 9.6.3.9.2 offer an alternative to the emergency voice alarm and communications system provisions (live voice or recorded voice announcements) of *NFPA 72, National Fire Alarm and Signaling Code*. Occupancies such as large-venue assembly occupancies and mercantile mall buildings are occupancies in which the physical configuration (e.g., large-volume spaces), function, and human behavior (including elevated levels of occupant-generated noise) present challenges with respect to effective occupant notification by standard means in accordance with *NFPA 72*. Because the routine operation of these occupancies demands highly reliant, acoustically capable, and sufficiently audible public address systems, properly trained staff can be relied on to use these public address systems to effect occupant evacuation, relocation, or both.

As 9.6.3.9.2 specifically permits an alternative means of notification to that prescribed by *NFPA 72*, it does not mandate that the secondary power supply and the intelligibility and audibility facets of the public address system comply with *NFPA 72* or suggest that equivalency with the related provisions of *NFPA 72* is required. However, it is anticipated that, when approving the secondary power and audibility capabilities of public address systems, authorities having jurisdiction will ensure that these systems are conceptually comparable to the emergency voice alarm and communications system provisions of *NFPA 72*, such that a reliable and effective occupant notification system is provided.

A.9.7.1.1 For a discussion of the effectiveness of automatic sprinklers, as well as a general discussion of automatic sprinklers, see the NFPA *Fire Protection Handbook*. Where partial sprinkler protection is permitted by another section of this *Code*, the limited area systems provisions of NFPA 13, *Standard for the Installation of Sprinkler Systems*, should apply.

A.9.7.1.4 Properly designed automatic sprinkler systems provide the dual function of both automatic alarms and automatic extinguishment. Dual function is not provided in those cases where early detection of incipient fire and early notification of occupants are needed to initiate actions in behalf of life safety earlier than can be expected from heat-sensitive fire detectors.

A.9.7.2.1 *NFPA 72, National Fire Alarm and Signaling Code*, provides details of standard practice in sprinkler supervision. Subject to the approval of the authority having jurisdiction, sprinkler supervision is also permitted to be provided by direct connection to municipal fire departments or, in the case of very large establishments, to a private headquarters providing similar functions. *NFPA 72* covers such matters. System components and parameters that are required to be monitored should include, but should not be limited to, control valves, water tank levels and temperatures, tank pressure, and air pressure on dry-pipe valves.

Where municipal fire alarm systems are involved, reference should also be made to NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems.*

A.9.8.1 There are typically two different ways that extinguishing systems other than fire sprinkler systems are used. The first is when the entire building is protected with one of these alternate systems. When this is the case, the exceptions, reductions, and alternative code provisions that are offered as options when fire sprinkler systems are installed should not be granted to the other extinguishing system unless the other system has demonstrated the same temperature control during a fire and reliability of operation as a fire sprinkler system. Reliability of operation needs to extend to the long-term use of the other system and an analysis of the reliability of the component parts. Some component of other extinguishing systems can show reliability data from their use in systems outside of fire protection where they get exercised on a regular basis, but acceptance on this basis is cautioned because many mechanical parts that sit for a long time without being exercised, as fire protection systems need to do, might not have the same reliability. A reliability analysis should also take into account inspection, testing, and maintenance criteria and the likelihood of a building owner knowing and understanding what needs to be performed to keep the other system operational.

The second manner in which other systems are used as alternatives to fire sprinkler systems are in individual rooms or spaces of otherwise sprinklered occupancies. Here the authority having jurisdiction needs to use some judgment in the application of exceptions, reductions, and alternative code provisions that are offered for sprinklered occupancies. The permission to utilize such exceptions, reductions, and alternative code provisions far from the space with the other fire protection system should be granted. Closer to the space with the alternate system, exceptions, reductions, and alternate code provisions for sprinklers could be granted if the system was analyzed as discussed above and found to be equivalent to a fire sprinkler system.

A.9.9 For a description of standard types of extinguishers and their installation, maintenance, and use, see NFPA 10, *Standard for Portable Fire Extinguishers.* The labels of recognized testing laboratories on extinguishers provide evidence of tests indicating the reliability and suitability of the extinguisher for its intended use. Many unlabeled extinguishers are offered for sale that are substandard by reason of insufficient extinguishing capacity, questionable reliability, or ineffective extinguishing agents for fires in ordinary combustible materials or because they pose a personal hazard to the user.

A.10.2 The requirements pertaining to interior finish are intended to restrict the spread of fire over the continuous surface forming the interior portions of a building.

Table A.10.2 shows the fire test methods and classification criteria that apply to different interior finish materials.

Table A.10.2 Fire Testing of Interior Finish Materials

Material	Test Method	Acceptance Criterion	Application Requirement	Section
Interior wall and ceiling finish materials, except as shown in this table	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	As required by relevant sections	10.2.3
	ASTM E 84 or ANSI/UL 723	Class B, in accordance with 10.2.3.4(2)	As required by relevant sections	10.2.3
	ASTM E 84 or ANSI/UL 723	Class C, in accordance with 10.2.3.4(3)	As required by relevant sections	10.2.3
	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.3.2
Materials having thickness $<\frac{1}{28}$ in. (<0.90 mm) applied directly to a noncombustible or limited-combustible surface of walls or ceilings	No testing required			10.2.1.2
Exposed portions of structural members complying with requirements for buildings of Type IV (2HH) construction in accordance with NFPA 220	No testing required			10.2.3.1

(continues)

Table A.10.2 ***Continued***

Material	Test Method	Acceptance Criterion	Application Requirement	Section
Cellular or foamed plastics (exposed foamed plastics and foamed plastics used in conjunction with textile or vinyl facing or cover)	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.4.3.1.1(1)
	ANSI/UL 1715	Pass	Permitted where Class A, B, or C is required by relevant sections	10.2.4.3.1.1(2)
	ANSI/UL 1040	Pass	Permitted where Class A, B, or C is required by relevant sections	10.2.4.3.1.1(3)
	FM 4880	Pass	Permitted where Class A, B, or C is required by relevant sections	10.2.4.3.1.1(4)
	Suitable large-scale fire test that substantiates combustibility characteristics for use intended under actual fire conditions	Pass	Permitted where Class A, B, or C is required by relevant sections	10.2.4.3.1
Textile wall coverings	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.4.1(6)
	NFPA 265, Method B	In accordance with 10.2.3.7.1	Permitted on walls and partitions	10.2.4.1(5)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted on walls, but also requires sprinklers per Section 9.7	10.2.4.1(1)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted on partitions not exceeding three-quarters of the floor-to-ceiling height or not exceeding 8 ft (2440 mm) in height, whichever is less	10.2.4.1(2)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted to extend not more than 48 in. (1220 mm) above finished floor on ceiling-height walls and ceiling-height partitions	10.2.4.1(3)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Previously approved existing installations of textile material meeting the requirements of Class A permitted to be continued to be used	10.2.4.1(4)
Expanded vinyl wall coverings	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.4.2(6)
	NFPA 265, Method B	In accordance with 10.2.3.7.1	Permitted on walls and partitions	10.2.4.2(5)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted on walls, but also requires sprinklers per Section 9.7	10.2.4.2(1)

Table A.10.2 ***Continued***

Material	Test Method	Acceptance Criterion	Application Requirement	Section
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted on partitions not exceeding three-quarters of the floor-to-ceiling height or not exceeding 8 ft (2440 mm) in height, whichever is less	10.2.4.2(2)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4 (1)	Permitted to extend not more than 48 in. (1220 mm) above finished floor on ceiling-height walls and ceiling-height partitions	10.2.4.2(3)
	ASTM E 84 or ANSI/UL 723	Class A, B, or C, in accordance with 10.2.3.4	Existing installations of materials with appropriate wall finish classification for occupancy involved, and with classification in accordance with the provisions of 10.2.3.4	10.2.4.2(4)
Textile ceiling coverings	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.4.1(6)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted on walls, but also requires sprinklers per Section 9.7	10.2.4.1(1)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Previously approved existing installations of textile material meeting the requirements of Class A permitted to be continued to be used	10.2.4.1(4)
Expanded vinyl ceiling coverings	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.4.2(6)
	ASTM E 84 or ANSI/UL 723	Class A, in accordance with 10.2.3.4(1)	Permitted on walls, but also requires sprinklers per Section 9.7	10.2.4.2(1)
	ASTM E 84 or ANSI/UL 723	Class A, B, or C, in accordance with 10.2.3.4	Existing installations of materials with appropriate wall finish classification for occupancy involved, and with classification in accordance with the provisions of 10.2.3.4	10.2.4.2(4)
Interior trim, other than foamed plastic and other than wall base	ASTM E 84 or ANSI/UL 723	Class C, in accordance with 10.2.3.4	Interior wall and ceiling trim and incidental finish, other than wall base not in excess of 10 percent of the specific wall and ceiling areas of any room or space to which it is applied where interior wall and ceiling finish of Class A or Class B is required	10.2.5.1
	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.3.2

(continues)

Table A.10.2 ***Continued***

Material	Test Method	Acceptance Criterion	Application Requirement	Section
Foamed plastic used as interior trim	ASTM E 84 or ANSI/UL 723	Flame spread index = 75	(1) Minimum density of interior trim required to be 20 lb/ft^3 (320 kg/m^3)	10.2.4.3.2
			(2) Maximum thickness of interior trim required to be ½ in. (13 mm), and maximum width required to be 4 in. (100 mm)	10.2.4.3.2
			(3) Interior trim not permitted to constitute more than 10 percent of the specific wall or ceiling area of a room or space to which it is applied	10.2.4.3.2
	NFPA 286	In accordance with 10.2.3.7.2	Permitted where Class A, B, or C is required by relevant sections	10.2.3.2
Fire-retardant coatings	NFPA 703	Class A, B, or C, when tested by ASTM E 84 or ANSI/UL 723, in accordance with 10.2.3.4	Required flame spread index or smoke developed index values of existing surfaces of walls, partitions, columns, and ceilings permitted to be secured by applying approved fire-retardant coatings to surfaces having higher flame spread index values than permitted; such treatments required to be tested or listed and labeled for application to material to which they are applied	10.2.6.1
Factory-applied fire-retardant–coated assemblies (listed and labeled)	ASTM E 2768 on the coated surface	Pass	Surfaces of walls. partitions, columns, and ceilings in new construction	10.2.6.2
Carpet and carpetlike interior floor finishes	ASTM D 2859	Pass	All areas	10.2.7.1
Floor coverings, other than carpet, judged to represent an unusual hazard (excluding traditional finish floors and floor coverings, such as wood flooring and resilient floor coverings)	NFPA 253	Critical radiant flux = 0.1 W/cm^2	All areas	10.2.7.2
Interior floor finish, other than carpet and carpetlike materials	NFPA 253	Class I: Critical radiant flux = 0.45 W/cm^2, in accordance with 10.2.7.4	As required by relevant sections	10.2.7.3
	NFPA 253	Class II: Critical radiant flux = 0.22 W/cm^2, in accordance with 10.2.7.4	As required by relevant sections	10.2.7.3
Wall base [interior floor trim material used at junction of wall and floor to provide a functional or decorative border, and not exceeding 6 in. (150 mm) in height]	NFPA 253	Class II: Critical radiant flux = 0.22 W/cm^2, in accordance with 10.2.7.4	All areas	10.2.5.2
	NFPA 253	Class I: Critical radiant flux = 0.45 W/cm^2, in accordance with 10.2.7.4	If interior floor finish is required to meet Class I critical radiant flux	10.2.5.2
Floor finish of traditional type, such as wood flooring and resilient floor coverings	No testing required			10.2.2.2

A.10.2.1 The requirements pertaining to interior finish are intended to restrict the spread of fire over the continuous surface forming the interior portions of a building. The presence of multiple paint layers has the potential for paint delamination and bubbling or blistering of paint. Testing (NFPA *Fire Technology*, August 1974, "Fire Tests of Building Interior Covering Systems," David Waksman and John Ferguson, Institute for Applied Technology, National Bureau of Standards) has shown that adding up to two layers of paint with a dry film thickness of about 0.007 in. (0.18 mm) will not change the fire properties of surface-covering systems. Testing has shown that the fire properties of the surface-covering systems are highly substrate dependent and that thin coatings generally take on the characteristics of the substrate. When exposed to fire, the delamination, bubbling, and blistering of paint can result in an accelerated rate of flame spread.

A.10.2.1.5 Such partitions are intended to include washroom water closet partitions.

A.10.2.2 Table A.10.2.2 provides a compilation of the interior finish requirements of 7.1.4 and the occupancy chapters (Chapters 12 through 42) of this *Code*.

A.10.2.2.2 This paragraph recognizes that traditional finish floors and floor coverings, such as wood flooring and resilient floor coverings, have not proved to present an unusual hazard.

A.10.2.3 ASTM E 84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, and UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, are considered nationally recognized consensus standard test methods for determining the flame spread index and smoke developed index of building materials and are likely to yield equivalent test results. *(See also A.10.2.4.1.)*

A.10.2.3.4 It has been shown that the method of mounting interior finish materials usually affects actual performance. The use of standard mounting methods will be helpful in determining appropriate fire test results. Where materials are tested in intimate contact with a substrate to determine a classification, such materials should be installed in intimate contact with a similar substrate. Such details are especially important for "thermally thin" materials. For further information, see ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*.

Some interior wall and ceiling finish materials, such as fabrics not applied to a solid backing, do not lend themselves to a test made in accordance with ASTM E 84. In such cases, the large-scale test outlined in NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, is permitted to be used. In 1989 the NFPA Technical Committee on Fire Tests eliminated the so-called "small-scale test" from NFPA 701 because the results had been shown not to represent a fire performance that corresponded to what happened in real scale. Since then, NFPA 701 no longer contains a "small-scale test" but it now contains two tests (Test 1 and Test 2), which apply to materials as a function of their areal density. Thus NFPA 701 Test 1 applies to fabrics (other than vinyl-coated fabric blackout linings) having an areal density less than or equal to 21 oz/yd^2 (700 g/m^2), while NFPA 701 Test 2 applies to fabrics with an areal density greater than 21 oz/yd^2 (700 g/m^2), vinyl-coated fabric blackout linings, decorative objects, and films. Representations that materials or products have been tested to the small-scale test in NFPA 701 normally refer to the pre-1989 small-scale test, which no longer exists and which does not represent acceptable fire performance.

Prior to 1978, the test report described by ASTM E 84 included an evaluation of the fuel contribution as well as the flame spread index and the smoke developed index. However, it is now recognized that the measurement on which the fuel contribution is based does not provide a valid measure. Therefore, although the data are recorded during the test, the information is no longer normally reported. Classification of interior wall and ceiling finish thus relies only on the flame spread index and smoke developed index.

The 450 smoke developed index limit is based solely on obscuration. *(See A.10.2.4.1.)*

A.10.2.3.7 The methodology specified in NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*, includes provisions for measuring smoke obscuration. Such measurement is considered desirable, but the basis for specific recommended values is not currently available. *(See A.10.2.4.1.)*

A.10.2.3.7.1 See A.10.2.3.7 and A.10.2.4.1.

A.10.2.4 Surface nonmetallic raceway products, as permitted by *NFPA 70*, *National Electrical Code*, are not interior finishes and are not subject to the provisions of Chapter 10.

A.10.2.4.1 Previous editions of the *Code* have regulated textile materials on walls and ceilings using ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Full-scale room/corner fire test research has shown that flame spread indices produced by ASTM E 84 or ANSI/UL 723 might not reliably predict all aspects of the fire behavior of textile wall and ceiling coverings.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*, and NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, both known as room/corner tests, were developed for assessing the fire and smoke obscuration performance of textile wall coverings and interior wall and ceiling finish materials, respectively. As long as an interior wall or ceiling finish material is tested by NFPA 265 or NFPA 286, as appropriate, using a mounting system, substrate, and adhesive (if appropriate) that are representative of actual use, the room/corner test provides an adequate evaluation of a product's flammability and smoke obscuration behavior. Manufacturers, installers, and specifiers should be encouraged to use NFPA 265 or NFPA 286, as appropriate — but not both — because each of these standard fire tests has the ability to characterize actual product behavior, as opposed to data generated by tests using ASTM E 84 or ANSI/UL 723, which only allow comparisons of one product's performance with another. If a manufacturer or installer chooses to test a wall finish in accordance with NFPA 286, additional testing in accordance with ASTM E 84 or ANSI/UL 723 is not necessary.

The test results from ASTM E 84 or ANSI/UL 723 are suitable for classification purposes but should not be used as input into fire models, because they are not generated in units suitable for engineering calculations. Actual test results for heat, smoke, and combustion product release from NFPA 265, and from NFPA 286, are suitable for use as input into fire models for performance-based design.

Table A.10.2.2 Interior Finish Classification Limitations

Occupancy	Exits	Exit Access Corridors	Other Spaces
Assembly — New			
>300 occupant load	A	A or B	A or B
	I or II	I or II	NA
≤300 occupant load	A	A or B	A, B, or C
	I or II	I or II	NA
Assembly — Existing			
>300 occupant load	A	A or B	A or B
≤300 occupant load	A	A or B	A, B, or C
Educational — New	A	A or B	A or B; C on low partitions†
	I or II	I or II	NA
Educational — Existing	A	A or B	A, B, or C
Day-Care Centers — New	A	A	A or B
	I or II	I or II	NA
Day-Care Centers — Existing	A or B	A or B	A or B
Day-Care Homes — New	A or B	A or B	A, B, or C
	I or II		NA
Day-Care Homes — Existing	A or B	A, B, or C	A, B, or C
Health Care — New	A	A	A
	NA	B on lower portion of corridor wall†	B in small individual rooms†
	I or II	I or II	NA
Health Care — Existing	A or B	A or B	A or B
Detention and Correctional — New (sprinklers mandatory)	A or B	A or B	A, B, or C
	I or II	I or II	NA
Detention and Correctional — Existing	A or B	A or B	A, B, or C
	I or II	I or II	NA
One- and Two-Family Dwellings and Lodging or Rooming Houses	A, B, or C	A, B, or C	A, B, or C
Hotels and Dormitories — New	A	A or B	A, B, or C
	I or II	I or II	NA
Hotels and Dormitories — Existing	A or B	A or B	A, B, or C
	I or II†	I or II†	NA
Apartment Buildings — New	A	A or B	A, B, or C
	I or II	I or II	NA
Apartment Buildings — Existing	A or B	A or B	A, B, or C
	I or II†	I or II†	NA
Residential Board and Care — *(See Chapters 32 and 33.)*			
Mercantile — New	A or B	A or B	A or B
	I or II		NA
Mercantile — Existing			
Class A or Class B stores	A or B	A or B	Ceilings — A or B; walls — A, B, or C
Class C stores	A, B, or C	A, B, or C	A, B, or C
Business and Ambulatory Health Care — New	A or B	A or B	A, B, or C
	I or II		NA
Business and Ambulatory Health Care — Existing	A or B	A or B	A, B, or C
Industrial	A or B	A, B, or C	A, B, or C
	I or II	I or II	NA
Storage	A or B	A, B, or C	A, B, or C
	I or II		NA

NA: Not applicable.Notes:

(1) Class A interior wall and ceiling finish — flame spread index, 0–25 (new applications); smoke developed index, 0–450.

(2) Class B interior wall and ceiling finish — flame spread index, 26–75 (new applications); smoke developed index, 0–450.

(3) Class C interior wall and ceiling finish — flame spread index, 76–200 (new applications); smoke developed index, 0–450.

(4) Class I interior floor finish — critical radiant flux, not less than 0.45 W/cm^2.

(5) Class II interior floor finish — critical radiant flux, not more than 0.22 W/cm^2, but less than 0.45 W/cm^2.

(6) Automatic sprinklers — where a complete standard system of automatic sprinklers is installed, interior wall and ceiling finish with a flame spread rating not exceeding Class C is permitted to be used in any location where Class B is required, and Class B interior wall and ceiling finish is permitted to be used in any location where Class A is required; similarly, Class II interior floor finish is permitted to be used in any location where Class I is required, and no interior floor finish classification is required where Class II is required. These provisions do not apply to new detention and correctional occupancies.

(7) Exposed portions of structural members complying with the requirements for heavy timber construction are permitted.

†See corresponding chapters for details.

A.10.2.4.2 Expanded vinyl wall covering consists of a woven textile backing, an expanded vinyl base coat layer, and a non-expanded vinyl skin coat. The expanded base coat layer is a homogeneous vinyl layer that contains a blowing agent. During processing, the blowing agent decomposes, which causes this layer to expand by forming closed cells. The total thickness of the wall covering is approximately 0.055 in. to 0.070 in. (1.4 mm to 1.8 mm).

A.10.2.4.3.1 See A.10.2.4.3.1.2.

A.10.2.4.3.1.2 Both NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, and ANSI/UL 1715, *Standard for Fire Test of Interior Finish Material*, contain smoke obscuration criteria. ANSI/UL 1040, *Standard for Fire Test of Insulated Wall Construction*, and FM 4880, *Approval Standard for Class I Insulated Wall or Wall and Roof/Ceiling Panels; Plastic Interior Finish Materials; Plastic Exterior Building Panels; Wall/Ceiling Coating Systems; Interior or Exterior Finish Systems*, do not. Smoke obscuration is an important component of the fire performance of cellular or foamed plastic materials.

A.10.2.4.4 Light-transmitting plastics are used for a variety of purposes, including light diffusers, exterior wall panels, skylights, canopies, glazing, and the like. Previous editions of the *Code* have not addressed the use of light-transmitting plastics. Light-transmitting plastics will not normally be used in applications representative of interior finishes. Accordingly, ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* can produce test results that might or might not apply.

Light-transmitting plastics are regulated by model building codes such as *NFPA 5000*, *Building Construction and Safety Code*. Model building codes provide adequate regulation for most applications of light-transmitting plastics. Where an authority having jurisdiction determines that a use is contemplated that differs from uses regulated by model building codes, light-transmitting plastics in such applications can be substantiated by fire tests that demonstrate the combustibility characteristics of the light-transmitting plastics for the use intended under actual fire conditions.

For additional information on light transmitting plastics, see Section 48.7 of *NFPA 5000*.

A.10.2.6 Fire-retardant coatings need to be applied to surfaces properly prepared for the material, and application needs to be consistent with the product listing. Deterioration of coatings applied to interior finishes can occur due to repeated cleaning of the surface or painting over applied coatings.

A.10.2.6.1 It is the intent of the *Code* to mandate interior wall and ceiling finish materials that obtain their fire performance and smoke developed characteristics in their original form. However, in renovations, particularly those involving historic buildings, and in changes of occupancy, the required fire performance or smoke developed characteristics of existing surfaces of walls, partitions, columns, and ceilings might have to be secured by applying approved fire-retardant coatings to surfaces having higher flame spread ratings than permitted. Such treatments should comply with the requirements of NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials*. When fire-retardant coatings are used, they need to be applied to surfaces properly prepared for the material, and application needs to be consistent with the product listing. Deterioration of coatings applied to interior finishes can occur due to repeated cleaning of the surface or painting over applied coatings, but permanency must be assured in some appropriate fashion. Fire-retardant coatings must possess the desired degree of permanency and be maintained so as to retain the effectiveness of the treatment under the service conditions encountered in actual use.

A.10.2.6.2 The intent of this section is that factory-applied fire-retardant-coated products, such as panels or tiles applied to walls or ceilings, replace the existing finish and are not applied on top of the existing finish.

A.10.2.7 The flooring radiant panel provides a measure of a floor covering's tendency to spread flames where located in a corridor and exposed to the flame and hot gases from a room fire. The flooring radiant panel test method is to be used as a basis for estimating the fire performance of a floor covering installed in the building corridor. Floor coverings in open building spaces and in rooms within buildings merit no further regulation, provided that it can be shown that the floor covering is at least as resistant to spread of flame as a material that meets the U.S. federal flammability standard 16 CFR 1630, "Standard for the Surface Flammability of Carpets and Rugs" (FF 1-70). All carpeting sold in the United States since 1971 is required to meet this standard and, therefore, is not likely to become involved in a fire until a room reaches or approaches flashover. Therefore, no further regulations are necessary for carpet, other than carpet in exitways and corridors.

It has not been found necessary or practical to regulate interior floor finishes on the basis of smoke development.

Full-scale fire tests and fire experience have shown that floor coverings in open building spaces merit no regulation beyond the U.S. federally mandated DOC FF 1-70 "pill test." This is because floor coverings meeting the pill test will not spread flame significantly until a room fire approaches flashover. At flashover, the spread of flame across a floor covering will have minimal impact on the already existing hazard. The minimum critical radiant flux of a floor covering that will pass the FF 1-70 test has been determined to be approximately 0.04 W/cm^2 (Tu, King-Mon and Davis, Sanford, "Flame Spread of Carpet Systems Involved in Room Fires," NFSIR 76-1013, Center for Fire Research, National Bureau of Standards, June 1976). The flooring radiant panel is only able to determine critical radiant flux values to 0.1 W/cm^2. This provision will prevent use of a noncomplying material, which can create a problem, especially when the *Code* is used outside the United States where U.S. federal regulation FF 1-70 (16 CFR 1630) is not mandated.

A.10.2.7.1 Compliance with 16 CFR 1630, "Standard for the Surface Flammability of Carpets and Rugs" (FFI-70), is considered equivalent to compliance with ASTM D 2859, *Standard Test Method for Ignition Characteristic of Finished Textile Floor Covering Materials*.

A.10.2.7.2 The fire performance of some floor finishes has been tested, and traditional finish floors and floor coverings, such as wood flooring and resilient floor coverings, have not proved to present an unusual hazard.

A.10.2.7.3 ASTM E 648, *Standard Test Method for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, and NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, are considered nationally recognized consensus standard test methods for determining the critical radiant flux from floor covering systems and are likely to yield equivalent test results.

A.10.3.1 Testing per NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, applies to textiles and films used in a hanging configuration. If the textiles are to be applied to surfaces of buildings or backing materials as interior finishes for use in buildings, they should be treated as interior wall and ceiling finishes in accordance with Section 10.2 of this *Code*, and they should then be tested for flame spread index and smoke developed index values in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, or for flame spread and flashover in accordance with NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*. Films and other materials used as interior finish applied to surfaces of buildings should be tested for flame spread index and smoke developed index values in accordance with ASTM E 84 or ANSI/UL 723 or for heat and smoke release and flashover in accordance with NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*.

The test results from NFPA 701 are suitable for classification purposes but should not be used as input into fire models, because they are not generated in units suitable for engineering calculations.

A.10.3.2.1 The Class I requirement associated with testing in accordance with NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture*, and the char length of not more than 1½ in. (38 mm) required with testing in accordance with NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes*, are indicators that the furniture item or mattress is resistant to a cigarette ignition. A fire that smolders for an excessive period of time without flaming can reduce the tenability within the room or area of fire origin without developing the temperatures necessary to operate automatic sprinklers.

The test results from NFPA 260 and from NFPA 261 are suitable for classification purposes but should not be used as input into fire models because they are not generated in units suitable for engineering calculations.

Until recently, NFPA 260 was equivalent to ASTM E 1353, *Standard Test Methods for Cigarette Ignition Resistance of Components of Upholstered Furniture*, and NFPA 261 was equivalent to ASTM E 1352, *Standard Test Method for Cigarette Ignition Resistance of Mock-Up Upholstered Furniture Assemblies*. However, that changed when NFPA 260 and NFPA 261 adopted the new NIST standard reference material (SRM 1196) as the igniting cigarette and ASTM E 1352 and ASTM E 1353 did not, meaning that ASTM E 1352 and ASTM E 1353 use commercial cigarettes that are low-ignition propensity and have a low likelihood of properly assessing smoldering potential.

A.10.3.2.2 The char length of not more than 2 in. (51 mm) required in 16 CFR 1632, "Standard for the Flammability of Mattresses and Mattress Pads" (FF 4-72), is an indicator that the mattress is resistant to a cigarette ignition. United States federal regulations require mattresses in this country to comply with 16 CFR 1632.

A.10.3.3 The intent of the provisions of 10.3.3 is as follows:

(1) The peak heat release rate of not more than 80 kW by a single upholstered furniture item was chosen based on maintaining a tenable environment within the room of fire origin, and the sprinkler exception was developed because the sprinkler system helps to maintain tenable conditions, even if the single upholstered furniture item were to have a peak rate of heat release in excess of 80 kW.
(2) The total heat release of not more than 25 MJ by the single upholstered furniture item during the first 10 minutes of the test was established as an additional safeguard to protect against the adverse conditions that would be created by an upholstered furniture item that released its heat in other than the usual measured scenario, and the following should also be noted:
   (a) During the test for measurement of rate of heat release, the instantaneous heat release value usually peaks quickly and then quickly falls off, so as to create a triangle-shaped curve.
   (b) In the atypical case, if the heat release were to peak and remain steady at that elevated level, as opposed to quickly falling off, the 80 kW limit would not ensure safety.
   (c) Only a sprinkler exception is permitted in lieu of the test because of the ability of the sprinkler system to control the fire.

Actual test results for heat, smoke, and combustion product release from ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, might be suitable for use as input into fire models for performance-based design. Furthermore, California Technical Bulletin 133, "Flammability Test Procedure for Seating Furniture for Use in Public Occupancies," includes pass/fail criteria for a single upholstered furniture item of 80 kW peak heat release rate and 25 MJ total heat release over the first 10 minutes of the test.

A.10.3.4 The intent of the provisions of 10.3.4 is as follows:

(1) The peak heat release rate of not more than 100 kW by a single mattress was chosen based on maintaining a tenable environment within the room of fire origin, and the sprinkler exception was developed because the sprinkler system helps to maintain tenable conditions, even if the single mattress were to have a peak rate of heat release in excess of 100 kW.
(2) The total heat release of not more than 25 MJ by the single mattress during the first 10 minutes of the test was established as an additional safeguard to protect against the adverse conditions that would be created by a mattress that released its heat in other than the usual measured scenario, and the following should also be noted:
   (a) During the test for measurement of rate of heat release, the instantaneous heat release value usually peaks quickly and then quickly falls off, so as to create a triangle-shaped curve.
   (b) In the atypical case, if the heat release were to peak and remain steady at that elevated level, as opposed to quickly falling off, the 100 kW limit would not ensure safety.
   (c) Only a sprinkler exception is permitted in lieu of the test because of the ability of the sprinkler system to control the fire.

Actual test results for heat, smoke, and combustion product release from ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses*, might be suitable for use as input into fire models for performance-based design. Furthermore, California Technical Bulletin 129, "Flammability Test Procedure for

Mattresses for Use in Public Buildings," includes pass/fail criteria for a single mattress of 100 kW peak heat release rate and 25 MJ total heat release over the first 10 minutes of test.

A.10.3.5 Christmas trees that are not effectively flame-retardant treated, ordinary crepe paper decorations, and pyroxylin plastic decorations might be classified as highly flammable.

A.10.3.7 Neither UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, nor NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, is intended for evaluating interior wall and ceiling finish materials. Actual test results for heat, smoke, and combustion product release from UL 1975 or from NFPA 289 might be suitable for use as input into fire models intended for performance-based design.

A.11.2.2 Escape chutes, controlled descent devices, and elevators are permitted to provide escape routes in special structures; however, they should not be substituted for the provisions of this *Code*.

A.11.2.2.4.1 The grade level of open structures, which by their very nature contain an infinite number of means of egress, are exempt from the requirements for number of means of egress.

A.11.3.1.3.1(2) The incidental accessory uses are intended to apply to small office spaces or lounge areas and similar uses that are used by tower employees.

A.11.3.2.4 The Washington Monument in Washington, DC, is an example of a tower where it would be impracticable to provide a second stairway.

A.11.3.4.2(2) The incidental accessory uses are intended to apply to small office spaces or lounge areas and similar uses that are used by tower employees.

A.11.3.4.4.6.2(2) Occupants of air traffic control towers might be required by administrative controls to remain in the facility when a fire occurs so they can perform orderly transfer of operations. Methods to limit compromising the means of egress might include a fire resistance–rated separation between discharge paths or smoke control in large spaces.

A.11.5 For further information on pier fire protection, see NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*.

A.11.6 Fire safety information for manufactured home parks is found in NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*.

A.11.7.3.2 It is not the intent that emergency access openings be readily openable from the exterior by the public but that they be easily opened with normal fire department equipment.

A.11.8.3.1 Where an occupancy chapter (Chapters 12 through 42) permits the omission of sprinklers in specific spaces, such as small bathrooms and closets in residential occupancies, the building is still considered to be protected throughout for the purposes of 11.8.3.1.

A.11.8.4.1 The need for voice communication can be based on a decision regarding staged or partial evacuation versus total evacuation of all floors. The determination of need is a function of occupancy classification and building height.

A.11.8.6 It is not the intent of the paragraph to require any of the equipment in the list, other than the telephone for fire department use, but only to provide the controls, panels, annunciators, and similar equipment at this location if the equipment is provided or required by another section of the *Code*.

A.11.8.8.1 With video systems, such as standard CCTV security systems typically installed in high-rise buildings, real-time images of occupants' and emergency responders' presence and movement (or lack thereof) in exits, especially at multiple locations of the same exit stairway, can provide critical information about current and developing conditions that should be taken into account in emergency management in accordance with the building's Emergency Action Plan.

Having video cameras positioned to capture images of an exit stairway, including just prior to the discharge doorway from the exit, provides information on the number and flow (in persons per minute, for example) of the occupants, among other information, including access by responding fire fighters using stairs if elevators are not available. It is not essential that the camera views and image resolution be sufficient to identify specific individuals. Depending on the context (including security applications), such specific-person identification might be essential, desirable, undesirable or forbidden. For post-incident evaluation and analysis of egress performance, it is helpful to have image quality and camera angle such that the lateral and front-to-back positions of individuals, relative to the stair width, are clear.

For example, a high-rise building could have cameras at the ground level (assuming this is the level of exit discharge) and at every fifth floor above, and perhaps below grade, for each of the exit stairs. As well as providing a reasonable sampling of evacuee presence and movement within the exit stair system (information important for real-time situation awareness), a comparison of times at which particular individuals pass different cameras provides important data on evacuation movement speed and (indirectly) average occupant density, in addition to flow and number of evacuees overall.

When designing and installing a video monitoring system, and in conjunction with the authority having jurisdiction, the following items should be considered in the operation of the system:

(1) Inspection, testing, and maintenance of equipment
(2) Duration/hours of operation
(3) Storage and retention of information
(4) Activation of the system
(5) Integration with the building's emergency action plan

A.11.9.3.3.1 The requirements of this paragraph can be considered as a Class 4, Type 60, system per NFPA 110, *Standard for Emergency and Standby Power Systems*.

A.12.1.2 Assembly occupancy requirements should be determined on a room-by-room basis, a floor-by-floor basis, and a total building basis. The requirements for each room should be based on the occupant load of that room, and the requirements for each floor should be based on the occupant load of that floor, but the requirements for the assembly building overall should be based on the total occupant load. Therefore, it is quite feasible to have several assembly occupancies with occupant loads of 300 or less grouped together in a single building. Such a building would be an assembly occupancy with an occupant load of over 1000.

A.12.1.3.3 For example, an assembly room for the residents of a detention occupancy will not normally be subject to simultaneous occupancy.

A.12.1.4.2 An understanding of the term *accessory room* might be useful to the enforcer of the *Code*, although the term is not used within the *Code*. An accessory room includes a dressing room, the property master's work and storage rooms, the carpenter's room, or similar rooms necessary for legitimate stage operations.

A.12.1.7.1 The increase in occupant load above that calculated using occupant load factors from Table 7.3.1.2 is permitted if the provisions of 12.1.7.1 are followed. The owner or operator has the right to submit plans and to be permitted an increase in occupant load if the plans comply with the *Code*. The authority having jurisdiction is permitted to reject the plan for increase in occupant load if the plan is unrealistic, inaccurate, or otherwise does not properly reflect compliance with other *Code* requirements. It is not the intent of the provisions of 12.1.7.1 to prohibit an increase in occupant load solely on the basis of exceeding the limits calculated using occupant load factors from Table 7.3.1.2.

To assist in preventing serious overcrowding incidents in sports arenas, stadia, and similar occupancies, spectator standing room should not be permitted between the seating areas and the playing areas, except in horse race and dog track facilities.

Where a capacity or near-capacity audience is anticipated, all seating should be assigned with tickets showing the section, row, and seat number.

Where standing room is permitted, the capacity of the standing area should meet the following criteria:

(1) The capacity should be determined on the basis of 5 ft^2 (0.46 m^2) per person.
(2) The capacity should be added to the seating capacity in determining egress requirements.
(3) The capacity should be located to the rear of the seating area.
(4) The capacity should be assigned standing-room-only tickets according to the area designated for the purpose.

The number of tickets sold, or otherwise distributed, should not exceed the aggregate number of seats plus the approved standing room numbers.

A.12.2.2.3.1(1) The seating plan and the means of egress should be reviewed each time the seating is substantially rearranged.

A.12.2.3.2 The provisions of 12.2.3.2 should be applied within the audience seating chamber and to the room doors. The capacity of means of egress components encountered after leaving the audience seating chamber, such as concourses, lobbies, exit stair enclosures, and the exit discharge, should be calculated in accordance with Section 7.3.

A.12.2.3.6.6 The original *Code* wording exempted sports arenas and railway stations. If an assembly occupancy was not similar to a sports arena or railway station, it was often judged ineligible to use the provision of 12.2.3.6.6. A list of exempted assembly venues also raises the question of why other occupancies are not included and necessitates additions to the list. For example, an exhibit hall of very large size might have several main entrances/exits. A theater extending the width of a block cannot really have a main entrance/exit in one confined location. A restaurant might have a main entrance serving the parking lot and another main entrance for those entering from the street. The authority having jurisdiction needs to determine where such arrangements are acceptable.

A.12.2.4 It is not the intent to require four means of egress from each level of an assembly occupancy building having a total occupant load of more than 1000 where, individually, the floors have occupant loads of less than 1000.

A.12.2.5.4.2 This requirement and the associated requirement of 12.2.5.4.3 have the effect of prohibiting festival seating, unless it truly is a form of seating, such as lawn seating, where generous spaces are commonly maintained between individuals and small groups so that people can circulate freely at any time. Such lawn seating is characterized by densities of about one person per 15 ft^2 (1.4 m^2). Both requirements prohibit uncontrolled crowd situations, such as in front of stages at rock music concerts where the number and density of people is uncontrolled by architectural or management features.

A.12.2.5.4.3 This requirement is intended to facilitate rapid emergency access to individuals who are experiencing a medical emergency, especially in the case of cardiopulmonary difficulties, where there is a need for rapid medical attention from trained personnel. The requirement also addresses the need for security and law enforcement personnel to reach individuals whose behavior is endangering themselves and others.

A.12.2.5.4.4 The catchment area served by an aisle accessway or aisle is the portion of the total space that is naturally served by the aisle accessway or aisle. Hence, the requirement for combining the required capacity where paths converge is, in effect, a restatement of the idea of a catchment area. The establishment of catchment areas should be based on a balanced use of all means of egress, with the number of persons in proportion to egress capacity.

A.12.2.5.5 For purposes of the means of egress requirements of this *Code*, tablet-arm chair seating is not considered seating at tables. Dinner theater–style configurations are required to comply with the aisle accessway provisions applying to seating at tables and the aisle requirements of 12.2.5.6, if the aisles contain steps or are ramped. *(See also 7.1.7 and A.7.1.7.2.)*

A.12.2.5.5.1 Seats having reclining backs are assumed to be in their most upright position when unoccupied.

A.12.2.5.5.5 The system known as *continental seating* has one pair of egress doors provided for every five rows that is located close to the ends of the rows. In previous editions of the *Code*, such egress doors were required to provide a clear width of not less than 66 in. (1675 mm) discharging into a foyer, into a lobby, or to the exterior of the building. This continental seating arrangement can result in egress flow times (i.e., with nominal flow times of approximately 100 seconds, rather than 200 seconds) that are approximately one-half as long as those resulting where side aisles lead to more remote doors. Such superior egress flow time performance is desirable in some situations; however, special attention should be given either to a comparably good egress capacity for other parts of the egress system or to sufficient space to accommodate queuing outside the seating space.

A.12.2.5.6.3 It is the intent to permit handrails to project not more than 3½ in. (90 mm) into the clear width of aisles required by 12.2.5.6.3.

A.12.2.5.6.4.1 Technical information about the convenience and safety of ramps and stairs having gradients in the region of 1 in 8 clearly suggests that the goal should be slopes for ramps that are less steep and combinations of stair risers and treads that are, for example, superior to 4 in. (100 mm) risers and 32 in. (865 mm) treads. This goal should be kept in mind by designers in establishing the gradient of seating areas to be served by aisles.

A.12.2.5.6.5(3) Tread depth is more important to stair safety than is riser height. Therefore, in cases where the seating area gradient is less than 5 in 11, it is recommended that the tread dimension be increased beyond 11 in. (280 mm), rather than reducing the riser height. Where the seating area gradient exceeds 8 in 11, it is recommended that the riser height be increased while maintaining a tread depth of not less than 11 in. (280 mm).

A.12.2.5.6.9 Failure to provide a handrail within a 30 in. (760 mm) horizontal distance of all required portions of the aisle stair width means that the egress capacity calculation is required to be modified as specified by 12.2.3.3(3). This modification might lead to an increase in the aisle width. Although this increase will compensate for reduced egress efficiency, it does not help individuals walking on such portions of stairs to recover from missteps, other than by possibly marginally reducing the crowding that might exacerbate the problem of falls. *(See also 7.2.2.4.)*

A.12.2.5.6.10 Certain tread cover materials such as plush carpets, which are often used in theaters, produce an inherently well-marked tread nosing under most lighting conditions. On the other hand, concrete treads have nosings with a sharp edge and, especially under outdoor lighting conditions, are difficult to discriminate. Therefore, concrete treads require an applied marking stripe. The slip resistance of such marking stripes should be similar to the rest of the treads, and no tripping hazard should be created; luminescent, self-luminous, and electroluminescent tread markings have the advantage of being apparent in reduced light or in the absence of light.

A.12.2.5.7 For purposes of the means of egress requirements of this *Code*, seating at counters or at other furnishings is considered to be the same as seating at tables.

A.12.2.5.7.2 Effectively, where the aisle accessway is bounded by movable seating, the 12 in. (305 mm) minimum width might be increased by about 15 in. to 30 in. (380 mm to 760 mm) as seating is pushed in toward tables. Moreover, it is such movement of chairs during normal and emergency egress situations that makes the zero-clearance allowance workable. The allowance also applies to booth seating where people sitting closest to the aisle normally move out ahead of people farthest from the aisle.

A.12.2.5.7.3 See A.12.2.5.8.3.

A.12.2.5.7.4 The minimum width requirement as a function of accessway length is as follows:

(1) 0 in. (0 mm) for the first 6 ft (1830 mm) of length toward the exit
(2) 12 in. (305 mm) for the next 6 ft (1830 mm); that is, up to 12 ft (3660 mm) of length
(3) 12 in. to 24 in. (305 mm to 610 mm) for lengths from 12 ft to 36 ft (3.7 m to 11 m), the maximum length to the closest aisle or egress doorway permitted by 12.2.5.7.5

Any additional width needed for seating is to be added to these widths, as described in 12.2.5.8.3.

A.12.2.5.8.1 See 7.1.7 and A.7.1.7.2 for special circulation safety precautions applicable where small elevation differences occur.

A.12.2.5.8.2 It is important to make facilities accessible to people using wheelchairs. See ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities,* which provides guidance on appropriate aisle widths.

A.12.2.5.8.3 Figure A.12.2.5.8.3 shows typical measurements involving seating and tables abutting an aisle. For purposes of the means of egress requirements of this *Code*, seating at counters or other furnishings is considered to be the same as seating at tables.

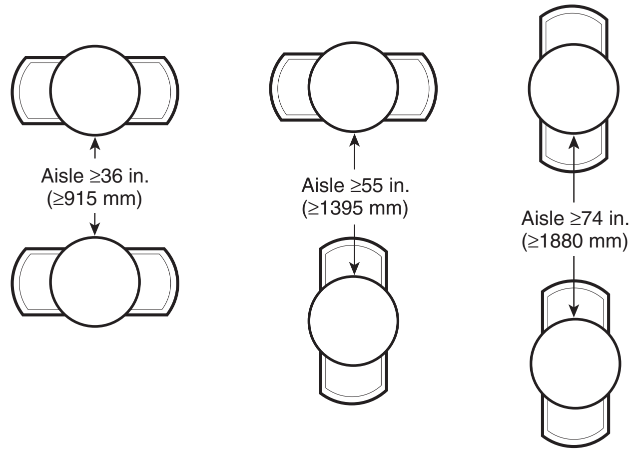


FIGURE A.12.2.5.8.3 Seating at Tables Abutting an Aisle.

A.12.2.11.1.1 This requirement includes provisions of guards and rails at the front of boxes, galleries, and balconies, and at aisle accessways adjacent to vomitories and orchestra pits.

A.12.2.11.1.6.2 The written plan should identify the unguarded areas and should include precautions and provisions to mitigate the fall hazard. Such precautions and provisions might include the following:

(1) Training
(2) Choreography
(3) Blocking
(4) Rehearsal
(5) Restricted access to the stage
(6) Restricted access to unguarded edges
(7) Warning lights
(8) Audible warnings
(9) Tactile edges
(10) Warning barriers
(11) Signage
(12) Temporary barriers
(13) Personal fall protection
(14) Fall restraint
(15) Spotters

A.12.3.1(1) The allowance for unenclosed stairs or ramps presumes the balcony or mezzanine complies with the other provisions of the *Code,* such as travel distance to exits in accordance with 12.2.6 and number of exits in accordance with 12.2.4. For the purposes of this exception, a balcony with glazing that provides a visual awareness of the main assembly area is considered open.

A.12.3.4.2.3 The intent is to require detectors only in nonsprinklered hazardous areas that are unoccupied. When the building is occupied, the detectors in the unoccupied, unsprinklered hazardous areas will initiate occupant notification. If the building is unoccupied, the fire in the nonsprinklered hazardous area is not a life safety issue, and the detectors, upon activation, are not required to notify anyone.

The signal from a detector is permitted to be sent to a control panel in an area that is occupied when the building is occupied, but that is unoccupied when the building is unoccupied, without the need for central station monitoring or the equivalent.

A.12.3.4.3.5 Examples of devices that might be used to provide alternative visible means include scoreboards, message boards, and other electronic devices.

A.12.3.5.3(1) It is the intent to permit a single multipurpose room of less than 12,000 ft^2 (1115 m^2) to have certain small rooms as part of the single room. These rooms could be a kitchen, an office, an equipment room, and the like. It is also the intent that an addition could be made to an existing building, without requiring that the existing building be sprinklered, where both the new and existing buildings have independent means of egress and a fire-rated separation is provided to isolate one building from the other.

A school gymnasium with egress independent of, and separated from, the school would be included in this exception, as would a function hall attached to a church with a similar egress arrangement.

A.12.3.5.3(3) Examples of low fire hazard uses include spectator sporting events, concerts, and performances on platforms.

The following uses are not low fire hazard uses: concerts and performances on stages; tradeshows; exhibitions and display of combustible items; displays of vehicles, boats, or similar items; or events using open flames or pyrotechnic effects.

A.12.4.1.1 Life safety evaluations are examples of performance-based approaches to life safety. In this respect, significant guidance in the form and process of life safety evaluations is provided by Chapter 5, keeping in mind the fire safety emphasis in Chapter 5. Performance criteria, scenarios, evaluation, safety factors, documentation, maintenance, and periodic assessment (including a warrant of fitness) all apply to the broader considerations in a life safety evaluation. A life safety evaluation deals not only with fire but also with storms, collapse, crowd behavior, and other related safety considerations for which a checklist is provided in A.12.4.1.3. Chapter 5 provides guidance, based on fire safety requirements, for establishing a documented case showing that products of combustion in all conceivable fire scenarios will not significantly endanger occupants using means of egress in the facility (e.g., due to fire detection, automatic suppression, smoke control, large-volume space, or management procedures). Moreover, means of egress facilities plus facility management capabilities should be adequate to cope with scenarios where certain egress routes are blocked for some reason.

In addition to making realistic assumptions about the capabilities of persons in the facility (e.g., an assembled crowd including many disabled persons or persons unfamiliar with the facility), the life safety evaluation should include a factor of safety of not less than 2.0 in all calculations relating to hazard development time and required egress time (the combination of flow time and other time needed to detect and assess an emergency condition, initiate egress, and move along the egress routes). The factor of safety takes into account the possibility that half of the egress routes might not be used (or be usable) in certain situations.

Regarding crowd behavior, the potential hazards created by larger masses of people and greater crowd densities (which can be problematic during ingress, occupancy, and egress) demand that technology be used by designers, managers, and authorities responsible for buildings to compensate for the relaxed egress capacity provisions of Table 12.4.2.3. In very large buildings for assembly use, the hazard of crowd crushes can exceed that of fire or structural failure. Therefore, the building designers, managers, event planners, security personnel, police authorities, and fire authorities, as well as the building construction authorities, should understand the potential problems and solutions, including coordination of their activities. For crowd behavior, this understanding includes factors of space, energy, time, and information, as well as specific crowd management techniques, such as metering. Published guidance on these factors and techniques is found in the *SFPE Handbook of Fire Protection Engineering*, Section 3, Chapter 13, pp. 3-342–3-366 (Proulx, G., "Movement of People"), and the publications referenced therein.

Table 12.2.3.2 and Table 12.4.2.3 are based on a linear relationship between number of seats and nominal flow time, with not less than 200 seconds (3.3 minutes) for 2000 seats plus 1 second for every additional 50 seats up to 25,000. Beyond 25,000 total seats, the nominal flow time is limited to 660 seconds (11 minutes). Nominal flow time refers to the flow time for the most able group of patrons; some groups less familiar with the premises or less able groups might take longer to pass a point in the egress system. Although three or more digits are noted in the tables, the resulting calculations should be assumed to provide only two significant figures of precision.

A.12.4.1.3 Factors to be considered in a life safety evaluation include the following:

(1) Nature of the events being accommodated, including the following:
   (a) Ingress, intra-event movement, and egress patterns
   (b) Ticketing and seating policies/practices
   (c) Event purpose (e.g., sports contest, religious meeting)
   (d) Emotional qualities (e.g., competitiveness) of event
   (e) Time of day when event is held
   (f) Time duration of single event
   (g) Time duration of attendees' occupancy of the building
(2) Occupant characteristics and behavior, including the following:
   (a) Homogeneity
   (b) Cohesiveness
   (c) Familiarity with building
   (d) Familiarity with similar events
   (e) Capability (as influenced by factors such as age, physical abilities)
   (f) Socioeconomic factors
   (g) Small minority involved with recreational violence
   (h) Emotional involvement with the event and other occupants
   (i) Use of alcohol or drugs
   (j) Food consumption
   (k) Washroom utilization
(3) Management, including the following:
   (a) Clear, contractual arrangements for facility operation/use as follows:
      i. Between facility owner and operator
      ii. Between facility operator and event promoter
      iii. Between event promoter and performer
      iv. Between event promoter and attendee
      v. With police forces
      vi. With private security services
      vii. With ushering services

(b) Experience with the building
(c) Experience with similar events and attendees
(d) Thorough, up-to-date operations manual
(e) Training of personnel
(f) Supervision of personnel
(g) Communications systems and utilization
(h) Ratios of management and other personnel to attendees
(i) Location/distribution of personnel
(j) Central command location
(k) Rapport between personnel and attendees
(l) Personnel support of attendee goals
(m) Respect of attendees for personnel due to the following:
i. Dress (uniform) standards
ii. Age and perceived experience
iii. Personnel behavior, including interaction
iv. Distinction between crowd management and control
v. Management concern for facility quality (e.g., cleanliness)
vi. Management concern for entire event experience of attendees (i.e., not just during occupancy of the building)

(4) Emergency management preparedness, including the following:
(a) Complete range of emergencies addressed in operations manual
(b) Power loss
(c) Fire
(d) Severe weather
(e) Earthquake
(f) Crowd incident
(g) Terrorism
(h) Hazardous materials
(i) Transportation accident (e.g., road, rail, air)
(j) Communications systems available
(k) Personnel and emergency forces ready to respond
(l) Attendees clearly informed of situation and proper behavior

(5) Building systems, including the following:
(a) Structural soundness
(b) Normal static loads
(c) Abnormal static loads (e.g., crowds, precipitation)
(d) Dynamic loads (e.g., crowd sway, impact, explosion, wind, earthquake)
(e) Stability of nonstructural components (e.g., lighting)
(f) Stability of movable (e.g., telescoping) structures
(g) Fire protection
(h) Fire prevention (e.g., maintenance, contents, housekeeping)
(i) Compartmentation
(j) Automatic detection and suppression of fire
(k) Smoke control
(l) Alarm and communications systems
(m) Fire department access routes and response capability
(n) Structural integrity
(o) Weather protection
(p) Wind
(q) Precipitation (attendees rush for shelter or hold up egress of others)
(r) Lightning protection
(s) Circulation systems
(t) Flowline or network analysis
(u) Waywinding and orientation
(v) Merging of paths (e.g., precedence behavior)
(w) Decision/branching points
(x) Route redundancies
(y) Counterflow, crossflow, and queuing situations
(z) Control possibilities, including metering
(aa) Flow capacity adequacy
(bb) System balance
(cc) Movement time performance
(dd) Flow times
(ee) Travel times
(ff) Queuing times
(gg) Route quality
(hh) Walking surfaces (e.g., traction, discontinuities)
(ii) Appropriate widths and boundary conditions
(jj) Handrails, guardrails, and other rails
(kk) Ramp slopes
(ll) Step geometries
(mm) Perceptual aspects (e.g., orientation, signage, marking, lighting, glare, distractions)
(nn) Route choices, especially for vertical travel
(oo) Resting/waiting areas
(pp) Levels of service (overall crowd movement quality)
(qq) Services
(rr) Washroom provision and distribution
(ss) Concessions
(tt) First aid and EMS facilities
(uu) General attendee services

A scenario-based approach to performance-based fire safety is addressed in Chapter 5. In addition to using such scenarios and, more generally, the attention to performance criteria, evaluation, safety factors, documentation, maintenance, and periodic assessment required when the Chapter 5 option is used, life safety evaluations should consider scenarios based on characteristics important in assembly occupancies. These characteristics include the following:

(1) Whether there is a local or mass awareness of an incident, event, or condition that might provoke egress
(2) Whether the incident, event, or condition stays localized or spreads
(3) Whether or not egress is desired by facility occupants
(4) Whether there is a localized start to any egress or mass start to egress
(5) Whether exits are available or not available

Examples of scenarios and sets of characteristics that might occur in a facility follow.

Scenario 1. Characteristics: mass start, egress desired (by management and attendees), exits not available, local awareness.

Normal egress at the end of an event occurs just as a severe weather condition induces evacuees at the exterior doors to retard or stop their egress. The backup that occurs in the egress system is not known to most evacuees, who continue to press forward, potentially resulting in a crowd crush.

Scenario 2. Characteristics: mass start, egress not desired (by management), exits possibly not available, mass awareness.

An earthquake occurs during an event. The attendees are relatively safe in the seating area. The means of egress outside the seating area are relatively unsafe and vulnerable to aftershock damage. Facility management discourages mass egress until the means of egress can be checked and cleared for use.

Scenario 3. Characteristics: local start, incident stays local, egress desired (by attendees and management), exits available, mass awareness.

A localized civil disturbance (e.g., firearms violence) provokes localized egress, which is seen by attendees, generally, who then decide to leave also.

Scenario 4. Characteristics: mass start, egress desired (by attendees), incident spreads, exits not available, mass awareness.

In an open-air facility unprotected from wind, precipitation, and lightning, sudden severe weather prompts egress to shelter, but not from the facility. The means of egress congest and block quickly as people in front stop once they are under shelter, while people behind them continue to press forward, potentially resulting in a crowd crush.

These scenarios illustrate some of the broader factors to be taken into account when assessing the capability of both building systems and management features on which reliance is placed in a range of situations, not just fire emergencies. Some scenarios also illustrate the conflicting motivations of management and attendees, based on differing perceptions of danger and differing knowledge of hazards, countermeasures, and capabilities. Mass egress might not be the most appropriate life safety strategy in some scenarios, such as Scenario 2.

Table A.12.4.1.3 summarizes the characteristics in the scenarios and provides a framework for developing other characteristics and scenarios that might be important for a particular facility, hazard, occupant type, event, or management.

A.12.4.2 Outdoor facilities are not accepted as inherently smoke-protected but must meet the requirements of smoke-protected assembly seating in order to utilize the special requirements for means of egress.

A.12.4.6.12 Prior editions of the *Code* required stages to be protected by a Class III standpipe system in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.* NFPA 14 requires that Class II and Class III standpipes be automatic — not manual — because they are intended to be used by building occupants. Automatic standpipe systems are required to provide not less than 500 gpm (1890 L/min) at 100 psi (689 kN/m^2). This requirement often can be met only if a fire pump is installed. Installation of a fire pump presents an unreasonable burden for the system supplying the two hose outlets at the side of the stage. The revised wording of 12.4.6.12 offers some relief by permitting the hose outlets to be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

A.12.4.8 Where a special amusement building is installed inside another building, such as within an exhibit hall, the special amusement building requirements apply only to the special amusement building. For example, the smoke detectors required by 12.4.8.4 are not required to be connected to the building's system. Where installed in an exhibit hall, such smoke detectors are also required to comply with the provisions applicable to an exhibit.

A.12.4.8.1 The aggregate horizontal projections of a multilevel play structure are indicative of the number of children who might be within the structure and at risk from a fire or similar emergency. The word "aggregate" is used in recognition of the fact that the platforms and tubes that make up the multilevel play structure run above each other at various levels. In calculating the area of the projections, it is important to account for all areas that might be expected to be occupied within, on top of, or beneath the components of the structure when the structure is used for its intended function.

A.12.4.8.2 See A.12.4.8.1.

A.12.4.8.7.3 Consideration should be given to the provision of directional exit marking on or adjacent to the floor.

A.12.4.11.2(2) Delayed-egress locks on doors from the airport loading walkway into the airport terminal building might compromise life safety due to the limited period of time the airport loading walkway will provide protection for emergency egress. The requirement of 12.4.11.2(2) would not limit the use of access-controlled or delayed-egress hardware from the airport terminal building into the airport loading walkway.

A.12.7.3(3)(a) Securely supported altar candles in churches that are well separated from any combustible material are permitted. On the other hand, lighted candles carried by children wearing cotton robes present a hazard too great to be permitted. There are many other situations of intermediate hazard where the authority having jurisdiction will have to exercise judgment.

A.12.7.4.1 Fabric applied over unused seating sections should meet the requirements of 12.7.4.

A.12.7.4.3 The phrase "unprotected materials containing foamed plastic" is meant to include foamed plastic items covered by "thermally thin" combustible fabrics or paint. *(See A.10.2.3.4.)*

A.12.7.5.3.7.1(3) See A.12.4.1.1.

A.12.7.6.2 Crowd managers and crowd manager supervisors need to clearly understand the required duties and responsibilities specific to the venue's emergency plan. The crowd management training program should include a clear appreciation of crowd dynamics factors including space, energy, time, and information, as well as specific crowd management techniques, such as metering. Training should involve specific actions necessary during normal and emergency operations, and include an assessment of people-handling capabilities of a space prior to its use, the identification of hazards, an evaluation of projected levels of occupancy, the adequacy of means of ingress and egress and identification of ingress and egress barriers, the processing procedures such as ticket collection, and the expected types of human behavior. Training should

Table A.12.4.1.3 Life Safety Evaluation Scenario Characteristics Matrix

					Management		Occupants						
Scenario	Local Awareness	Mass Awareness	Incident Localized	Incident Spreads	Egress Desired	Egress Not Desired	Egress Desired	Egress Not Desired	Local Start	Mass Start	Exits Available	Exits Not Available	Other
1	X	—	—	—	X	—	X	—	—	X	—	X	—
2	—	X	—	—	—	X	—	—	—	X	—	X	—
3	—	X	X	—	X	—	X	—	X	—	X	—	—
4	—	X	—	X	—	—	X	—	—	X	—	X	—

also involve the different types of emergency evacuations and, where required by the emergency plan, relocation and shelter-in-place operations, and the challenges associated with each.

A.12.7.6.4 In large facilities, crowd managers typically have a specific area of responsibility. In such facilities, the requirements of 12.7.6.4 might apply only to the crowd managers' area of responsibility.

A.12.7.7 It is important that an adequate number of competent attendants is on duty at all times when the assembly occupancy is occupied.

A.12.7.7.3 It is not the intent of this provision to require an announcement in bowling alleys, cocktail lounges, restaurants, or places of worship.

A.13.1.2 Assembly occupancy requirements should be determined on a room-by-room basis, a floor-by-floor basis, and a total building basis. The requirements for each room should be based on the occupant load of that room, and the requirements for each floor should be based on the occupant load of that floor, but the requirements for the assembly building overall should be based on the total occupant load. Therefore, it is quite feasible to have several assembly occupancies with occupant loads of 300 or less grouped together in a single building. Such a building would be an assembly occupancy with an occupant load of over 1000.

A.13.1.3.3 For example, an assembly room for the residents of a detention occupancy will not normally be subject to simultaneous occupancy.

A.13.1.4.2 An understanding of the term *accessory room* might be useful to the enforcer of the *Code*, although the term is not used within the *Code*. An accessory room includes a dressing room, the property master's work and storage rooms, the carpenter's room, or similar rooms necessary for legitimate stage operations.

A.13.1.7.1 The increase in occupant load above that calculated using occupant load factors from Table 7.3.1.2 is permitted if the provisions of 13.1.7.1 are followed. The owner or operator has the right to submit plans and to be permitted an increase in occupant load if the plans comply with the *Code*. The authority having jurisdiction is permitted to reject the plan for increase in occupant load if the plan is unrealistic, inaccurate, or otherwise does not properly reflect compliance with other *Code* requirements. It is not the intent of the provisions of 13.1.7.1 to prohibit an increase in occupant load solely on the basis of exceeding the limits calculated using occupant load factors from Table 7.3.1.2.

Existing auditorium and arena structures might not be designed for the added occupant load beyond the fixed seating. The authority having jurisdiction should consider exit access and aisles before permitting additional occupant load in areas using seating such as festival seating or movable seating on the auditorium or arena floor area.

To assist in preventing serious overcrowding incidents in sports arenas, stadia, and similar occupancies, spectator standing room should not be permitted between the seating areas and the playing areas, except in horse race and dog track facilities.

Where a capacity or near-capacity audience is anticipated, all seating should be assigned with tickets showing the section, row, and seat number.

Where standing room is permitted, the capacity of the standing area should meet the following criteria:

(1) The capacity should be determined on the basis of 5 ft^2 (0.46 m^2) per person.
(2) The capacity should be added to the seating capacity in determining egress requirements.
(3) The capacity should be located to the rear of the seating area.
(4) The capacity should be assigned standing-room-only tickets according to the area designated for the purpose.

The number of tickets sold, or otherwise distributed, should not exceed the aggregate number of seats plus the approved standing room numbers.

A.13.2.2.3.1(1) The seating plan and the means of egress should be reviewed each time the seating is substantially rearranged.

A.13.2.3.2 The provisions of 13.2.3.2 should be applied within the audience seating chamber and to the room doors. The capacity of means of egress components encountered after leaving the audience seating chamber, such as concourses, lobbies, exit stair enclosures, and the exit discharge, should be calculated in accordance with Section 7.3.

A.13.2.3.6.6 The original *Code* wording exempted sports arenas and railway stations. If an assembly occupancy was not similar to a sports arena or railway station, it was often judged ineligible to use the provision of 13.2.3.6.6. A list of exempted assembly venues also raises the question of why other occupancies are not included and necessitates additions to the list. For example, an exhibit hall of very large size might have several main entrances/exits. A theater extending the width of a block cannot really have a main entrance/exit in one confined location. A restaurant might have a main entrance serving the parking lot and another main entrance for those entering from the street. The authority having jurisdiction needs to determine where such arrangements are acceptable.

A.13.2.4 It is not the intent to require four means of egress from each level of an assembly occupancy building having a total occupant load of more than 1000 where, individually, the floors have occupant loads of less than 1000.

A.13.2.5.4.2 This requirement and the associated requirement of 13.2.5.4.3 have the effect of prohibiting festival seating, unless it truly is a form of seating, such as lawn seating, where generous spaces are commonly maintained between individuals and small groups so that people can circulate freely at any time. Such lawn seating is characterized by densities of about one person per 15 ft^2 (1.4 m^2). Both requirements prohibit uncontrolled crowd situations, such as in front of stages at rock music concerts where the number and density of people is uncontrolled by architectural or management features.

A.13.2.5.4.3 This requirement is intended to facilitate rapid emergency access to individuals who are experiencing a medical emergency, especially in the case of cardiopulmonary difficulties, where there is a need for rapid medical attention from trained personnel. The requirement also addresses the need for security and law enforcement personnel to reach individuals whose behavior is endangering themselves and others.

A.13.2.5.4.4 The catchment area served by an aisle accessway or aisle is the portion of the total space that is naturally served by the aisle accessway or aisle. Hence, the requirement for combining the required capacity where paths converge is, in effect, a restatement of the idea of a catchment area. The establishment of catchment areas should be based on a balanced use of all means of egress, with the number of persons in proportion to egress capacity.

A.13.2.5.5 For purposes of the means of egress requirements of this *Code*, tablet-arm chair seating is not considered seating at tables. Dinner theater–style configurations are required to comply with the aisle accessway provisions applying to seating at tables and the aisle requirements of 13.2.5.6, if the aisles contain steps or are ramped. *(See also 7.1.7 and A.7.1.7.2.)*

A.13.2.5.5.1 Seats having reclining backs are assumed to be in their most upright position when unoccupied.

A.13.2.5.5.5 The system known as *continental seating* has one pair of egress doors provided for every five rows that is located close to the ends of the rows. In previous editions of the *Code*, such egress doors were required to provide a clear width of not less than 66 in. (1675 mm) discharging into a foyer, into a lobby, or to the exterior of the building. This continental seating arrangement can result in egress flow times (i.e., with nominal flow times of approximately 100 seconds, rather than 200 seconds) that are approximately one-half as long as those resulting where side aisles lead to more remote doors. Such superior egress flow time performance is desirable in some situations; however, special attention should be given either to a comparably good egress capacity for other parts of the egress system or to sufficient space to accommodate queuing outside the seating space.

A.13.2.5.6.3 It is the intent to permit handrails to project not more than 3½ in. (90 mm) into the clear width of aisles required by 13.2.5.6.3.

A.13.2.5.6.4.1 Technical information about the convenience and safety of ramps and stairs having gradients in the region of 1 in 8 clearly suggests that the goal should be slopes for ramps that are less steep and combinations of stair risers and treads that are, for example, superior to 4 in. (100 mm) risers and 32 in. (865 mm) treads. This goal should be kept in mind by designers in establishing the gradient of seating areas to be served by aisles.

A.13.2.5.6.5(3) Tread depth is more important to stair safety than is riser height. Therefore, in cases where the seating area gradient is less than 5 in 11, it is recommended that the tread dimension be increased beyond 11 in. (280 mm), rather than reducing the riser height. Where the seating area gradient exceeds 8 in 11, it is recommended that the riser height be increased while maintaining a tread depth of not less than 11 in. (280 mm).

A.13.2.5.6.5(5) Completely uniform tread dimensions are preferred over aisle stair designs where tread depths alternate between relatively small intermediate treads between seating platforms and relatively large treads at seating platforms. A larger tread that is level with the seating platform is not needed to facilitate easy access to, and egress from, a row of seating. If this arrangement is used, it is important to provide a tread depth that is better than minimum for the intermediate tread; hence, 13 in. (330 mm) is specified. Where nonuniformities exist due to construction tolerance, they should not exceed 3⁄16 in. (4.8 mm) between adjacent treads.

A.13.2.5.6.9 Failure to provide a handrail within a 30 in. (760 mm) horizontal distance of all required portions of the aisle stair width means that the egress capacity calculation is required to be modified as specified by 13.2.3.3(3). This modification might lead to an increase in the aisle width. Although this increase will compensate for reduced egress efficiency, it does not help individuals walking on such portions of stairs to recover from missteps, other than by possibly marginally reducing the crowding that might exacerbate the problem of falls. *(See also 7.2.2.4.)*

A.13.2.5.6.10 Certain tread cover materials such as plush carpets, which are often used in theaters, produce an inherently well-marked tread nosing under most lighting conditions. On the other hand, concrete treads have nosings with a sharp edge and, especially under outdoor lighting conditions, are difficult to discriminate. Therefore, concrete treads require an applied marking stripe. The slip resistance of such marking stripes should be similar to the rest of the treads, and no tripping hazard should be created; luminescent, self-luminous, and electroluminescent tread markings have the advantage of being apparent in reduced light or in the absence of light.

A.13.2.5.7 For purposes of the means of egress requirements of this *Code*, seating at counters or at other furnishings is considered to be the same as seating at tables.

A.13.2.5.7.2 Effectively, where the aisle accessway is bounded by movable seating, the 12 in. (305 mm) minimum width might be increased by about 15 in. to 30 in. (380 mm to 760 mm) as seating is pushed in toward tables. Moreover, it is such movement of chairs during normal and emergency egress situations that makes the zero-clearance exception workable. The exception also applies to booth seating where people sitting closest to the aisle normally move out ahead of people farthest from the aisle.

A.13.2.5.7.3 See A.13.2.5.8.3.

A.13.2.5.7.4 The minimum width requirement as a function of accessway length is as follows:

(1) 0 in. (0 mm) for the first 6 ft (1830 mm) of length toward the exit
(2) 12 in. (305 mm) for the next 6 ft (1830 mm); that is, up to 12 ft (3660 mm) of length
(3) 12 in. to 24 in. (305 mm to 610 mm) for lengths from 12 ft to 36 ft (3.7 m to 11 m), the maximum length to the closest aisle or egress doorway permitted by 13.2.5.7.5

Any additional width needed for seating is to be added to these widths, as described in 13.2.5.8.3.

A.13.2.5.8.1 See 7.1.7 and A.7.1.7.2 for special circulation safety precautions applicable where small elevation differences occur.

A.13.2.5.8.2 It is important to make facilities accessible to people using wheelchairs. See ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities,* which provides guidance on appropriate aisle widths.

A.13.2.5.8.3 Figure A.13.2.5.8.3 shows typical measurements involving seating and tables abutting an aisle. Note that, for purposes of the means of egress requirements of this *Code*, seating at counters or other furnishings is considered to be the same as seating at tables.

A.13.3.1(1) The allowance for unenclosed stairs or ramps presumes the balcony or mezzanine complies with the other provisions of the *Code*, such as travel distance to exits in accordance with 13.2.6 and number of exits in accordance with 13.2.4. For the purposes of this exception, a balcony with glazing that provides a visual awareness of the main assembly area is considered open.

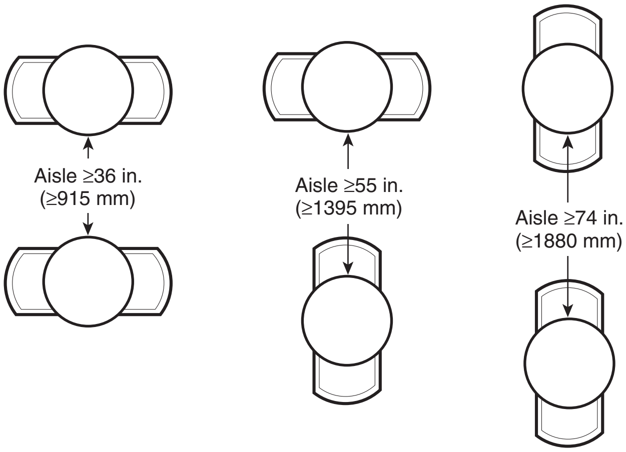


FIGURE A.13.2.5.8.3 Seating at Tables Abutting an Aisle.

A.13.3.4.2.3 The intent is to require detectors only in nonsprinklered hazardous areas that are unoccupied. Where the building is occupied, the detectors in the unoccupied, unsprinklered hazardous areas will initiate occupant notification. If the building is unoccupied, the fire in the nonsprinklered hazardous area is not a life safety issue, and the detectors, upon activation, are not required to notify anyone. The signal from a detector is permitted to be sent to a control panel in an area that is occupied when the building is occupied, but that is unoccupied when the building is unoccupied, without the need for central station monitoring or the equivalent.

A.13.4.1.1 Life safety evaluations are examples of performance-based approaches to life safety. In this respect, significant guidance in the form and process of life safety evaluations is provided by Chapter 5, keeping in mind the fire safety emphasis in Chapter 5. Performance criteria, scenarios, evaluation, safety factors, documentation, maintenance, and periodic assessment (including a warrant of fitness) all apply to the broader considerations in a life safety evaluation. A life safety evaluation deals not only with fire but also with storms, collapse, crowd behavior, and other related safety considerations for which a checklist is provided in A.13.4.1.3. Chapter 5 provides guidance, based on fire safety requirements, for establishing a documented case showing that products of combustion in all conceivable fire scenarios will not significantly endanger occupants using means of egress in the facility (e.g., due to fire detection, automatic suppression, smoke control, large-volume space, or management procedures). Moreover, means of egress facilities plus facility management capabilities should be adequate to cope with scenarios where certain egress routes are blocked for some reason.

In addition to making realistic assumptions about the capabilities of persons in the facility (e.g., an assembled crowd including many disabled persons or persons unfamiliar with the facility), the life safety evaluation should include a factor of safety of not less than 2.0 in all calculations relating to hazard development time and required egress time (the combination of flow time and other time needed to detect and assess an emergency condition, initiate egress, and move along the egress routes). This factor of safety takes into account the possibility that half of the egress routes might not be used (or usable) in certain situations.

Regarding crowd behavior, the potential hazards created by larger masses of people and greater crowd densities (which can be problematic during ingress, occupancy, and egress) demand that technology be used by designers, managers, and authorities responsible for buildings to compensate for the relaxed egress capacity provisions of Table 13.4.2.3. In very large buildings for assembly use, the hazard of crowd crushes can exceed that of fire or structural failure. Therefore, the building designers, managers, event planners, security personnel, police authorities, and fire authorities, as well as the building construction authorities, should understand the potential problems and solutions, including coordination of their activities. For crowd behavior, this understanding includes factors of space, energy, time, and information, as well as specific crowd management techniques, such as metering. Published guidance on these factors and techniques is found in the *SFPE Handbook of Fire Protection Engineering*, Section 3, Chapter 13, pp. 3-342–3-366 (Proulx, G., "Movement of People"), and the publications referenced therein.

Table 13.2.3.2 and Table 13.4.2.3 are based on a linear relationship between number of seats and nominal flow time, with not less than 200 seconds (3.3 minutes) for 2000 seats plus 1 second for every additional 50 seats up to 25,000. Beyond 25,000 total seats, the nominal flow time is limited to 660 seconds (11 minutes). Nominal flow time refers to the flow time for the most able group of patrons; some groups less familiar with the premises or less able groups might take longer to pass a point in the egress system. Although three or more digits are noted in the tables, the resulting calculations should be assumed to provide only two significant figures of precision.

A.13.4.1.3 Factors to be considered in a life safety evaluation might include the following:

(1) Nature of the events being accommodated, including the following:
   (a) Ingress, intra-event movement, and egress patterns
   (b) Ticketing and seating policies/practices
   (c) Event purpose (e.g., sports contest, religious meeting)
   (d) Emotional qualities (e.g., competitiveness) of event
   (e) Time of day when event is held
   (f) Time duration of single event
   (g) Time duration of attendees' occupancy of the building
(2) Occupant characteristics and behavior, including the following:
   (a) Homogeneity
   (b) Cohesiveness
   (c) Familiarity with building
   (d) Familiarity with similar events
   (e) Capability (as influenced by factors such as age, physical abilities)
   (f) Socioeconomic factors
   (g) Small minority involved with recreational violence
   (h) Emotional involvement with the event and other occupants
   (i) Use of alcohol or drugs
   (j) Food consumption
   (k) Washroom utilization
(3) Management, including the following:
   (a) Clear, contractual arrangements for facility operation/use as follows:
      i. Between facility owner and operator
      ii. Between facility operator and event promoter
      iii. Between event promoter and performer
      iv. Between event promoter and attendee
      v. With police forces
      vi. With private security services
      vii. With ushering services

(b) Experience with the building
(c) Experience with similar events and attendees
(d) Thorough, up-to-date operations manual
(e) Training of personnel
(f) Supervision of personnel
(g) Communications systems and utilization
(h) Ratios of management and other personnel to attendees
(i) Location/distribution of personnel
(j) Central command location
(k) Rapport between personnel and attendees
(l) Personnel support of attendee goals
(m) Respect of attendees for personnel due to the following:
    i. Dress (uniform) standards
    ii. Age and perceived experience
    iii. Personnel behavior, including interaction
    iv. Distinction between crowd management and control
    v. Management concern for facility quality (e.g., cleanliness)
    vi. entire event experience of attendees (i.e., not just during occupancy of the building)

(4) Emergency management preparedness, including the following:
(a) Complete range of emergencies addressed in operations manual
(b) Power loss
(c) Fire
(d) Severe weather
(e) Earthquake
(f) Crowd incident
(g) Terrorism
(h) Hazardous materials
(i) Transportation accident (e.g., road, rail, air)
(j) Communications systems available
(k) Personnel and emergency forces ready to respond
(l) Attendees clearly informed of situation and proper behavior

(5) Building systems, including the following:
(a) Structural soundness
(b) Normal static loads
(c) Abnormal static loads (e.g., crowds, precipitation)
(d) Dynamic loads (e.g., crowd sway, impact, explosion, wind, earthquake)
(e) Stability of nonstructural components (e.g., lighting)
(f) Stability of movable (e.g., telescoping) structures
(g) Fire protection
(h) Fire prevention (e.g., maintenance, contents, housekeeping)
(i) Compartmentation
(j) Automatic detection and suppression of fire
(k) Smoke control
(l) Alarm and communications systems
(m) Fire department access routes and response capability
(n) Structural integrity
(o) Weather protection
(p) Wind
(q) Precipitation (attendees rush for shelter or hold up egress of others)
(r) Lightning protection
(s) Circulation systems
(t) Flowline or network analysis
(u) Waywinding and orientation
(v) Merging of paths (e.g., precedence behavior)
(w) Decision/branching points
(x) Route redundancies
(y) Counterflow, crossflow, and queuing situations
(z) Control possibilities, including metering
(aa) Flow capacity adequacy
(bb) System balance
(cc) Movement time performance
(dd) Flow times
(ee) Travel times
(ff) Queuing times
(gg) Route quality
(hh) Walking surfaces (e.g., traction, discontinuities)
(ii) Appropriate widths and boundary conditions
(jj) Handrails, guardrails, and other rails
(kk) Ramp slopes
(ll) Step geometries
(mm) Perceptual aspects (e.g., orientation, signage, marking, lighting, glare, distractions)
(nn) Route choices, especially for vertical travel
(oo) Resting/waiting areas
(pp) Levels of service (overall crowd movement quality)
(qq) Services
(rr) Washroom provision and distribution
(ss) Concessions
(tt) First aid and EMS facilities
(uu) General attendee services

A scenario-based approach to performance-based fire safety is addressed in Chapter 5. In addition to utilizing such scenarios and, more generally, the attention to performance criteria, evaluation, safety factors, documentation, maintenance, and periodic assessment required when the Chapter 5 option is used, life safety evaluations should consider scenarios based on characteristics important in assembly occupancies. These characteristics include the following:

(1) Whether there is a local or mass awareness of an incident, event, or condition that might provoke egress
(2) Whether the incident, event, or condition stays localized or spreads
(3) Whether or not egress is desired by facility occupants
(4) Whether there is a localized start to any egress or mass start to egress
(5) Whether exits are available or not available

Examples of scenarios and sets of characteristics that might occur in a facility follow.

Scenario 1. Characteristics: mass start, egress desired (by management and attendees), exits not available, local awareness.

Normal egress at the end of an event occurs just as a severe weather condition induces evacuees at the exterior doors to retard or stop their egress. The backup that occurs in the egress system is not known to most evacuees, who continue to press forward, potentially resulting in a crowd crush.

Scenario 2. Characteristics: mass start, egress not desired (by management), exits possibly not available, mass awareness.

An earthquake occurs during an event. The attendees are relatively safe in the seating area. The means of egress outside the seating area are relatively unsafe and vulnerable to aftershock damage. Facility management discourages mass egress until the means of egress can be checked and cleared for use.

Scenario 3. Characteristics: local start, incident stays local, egress desired (by attendees and management), exits available, mass awareness.

A localized civil disturbance (e.g., firearms violence) provokes localized egress, which is seen by attendees, generally, who then decide to leave also.

Scenario 4. Characteristics: mass start, egress desired (by attendees), incident spreads, exits not available, mass awareness.

In an open-air facility unprotected from wind, precipitation, and lightning, sudden severe weather prompts egress to shelter but not from the facility. The means of egress congest and block quickly as people in front stop once they are under shelter, while people behind them continue to press forward, potentially resulting in a crowd crush.

These scenarios illustrate some of the broader factors to be taken into account when assessing the capability of both building systems and management features on which reliance is placed in a range of situations, not just fire emergencies. Some scenarios also illustrate the conflicting motivations of management and attendees based on differing perceptions of danger and differing knowledge of hazards, countermeasures, and capabilities. Mass egress might not be the most appropriate life safety strategy in some scenarios, such as Scenario 2.

Table A.13.4.1.3 summarizes the characteristics in the scenarios and provides a framework for developing other characteristics and scenarios that might be important for a particular facility, hazard, occupant type, event, or management.

A.13.4.2 Outdoor facilities are not accepted as inherently smoke-protected but must meet the requirements of smoke-protected assembly seating in order to use the special requirements for means of egress.

A.13.4.6.12 Prior editions of the *Code* required stages to be protected by a Class III standpipe system in accordance with NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.* NFPA 14 requires that Class II and Class III standpipes be automatic — not manual — because they are intended to be used by building occupants. Automatic standpipe systems are required to provide not less than 500 gpm (1890 L/min) at 100 psi (689 kN/m^2). This requirement often can be met only if a fire pump is installed. Installation of a fire pump presents an unreasonable burden for the system supplying the two hose outlets at the side of the stage. The revised wording of 13.4.6.12 offers some relief by permitting the hose outlets to be in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

A.13.4.8 Where a special amusement building is installed inside another building, such as within an exhibit hall, the special amusement building requirements apply only to the special amusement building. For example, the smoke detectors required by 13.4.8.4 are not required to be connected to the building's system. Where installed in an exhibit hall, such smoke detectors are also required to comply with the provisions applicable to an exhibit.

A.13.4.8.1 The aggregate horizontal projections of a multilevel play structure are indicative of the number of children who might be within the structure and at risk from a fire or similar emergency. The word "aggregate" is used in recognition of the fact that the platforms and tubes that make up the multilevel play structure run above each other at various levels. In calculating the area of the projections, it is important to account for all areas that might be expected to be occupied within, on top of, or beneath the components of the structure when the structure is used for its intended function.

A.13.4.8.2 See A.13.4.8.1.

A.13.4.8.7.3 Consideration should be given to the provision of directional exit marking on or adjacent to the floor.

A.13.4.11.2(2) Delayed-egress locks on doors from the airport loading walkway into the airport terminal building might compromise life safety due to the limited period of time the airport loading walkway will provide protection for emergency egress. The requirement of 13.4.11.2(2) would not limit the use of access-controlled or delayed-egress hardware from the airport terminal building into the airport loading walkway.

A.13.7.3(3)(a) Securely supported altar candles in churches that are well separated from any combustible material are permitted. On the other hand, lighted candles carried by children wearing cotton robes present a hazard too great to be permitted. There are many other situations of intermediate hazard where the authority having jurisdiction will have to exercise judgment.

A.13.7.4.1 Fabric applied over unused seating sections should meet the requirements of 13.7.4.

A.13.7.4.3 The phrase "unprotected materials containing foamed plastic" is meant to include foamed plastic items covered by "thermally thin" combustible fabrics or paint. *(See A.10.2.3.4.)*

A.13.7.5.3.7.1(3) See A.13.4.1.1.

A.13.7.6.2 Crowd managers and crowd manager supervisors need to clearly understand the required duties and responsibilities specific to the venue's emergency plan. The crowd management training program should include a clear appreciation of crowd dynamics factors including space, energy, time, and information, as well as specific crowd management techniques, such as metering. Training should involve specific actions necessary during normal and emergency operations, and include an assessment of people-handling capabilities of a space prior to its use, the identification of hazards, an evaluation of projected levels of occupancy, the adequacy of means of ingress and egress and identification of ingress and egress barriers, the processing procedures such as ticket collection,

Table A.13.4.1.3 Life Safety Evaluation Scenario Characteristics Matrix

					Management		Occupants						
Scenario	Local Awareness	Mass Awareness	Incident Localized	Incident Spreads	Egress Desired	Egress Not Desired	Egress Desired	Egress Not Desired	Local Start	Mass Start	Exits Available	Exits Not Available	Other
1	X	—	—	—	X	—	X	—	—	X	—	X	—
2	—	X	—	—	—	X	—	—	—	X	—	X	—
3	—	X	X	—	X	—	X	—	X	—	X	—	—
4	—	X	—	X	—	—	X	—	—	X	—	X	—

and the expected types of human behavior. Training should also involve the different types of emergency evacuations and, where required by the emergency plan, relocation and shelter-in-place operations, and the challenges associated with each.

A.13.7.6.4 In large facilities, crowd managers typically have a specific area of responsibility. In such facilities, the requirements of 13.7.6.4 might apply only to the crowd managers' area of responsibility.

A.13.7.7 It is important that an adequate number of competent attendants is on duty at all times when the assembly occupancy is occupied.

A.13.7.7.3 It is not the intent of this provision to require an announcement in bowling alleys, cocktail lounges, restaurants, or places of worship.

A.14.2.2.3 See 7.2.2.4.5.4 regarding additional handrails on stairs that are used extensively by children 5 years of age or less.

A.14.2.5.9 A corridor roofed over and enclosed on its long side and open to the atmosphere at the end is permitted to be considered an exterior corridor if either of the following criteria are met:

(1) Clear story openings for the corridor are provided on both sides of the corridor and above adjacent roofs or buildings, and such clear openings are not less than one-half the height of the corridor walls.
(2) The corridor roof has unobstructed openings to the sky not less than 50 percent of the area of the roof.

The openings detailed in A.14.2.5.9(1) and (2) are to be equally distributed, and, if louvers are installed, they are to be fixed open with a clear area based on the actual openings between louver vanes.

A.14.2.11.1 It is highly desirable that all windows be of a type that can be readily opened from inside and that they are large enough and low enough for use by students, teachers, and fire fighters. Windows are permitted to serve as a supplementary means of emergency escape, particularly where ladders can be raised by fire fighters or others.

A.14.3.3.2 The definition of interior wall finish is meant to include washroom water closet partitions.

A.14.3.4.2.3.1 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal.

A.14.3.4.2.3.2 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal.

A.14.3.5.1 It is the intent to permit use of the criteria of 8.2.1.3(1) to create separate buildings for purposes of limiting educational occupancy building area to not more than 12,000 ft^2 (1120 m^2).

A.14.7.2.1 The requirements are, of necessity, general in scope, as it is recognized that they apply to all types of educational occupancies as well as conditions of occupancies, such as truant schools; schools for the mentally handicapped, vision impaired, hearing impaired, and speech impaired; and public schools. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators to issue supplements to these requirements, but all supplements should be consistent with these requirements.

A.14.7.3.1 Particular attention should be given to keeping all doors unlocked; keeping doors that serve to protect the safety of paths of egress closed and under no conditions blocked open, such as doors on stairway enclosures; keeping outside stairs and fire escape stairs free from all obstructions and clear of snow and ice; and allowing no accumulation of snow or ice or materials of any kind outside exit doors that might prevent the opening of the door or interfere with rapid escape from the building.

Any condition likely to interfere with safe egress should be corrected immediately, if possible, or otherwise should be reported at once to the appropriate authorities.

A.15.2.2.3 See 7.2.2.4.5.4 regarding additional handrails on stairs that are used extensively by children 5 years of age or less.

A.15.2.5.9 A corridor roofed over and enclosed on its long side and open to the atmosphere at the end is permitted to be considered an exterior corridor if either of the following criteria are met:

(1) Clear story openings for the corridor are provided on both sides of the corridor and above adjacent roofs or buildings, and such clear openings are not less than one-half the height of the corridor walls.
(2) The corridor roof has unobstructed openings to the sky not less than 50 percent of the area of the roof.

The openings detailed in A.15.2.5.9(1) are to be equally distributed, and, if louvers are installed, they are to be fixed open with a clear area based on the actual openings between louver vanes.

A.15.2.11.1 It is highly desirable that all windows be of a type that can be readily opened from inside and that they are large enough and low enough for use by students, teachers, and fire fighters. Windows are permitted to serve as a supplementary means of emergency escape, particularly where ladders can be raised by fire fighters or others.

A.15.3.4.2.3.1 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal.

A.15.3.4.2.3.2 Occupied portions of the building should have access to a central point for manual activation of the evacuation signal.

A.15.3.4.3.1.1 The audible occupant notification signal for evacuation of an educational occupancy building should be the distinctive three-pulse temporal pattern fire alarm evacuation signal that is required of new systems by *NFPA 72, National Fire Alarm and Signaling Code.* The temporal pattern will help educate students to recognize the need to evacuate when they are in other occupancies. Existing fire alarm systems should be modified, as feasible, to sound the three-pulse temporal pattern.

A.15.3.6(2) This provision permits valve supervision in accordance with Section 9.7, rather than requiring that the entire automatic sprinkler system be electrically supervised. It is intended that the valve supervision be performed electrically, not by chaining and locking the valves in the open position.

A.15.7.2.1 The requirements are, of necessity, general in scope, as it is recognized that they apply to all types of educational occupancies as well as conditions of occupancies, such as truant schools; schools for the mentally handicapped, vision impaired, hearing impaired, and speech impaired; and public schools. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators to issue supplements to these requirements, but all supplements should be consistent with these requirements.

A.15.7.3.1 Particular attention should be given to keeping all doors unlocked; keeping doors that serve to protect the safety of paths of egress closed and under no conditions blocked open, such as doors on stairway enclosures; keeping outside stairs and fire escape stairs free from all obstructions and clear of snow and ice; and allowing no accumulation of snow or ice or materials of any kind outside exit doors that might prevent the opening of the door or interfere with rapid escape from the building.

Any condition likely to interfere with safe egress should be corrected immediately, if possible, or otherwise should be reported at once to the appropriate authorities.

A.16.1.1 Day-care occupancies do not provide for the full-time maintenance of a client. Occupancies that provide a primary place of residence are addressed in other occupancy chapters. *(See Chapters 24 through 33.)*

The requirements of Chapter 16 are based on the need to adequately protect the occupants in case of fire. The requirements assume that adequate staffing will be available and are based on staffing similar to that outlined in Table A.16.1.1.

Table A.16.1.1 Staffing

Staff-to-Client Ratio	Age (mo.)
1:3	0–24
1:4	25–36
1:7	37–60
1:10	61–96
1:12	≥97
1:3	Clients incapable of self-preservation

If staff-to-client ratios fall below those suggested by Table A.16.1.1, it is the responsibility of the authority having jurisdiction to determine the additional safeguards beyond the requirements of Chapter 16 that are necessary. Typical additional provisions might include restricting the day-care occupancy to the level of exit discharge, requiring additional smoke detection, requiring automatic sprinkler protection, requiring better or additional means of egress, and requiring similar types of provisions, depending on the situation.

A.16.1.2.3 A conversion from a day-care occupancy with more than 12 clients to a day-care home is not considered a change of occupancy. The resulting day-care home should be permitted to meet the requirements of Chapter 17 for existing day-care homes.

A.16.2.2.2.4 The purpose of this requirement is to prevent arrangements whereby a client can be trapped in a space or area. It is intended that this provision be broadly interpreted by the authority having jurisdiction to include equipment such as refrigerators and freezers.

A.16.2.2.3 See 7.2.2.4.5.4 regarding additional handrails on stairs that are used extensively by children 5 years of age or less.

A.16.3.2.1(2)(a) It is not the intent to classify a room with a domestic-type clothes washer and a domestic-type clothes dryer as a laundry.

A.16.6.1.4.2 A conversion from a day-care occupancy with more than 12 clients to a day-care home is not considered a change of occupancy. The resulting day-care home should be permitted to meet the requirements of Chapter 17 for existing day-care homes.

A.16.7.1 The requirements are, of necessity, general in scope, because it is recognized that they apply to all types of day-care occupancies as well as conditions of occupancies, such as truant day-care occupancies; occupancies for the mentally handicapped, vision impaired, hearing impaired, and speech impaired; adult day-care; care of infants; and day-care occupancies. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators, through the written fire emergency response plan, to issue supplements to these requirements; however, all supplements should be consistent with these requirements. Additionally, it is recommended that fire safety be a part of the educational programs of the occupancy for clients.

Fire emergency response plans need to be written and made available to all employees, including temporary or substitute staff, so that all employees know what is expected of them during a fire emergency. The elements needed in the written plan should be identified in coordination with the authority having jurisdiction.

The facility fire emergency response plan might be a module of a facility disaster plan that covers other emergencies.

The proper safeguarding of clients during a fire emergency requires prompt and effective response by the facility employees in accordance with the fire emergency response plan. Duties covered under the plan should be assigned by position rather than by employee name. Such assignment ensures that, in the absence of an employee, the duties of the position will be performed by a substitute or temporary employee assigned to the position. Temporary or substitute employees should be instructed in advance regarding their duties under the plan for the position to which they are assigned.

Written fire emergency response plans should include, but should not be limited to, information for employees regarding methods and devices available for alerting occupants of a fire emergency. Employees should know how the fire department is to be alerted. Even where automatic systems are expected to alert the fire department, the written plan should provide for backup alerting procedures by staff. Other responses of employees to a fire emergency should include the following:

(1) Removal of clients in immediate danger to areas of safety, as set forth in the plan
(2) Methods of using building features to confine the fire and its byproducts to the room or area of origin
(3) Control of actions and behaviors of clients during removal or evacuation activities and at predetermined safe assembly areas

The written plan should state clearly the facility policy regarding the actions staff are to take or not take to extinguish a fire. It should also incorporate the emergency egress and relocation drill procedures set forth in 16.7.2.

For additional guidance on emergency action plans, see *NFPA 1600, Standard on Disaster/Emergency Management and Business Continuity Programs*. This standard establishes a common set of criteria for disaster management, emergency management, and business continuity programs.

A.16.7.2.1 The requirements are, of necessity, general in scope, because it is recognized that they apply to all types of day-care occupancies as well as conditions of occupancies, such as truant day-care occupancies; and day-care occupancies for the mentally handicapped, vision impaired, hearing impaired, and speech impaired. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators to issue supplements to these requirements, but all supplements should be consistent with these requirements.

A.16.7.3.2 Particular attention should be given to keeping all doors unlocked; keeping doors that serve to protect the safety of paths of egress closed and under no conditions blocked open, such as doors on stairway enclosures; keeping outside stairs and fire escape stairs free from all obstructions and clear of snow and ice; and allowing no accumulation of snow or ice or materials of any kind outside exit doors that might prevent the opening of the door or interfere with rapid escape from the building.

A.16.7.5 It is the intent that the requirement for adequate adult staff to be awake at all times when clients are present be applied to family day-care and group day-care homes that are operated at night, as well as day-care occupancies.

A.17.1.1 Day-care occupancies do not provide for the full-time maintenance of a client. Occupancies that provide a primary place of residence are addressed in other occupancies. *(See Chapters 24 through 33.)*

The requirements of Chapter 17 are based on the need to adequately protect the occupants in case of fire. The requirements assume that adequate staffing will be available and are based on staffing similar to that outlined in Table A.17.1.1.

Table A.17.1.1 Staffing

Staff-to-Client Ratio	Age (mo.)
1:3	0–24
1:4	25–36
1:7	37–60
1:10	61–96
1:12	≥97
1:3	Clients incapable of self-preservation

If staff-to-client ratios fall below those suggested by Table A.17.1.1, it is the responsibility of the authority having jurisdiction to determine the additional safeguards beyond the requirements of Chapter 17 that are necessary. Typical additional provisions might include restricting the day-care occupancy to the level of exit discharge, requiring additional smoke detection, requiring automatic sprinkler protection, requiring better or additional means of egress, and requiring similar types of items, depending on the situation.

A.17.1.2.3 A conversion from a day-care occupancy with more than 12 clients to a day-care home is not considered a change of occupancy. The resulting day-care home should be permitted to meet the requirements of Chapter 17 for existing day-care homes.

A.17.2.2.2.4 The purpose of this requirement is to prevent arrangements where a client can be trapped in a space or area. It is intended that this provision be broadly interpreted by the authority having jurisdiction to include equipment such as refrigerators and freezers.

A.17.2.2.3 See 7.2.2.4.5.4 regarding additional handrails on stairs that are used extensively by children 5 years of age and under.

A.17.3.2.1(2)(a) It is not the intent to classify a room with a domestic-type clothes washer and a domestic-type clothes dryer as a laundry.

A.17.6.1.1.2 Day-care homes do not provide for the full-time maintenance of a client. Day-care occupancies that provide a primary place of residence are addressed in other occupancy chapters. *(See Chapters 24 through 33.)*

A.17.6.1.4.2 A conversion from a day-care occupancy with more than 12 clients to a day-care home is not considered a change of occupancy. The resulting day-care home should be permitted to meet the requirements of Chapter 17 for existing day-care homes.

A.17.7.1 The requirements are, of necessity, general in scope, because it is recognized that they apply to all types of day-care occupancies as well as conditions of occupancies, such as truant day-care occupancies; occupancies for the mentally handicapped, vision impaired, hearing impaired, and speech impaired; adult day-care; care of infants; and day-care occupancies. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators, through the written fire emergency response plan, to issue supplements to these requirements; however, all supplements should be consistent with these requirements. Additionally, it is recommended that fire safety be a part of the educational programs of the occupancy for clients.

Fire emergency response plans need to be written and made available to all employees, including temporary or substitute staff, so that all employees know what is expected of them during a fire emergency. The elements needed in the written plan should be identified in coordination with the authority having jurisdiction.

The facility fire emergency response plan might be a module of a facility disaster plan that covers other emergencies.

The proper safeguarding of clients during a fire emergency requires prompt and effective response by the facility employees in accordance with the fire emergency response plan. Duties covered under the plan should be assigned by position rather than by employee name. Such assignment ensures that, in the absence of an employee, the duties of the position will be performed by a substitute or temporary employee assigned to the position. Temporary or substitute employees should be instructed in advance regarding their duties under the plan for the position to which they are assigned.

Written fire emergency response plans should include, but should not be limited to, information for employees about methods and devices available for alerting occupants of a fire emergency. Employees should know how the fire department is to be alerted. Even where automatic systems are expected to alert the fire department, the written plan should provide for backup alerting procedures by staff. Other responses of employees to a fire emergency should include the following:

(1) Removal of clients in immediate danger to areas of safety, as set forth in the plan

(2) Methods of using building features to confine the fire and its byproducts to the room or area of origin
(3) Control of actions and behaviors of clients during removal or evacuation activities and at predetermined safe assembly areas

The written plan should state clearly the facility policy regarding the actions staff are to take or not take to extinguish a fire. It should also incorporate the emergency egress and relocation drill procedures set forth in 17.7.2.

For additional guidance on emergency action plans, see *NFPA 1600, Standard on Disaster/Emergency Management and Business Continuity Programs*. This standard establishes a common set of criteria for disaster management, emergency management, and business continuity programs.

A.17.7.2.1 The requirements are, of necessity, general in scope, because it is recognized that they apply to all types of day-care occupancies as well as conditions of occupancies, such as truant day-care occupancies; and day-care occupancies for the mentally handicapped, vision impaired, hearing impaired, and speech impaired. It is fully recognized that no one code can meet all the conditions of the various buildings involved, and it will be necessary for site administrators to issue supplements to these requirements, but all supplements should be consistent with these requirements.

A.17.7.3.2 Particular attention should be given to keeping all doors unlocked; keeping doors that serve to protect the safety of paths of egress closed and under no conditions blocked open, such as doors on stairway enclosures; keeping outside stairs and fire escape stairs free from all obstructions and clear of snow and ice; and allowing no accumulation of snow or ice or materials of any kind outside exit doors that might prevent the opening of the door or interfere with rapid escape from the building.

A.17.7.5 It is the intent that the requirement for adequate adult staff to be awake at all times when clients are present be applied to family day-care and group day-care homes that are operated at night, as well as day-care occupancies.

A.18.1.1.1.1 In determining equivalency for conversions, modernizations, renovations, or unusual design concepts of hospitals or nursing homes, the authority having jurisdiction is permitted to accept evaluations based on the health care occupancies for safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, utilizing the parameters for new construction.

A.18.1.1.1.7 There are many reasons why doors in the means of egress in health care occupancies might need to be locked for the protection of the patients or the public. Examples of conditions that might justify door locking include dementia, mental health, infant care, pediatric care, or patients under court detention order requiring medical treatment in a health care facility. See 18.2.2.2.5 for details on door locking.

A.18.1.1.1.10 The *Code* recognizes that certain functions necessary for the life safety of building occupants — such as the detection of fire and associated products of combustion, the closing of corridor doors, the operation of manual fire alarm devices, and the removal of patients from the room of fire origin — require the intervention of facility staff. It is not the intent of 18.1.1.1.10 to specify the levels or locations of staff necessary to meet this requirement.

A.18.1.1.2 This objective is accomplished in the context of the physical facilities, the type of activities undertaken, the provisions for the capabilities of staff, and the needs of all occupants through requirements directed at the following:

(1) Prevention of ignition
(2) Detection of fire
(3) Control of fire development
(4) Confinement of the effects of fire
(5) Extinguishment of fire
(6) Provision of refuge or evacuation facilities, or both
(7) Staff reaction

A.18.1.1.4.3.3 For the purpose of this requirement, a floor that is not divided by a smoke barrier is considered one smoke compartment. Where automatic sprinklers are retrofitted into existing nonsprinklered buildings, the construction alternatives for sprinklers provided in this *Code* are intended to apply to the renovated area.

A.18.1.1.4.3.4 In minor rehabilitation, only the rehabilitation itself — not the entire smoke compartment or building — is required to be brought up to the requirements for new nonsprinklered facilities.

A.18.1.3.4 Doctors' offices and treatment and diagnostic facilities that are intended solely for outpatient care and are physically separated from facilities for the treatment or care of inpatients, but that are otherwise associated with the management of an institution, might be classified as business occupancies rather than health care occupancies. Facilities that do not provide housing for patients on a 24-hour basis are required to be classified as other than health care occupancies per 18.1.1.1.9, except where services are provided routinely to four or more inpatients who are incapable of self-preservation.

A.18.1.3.5.1 It is the intent that these requirements apply to mobile, transportable, and relocatable structures (in accordance with 1.3.2) where such structures are used to provide shared medical services on an extended or a temporary basis. Where properly separated from the health care occupancy and intended to provide services simultaneously for three or fewer health care patients who are litterborne, the level of protection for such structures should be based on the appropriate occupancy classification of other chapters of this *Code*. Mobile, transportable, or relocatable structures that are not separated from a contiguous health care occupancy, or that are intended to provide services simultaneously for four or more health care patients who are litterborne, should be classified and designed as health care occupancies.

A.18.2.2 In planning egress, arrangements should be made to transfer patients from one section of a floor to another section of the same floor that is separated by a fire barrier or smoke barrier in such a manner that patients confined to their beds can be transferred in their beds. Where the building design will allow, the section of the corridor containing an entrance or elevator lobby should be separated from corridors leading from it by fire or smoke barriers. Such arrangement, where the lobby is centrally located, will, in effect, produce a smoke lock, placing a double barrier between the area to which patients might be taken and the area from which they need to be evacuated because of threatening smoke and fire.

A.18.2.2.2.4(2) Where delayed-egress locks complying with 7.2.1.6.1 are used, the provisions of 18.2.2.2.5 are not required.

A.18.2.2.2.4(3) Where access-controlled egress doors complying with 7.2.1.6.2 are used, the provisions of 18.2.2.2.5 are not required.

A.18.2.2.2.5.1 Psychiatric units, Alzheimer units, and dementia units are examples of areas with patients who might have clinical needs that justify door locking. Forensic units and detention units are examples of areas with patients who might pose a security threat. Where Alzheimer or dementia patients in nursing homes are not housed in specialized units, the provisions of 18.2.2.2.5.1 should not apply. *(See 18.2.2.2.5.2.)*

A.18.2.2.2.5.2 Pediatric units, maternity units, and emergency departments are examples of areas where patients might have special needs that justify door locking. Door locking arrangements should be permitted to reduce the risk of abduction of infants and children who are patients.

A.18.2.2.2.5.2(3) Where locked doors in accordance with 18.2.2.2.5.2 are proposed for an existing building that is not sprinklered throughout, the authority having jurisdiction might consider permitting the installation based on an analysis of the extent of sprinkler protection provided. Sprinklered areas should include, at a minimum, the secured compartment and compartments that the occupants of the secured compartment must travel through to egress the building.

A.18.2.2.2.7 In some health care occupancies, especially nursing homes, the use of murals to disguise doors has been found to be beneficial for certain patient populations. This provision is intended to apply to disguising of egress doors by painting the doors or the use of wall paper on the doors. The marking of the means of egress such as required exit signs should be clearly visible and not disguised by the mural. Where decorations are applied to the door, the requirements of Section 18.7 would still apply and painting a mural on the door would not be considered a decoration. Such murals should not obscure required vision panels or affect the required fire resistance rating of fire-rated door assemblies.

A.18.2.2.2.7(2) It is intended that the door-releasing hardware includes levers, locks, knobs, and panic bars, that are directly operated or grasped by staff.

A.18.2.2.2.7(3) It is intended that the door hardware that is permitted to be covered (i.e., disguised by the mural) includes items such as hinges, closers, and magnets, which would normally not be directly operated or grasped by staff.

A.18.2.2.2.8 It is desirable to keep doors in exit passageways, stair enclosures, horizontal exits, smoke barriers, and required enclosures around hazardous areas closed at all times to impede the travel of smoke and fire gases. Functionally, however, this involves decreased efficiency and limits patient observation by the staff of a facility. To accommodate such needs, it is practical to presume that such doors will be kept open, even to the extent of employing wood chocks and other makeshift devices. Doors in exit passageways, horizontal exits, and smoke barriers should, therefore, be equipped with automatic hold-open devices activated by the methods described, regardless of whether the original installation of the doors was predicated on a policy of keeping them closed.

A.18.2.3.4 It is not the intent that the required corridor width be maintained clear and unobstructed at all times. Projections into the required width are permitted by 7.3.2.2. It is not the intent that 18.2.3.4 supersede 7.3.2.2.

A.18.2.3.4(1) Occupant characteristics are an important factor to be evaluated in setting egress criteria. Egress components in nonpatient use areas, such as administrative office spaces, should be evaluated based on actual use. A clear corridor width of not less than 44 in. (1120 mm) is specified, assuming occupants in nonpatient areas will be mobile and capable of evacuation without assistance.

A.18.2.3.4(2) The intent of 18.2.3.4 is to permit limited noncontinuous projections along the corridor wall. These include hand-rub dispensing units complying with 18.3.2.6, nurse charting units, wall-mounted computers, telephones, artwork, bulletin boards, display case frames, cabinet frames, fire alarm boxes, and similar items. It is not the intent to permit the narrowing of the corridor by the walls themselves. The provision of 7.3.2.2 permits projections up to 4½ in. (114 mm) to be present at and below the 38 in. (965 mm) height specified in 18.2.3.4(2), and it is not the intent of 18.2.3.4 (2) to prohibit such projections. Permitting projections above the 38 in. (965 mm) handrail height complies with the intent of the requirement, as such projections will not interfere with the movement of gurneys, beds, and wheelchairs. Projections below handrail height for limited items, such as fire extinguisher cabinets and recessed water coolers, also will not interfere with equipment movement.

Building codes and accessibility codes might require cane detection below projections that exceed 4 in. (102 mm).

A.18.2.3.4(3) Exit access should be arranged to avoid any obstructions to the convenient removal of nonambulatory persons carried on stretchers or on mattresses serving as stretchers.

A.18.2.3.4(4)(c) Wheeled equipment and carts in use include food service carts, housekeeping carts, medication carts, isolation carts, and similar items. Isolation carts should be permitted in the corridor only where patients require isolation precautions.

Unattended wheeled crash carts and other similar wheeled emergency equipment are permitted to be located in the corridor when "not in use," because they need to be immediately accessible during a clinical emergency. Note that "not in use" is not the same as "in storage." Storage is not permitted to be open to the corridor, unless it meets one of the provisions permitted in 18.3.6.1 and is not a hazardous area.

Wheeled portable patient lift or transport equipment needs to be readily available to clinical staff for moving, transferring, toileting, or relocating patients. These devices are used daily for safe handling of patients and to provide for worker safety. This equipment might not be defined as "in use" but needs to be convenient for the use of caregivers at all times.

A.18.2.3.4(5) The means for affixing the furniture can be achieved with removable brackets to allow cleaning and maintenance. Affixing the furniture to the floor or wall prevents the furniture from moving, so as to maintain a minimum 6 ft (1830 mm) corridor clear width. Affixing the furniture to the floor or wall also provides a sturdiness that allows occupants to safely transfer in and out.

A.18.2.3.4(5)(f) Examples of building service and fire protection equipment include fire extinguishers, manual fire alarm boxes, shutoff valves, and similar equipment.

A.18.2.3.4(6) The 8 ft (2440 mm) corridor width does not need to be maintained at the door or the open door leaf. A reduction for the frame and leaf is acceptable as long as the minimum clear width is provided at the door opening in the direction of egress travel. In situations where egress occurs only in one direction, it is permissible to have a single door leaf.

A.18.2.3.5(1) See A.18.2.3.4(1).

A.18.2.3.5(2) The intent of 18.2.3.5 is to permit limited noncontinuous projections along the corridor wall. These include hand-rub dispensing units complying with 18.3.2.6, nurse charting units, wall-mounted computers, telephones, artwork, bulletin boards, display case frames, cabinet frames, fire alarm boxes, and similar items. It is not the intent to permit the narrowing of the corridor by the walls themselves. The provision of 7.3.2.2 permits projections up to 4½ in. (114 mm) to be present at and below the 38 in. (965 mm) height specified in 18.2.3.5(2), and it is not the intent of 18.2.3.5(2) to prohibit such projections. Permitting projections above the 38 in. (965 mm) handrail height complies with the intent of the requirement, as such projections will not interfere with the movement of gurneys, beds, and wheelchairs. Projections below handrail height for limited items, such as fire extinguisher cabinets and recessed water coolers, also will not interfere with equipment movement.

Building codes and accessibility codes might require cane detection below projections that exceed 4 in. (102 mm).

A.18.2.3.5(3) See A.18.2.3.4(3)(3).

A.18.2.3.5(4)(c) Wheeled equipment and carts in use include food service carts, housekeeping carts, medication carts, isolation carts, and similar items. Isolation carts should be permitted in the corridor only where patients require isolation precautions.

Unattended wheeled crash carts and other similar wheeled emergency equipment are permitted to be located in the corridor when "not in use," because they need to be immediately accessible during a clinical emergency. Note that "not in use," is not the same as "in storage." Storage is not permitted to be open to the corridor, unless it meets one of the provisions permitted in 18.3.6.1 and is not a hazardous area.

Wheeled portable patient lift or transport equipment needs to be readily available to clinical staff for moving, transferring, toileting, or relocating patients. These devices are used daily for safe handling of patients and to provide for worker safety. This equipment might not be defined as "in use" but needs to be convenient for the use of caregivers at all times.

A.18.2.3.5(5) The 6 ft 1830 mm) corridor width does not need to be maintained at the door or the open door leaf. A reduction for the frame and leaf is acceptable as long as the minimum clear width is provided at the door opening in the direction of egress travel. In situations where egress occurs only in one direction, it is permissible to have a single door leaf.

A.18.2.4.4 An exit is not necessary for each individual smoke compartment if there is access to an exit through other smoke compartments without passing through the smoke compartment of fire origin.

A.18.2.5.4 The term *intervening rooms or spaces* means rooms or spaces serving as a part of the required means of egress from another room.

A.18.2.5.6.1 For the purposes of this paragraph, it is the intent that the term *habitable rooms* not include individual bathrooms, closets, and similar spaces, as well as briefly occupied work spaces, such as control rooms in radiology and small storage rooms in a pharmacy.

A.18.2.5.7.1.2 Two or more contiguous suites with an aggregate area not exceeding the suite size limitations of 18.2.5.7.2.3 and 18.2.5.7.3.3 are permitted to be considered a single suite, so as not to require separation from each other.

A.18.2.5.7.1.3(A) The term *intervening room* means a room serving as a part of the required means of egress from another room.

A.18.2.5.7.1.3(C) Examples of suites that might be hazardous areas are medical records and pharmaceutical suites.

A.18.2.5.7.2.1(B) Supervision of sleeping suites is accomplished by direct supervision by staff, smoke detection, or a combination of direct supervision and smoke detection. The following three options are available for meeting the supervision requirements for patient sleeping suites having an area not exceeding 7500 ft^2 (700 m^2):

(1) Direct supervision of all sleeping rooms by staff from a normally attended location within the suite [in accordance with 18.2.5.7.2.1(B)(1)(a)].
(2) Supervision of those sleeping rooms that can be directly supervised [in accordance with 18.2.5.7.2.1(B)(1)(a)] and smoke detection provided in the sleeping rooms that cannot be directly supervised [in accordance with 18.2.5.7.2.1(B)(1)(b)] as depicted in Figure A.18.2.5.7.2.1(B)(a).
(3) Total (complete) coverage smoke detection throughout the sleeping suite [in accordance with 18.2.5.7.2.1(B)(2)] as depicted in Figure A.18.2.5.7.2.1(B)(b).

Where the option for total (complete) coverage smoke detection is used, the provision of 9.6.2.9 requires detectors in all occupiable areas that are suitable for smoke detector operation. For example, an area subject to shower steam would not require a smoke detector.

For patient sleeping suites having an area greater than 7500 ft^2 (700 m^2), both direct supervision by staff and total (complete) coverage smoke detection throughout the sleeping suite are required [in accordance with 18.2.5.7.2.3(C)] as depicted in Figure A.18.2.5.7.2.1(B)(c).

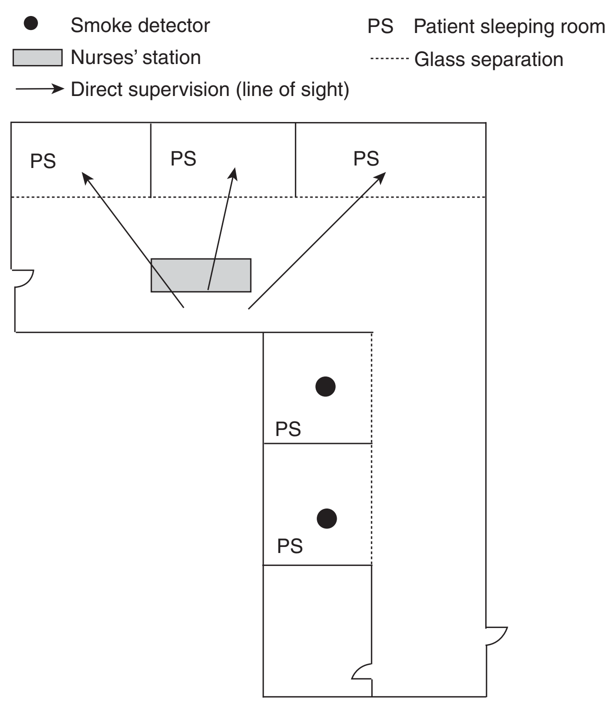


FIGURE A.18.2.5.7.2.1(B)(a) All Sleeping Rooms Provided Either with Direct Supervision by Staff or Smoke Detection.

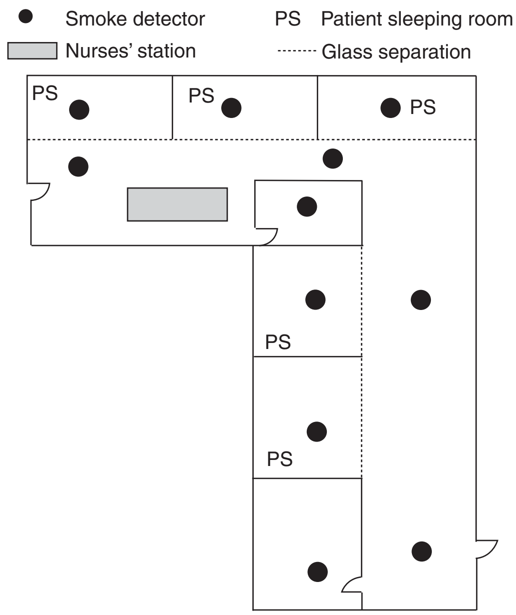


FIGURE A.18.2.5.7.2.1(B)(b) Supervision Provided by Total (Complete) Smoke Detection Throughout the Sleeping Suite.

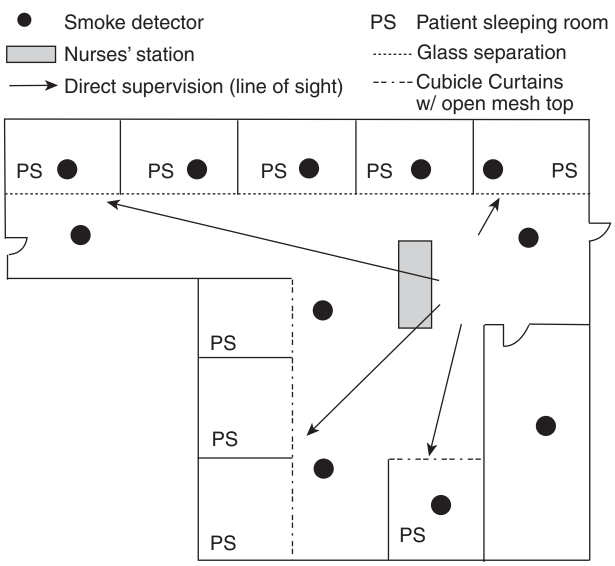


FIGURE A.18.2.5.7.2.1(B)(c) For Suites >7500 ft^2 (>700 m^2), All Sleeping Rooms Must Be Provided with Direct Supervision by Staff and Total (Complete) Smoke Detection Installed Throughout the Sleeping Suite.

A.18.2.5.7.2.1(B)(1) The interior partitions or walls might extend full height to the ceiling, provided that they do not obscure visual supervision of the suite. Where they do obscure visual supervision, see 18.2.5.7.2.1(B)(2).

A.18.2.5.7.2.2(A) Where only one means of egress is required from the suite, it needs to be provided by a door opening directly to a corridor complying with 18.3.6 or to a horizontal exit.

A.18.2.5.7.2.2(C) Where the second exit access for a sleeping suite is through an adjacent suite, it is the intent that the 100 ft (30 m) travel distance limitation in the suite be applied only to the suite under consideration.

A.18.2.5.7.2.3(C)(1) The alternative of 18.2.5.7.2.1(D)(1)(b) is not to be applied, since 18.2.5.7.2.3(C)(2) requires total coverage automatic smoke detection for the suite that exceeds 7500 ft^2 (700 m^2) but does not exceed 10,000 ft^2 (930 m^2).

A.18.2.5.7.3.1(C) Where the second exit access for a nonsleeping suite is through an adjacent suite, it is the intent that the adjacent suite not be considered an intervening room.

A.18.3.2.5.2 This provision is intended to permit appliances used for reheating, limited cooking, and food preparation, such as microwave ovens, hot plates, electric skillets, toasters, and nourishment centers to be exempt from the requirements for commercial cooking equipment and hazardous area protection. Limited quantities of butter, cooking spray, or oil can be used.

A.18.3.2.5.3 The intent of 18.3.2.5.3 is to limit the number of persons for whom meals are routinely prepared to not more than 30. Staff and feeding assistants are not included in this number.

A.18.3.2.5.3(3) The minimum airflow of 500 cfm (14,000 L/m) is intended to require the use of residential hood equipment at the higher end of equipment capacities. It is also intended to draw a sufficient amount of the cooking vapors into the grease baffle and filter system to reduce migration beyond the hood.

A.18.3.2.5.3(6) The intent of this provision is to limit cooking fuel to gas or electricity. The prohibition of solid fuels for cooking is not intended to prohibit charcoal grilling on grills located outside the facility.

A.18.3.2.5.3(9) The intent of this requirement is that the fuel source for the cooktop or range is to be turned on only when staff is present or aware that the kitchen is being used. The timer function is meant to provide an additional safeguard if the staff forgets to deactivate the cooktop or range. If a cooking activity lasts longer than 120 minutes, the timer would be required to be manually reset.

A.18.3.2.5.3(11) Protection of the cooktop or range is accomplished by the sprinklers that are required in the space and the required cooktop hood fire suppression system. The smoke alarms are intended to notify staff who might not be in the immediate area. Smoke alarms should be maintained a minimum of 20 ft (6.1 m) away from the cooktop or range as studies have shown this distance to be the threshold for significantly reducing nuisance alarms caused by cooking. The intent of the interconnected smoke alarms, with silence feature, is that while the devices would alert staff members to a potential problem, if it is a nuisance alarm, the staff members can use the silence feature instead of disabling the alarm. The referenced study indicates that nuisance alarms are reduced with photoelectric smoke alarms. Providing two interconnected alarms provides a safety factor since they are not electrically supervised by the fire alarm system. *(Smoke Alarms – Pilot Study of Nuisance Alarms Associated with Cooking)*

A.18.3.2.5.3(12) The provision of 18.3.2.5.3(12) recognizes that it is more important to maintain the 20 ft (6.1 m) minimum spacing criterion between the smoke alarm and the cooktop or range, to minimize nuisance alarms, than to assure that the smoke alarm is located within the kitchen area itself.

A.18.3.2.5.3(13) The requirements of 18.3.2.5.3(13) are intended to allow the local staff to silence and reset the system smoke detector without the assistance of the engineering or maintenance personnel. This provision is not intended to require the system smoke detector to initiate a building-wide occupant alarm signal or to notify the emergency forces.

A.18.3.2.5.4 The provisions of 18.3.2.5.4 differ from those of 18.3.2.5.3, as they apply to cooking equipment that is separated from the corridor.

A.18.3.2.5.5 The provision of 18.3.2.5.5 clarifies that protected commercial cooking equipment does not require an enclosure (separation) as a hazardous area in accordance with Section 8.7, as is required by 18.3.2.1.

A.18.3.3.2 The reductions in class of interior finish prescribed by 10.2.8.1 are permitted to be used.

A.18.3.4.2 It is not the intent of this *Code* to require single-station smoke alarms that might be required by local codes to be connected to or to initiate the building fire alarm system.

A.18.3.4.3.1(2) It is the intent of this provision to permit a visible fire alarm signal instead of an audible signal to reduce interference between the fire alarm and medical equipment monitoring alarms.

A.18.3.4.5.3 The requirement for smoke detectors in spaces open to the corridors eliminates the requirements of 18.3.6.1(1)(c), (2)(b), and (5)(b) for direct supervision by the facility staff of nursing homes.

A.18.3.5.1 In areas where the replenishment of water supplies is not immediately available from on-site sources, alternate provisions for the water-fill rate requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 22, *Standard for Water Tanks for Private Fire Protection*, that are acceptable to the authority having jurisdiction should be provided. Appropriate means for the replenishment of these supplies from other sources, such as fire department tankers, public safety organizations, or other independent contractors should be incorporated into the overall fire safety plan of the facility.

With automatic sprinkler protection required throughout new health care facilities and quick-response sprinklers required in smoke compartments containing patient sleeping rooms, a fire and its life-threatening byproducts can be reduced, thereby allowing the defend-in-place concept to continue. The difficulty in maintaining the proper integrity of life safety elements has been considered, and it has been judged that the probability of a sprinkler system operating as designed is equal to or greater than other life safety features.

A.18.3.5.6 The requirements for use of quick-response sprinklers intend that quick-response sprinklers be the predominant type of sprinkler installed in the smoke compartment. It is recognized, however, that quick-response sprinklers might not be approved for installation in all areas, such as those where NFPA 13, *Standard for the Installation of Sprinkler Systems*, requires sprinklers of the intermediate- or high-temperature classification. It is not the intent of the 18.3.5.6 requirements to prohibit the use of standard sprinklers in limited areas of a smoke compartment where intermediate- or high-temperature sprinklers are required.

Residential sprinklers are considered acceptable in patient sleeping rooms of all health care facilities, even though not specifically listed for this purpose in all cases.

Where the installation of quick-response sprinklers is impracticable in patient sleeping room areas, appropriate equivalent protection features acceptable to the authority having jurisdiction should be provided. It is recognized that the use of quick-response sprinklers might be limited in facilities housing certain types of patients or by the installation limitations of quick-response sprinklers.

A.18.3.5.10 This exception is limited to hospitals, as nursing homes and many limited care facilities might have more combustibles within the closets. The limited amount of clothing found in the small clothes closets in hospital patient rooms is typically far less than the amount of combustibles in casework cabinets that do not require sprinkler protection, such as nurse servers. In many hospitals, especially new hospitals, it is difficult to make a distinction between clothes closets and cabinet work. The exception is far more restrictive than similar exceptions for hotels and apartment buildings. NFPA 13, *Standard for the Installation of Sprinkler Systems,* already permits the omission of sprinklers in wardrobes [see 8.1.1(7) of NFPA 13]. It is not the intent of 18.3.5.10 to affect the wardrobe provisions of NFPA 13. It is the intent that the sprinkler protection in the room covers the closet as if there were no door on the closet. *(See 8.5.3.2.3 of NFPA 13.)*

A.18.3.5.11 For the proper operation of sprinkler systems, cubicle curtains and sprinkler locations need to be coordinated. Improperly designed systems might obstruct the sprinkler spray from reaching the fire or might shield the heat from the sprinkler. Many options are available to the designer including, but not limited to, hanging the cubicle curtains 18 in. (455 mm) below the sprinkler deflector; using a ½ in. (13 mm) diagonal mesh or a 70 percent open weave top panel that extends 18 in. (455 mm) below the sprinkler deflector; or designing the system to have a horizontal and minimum vertical distance that meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems.* The test data that form the basis of the NFPA 13 requirements are from fire tests with sprinkler discharge that penetrated a single privacy curtain.

A.18.3.6.1(1)(a) The presence of stored combustible materials in a room or space open to the corridor does not necessarily result in the room or space being classified as a hazardous area. In some circumstances, the amount and type of combustibles might result in the room or space being classified as a hazardous area by the authority having jurisdiction.

A.18.3.6.1(3) A typical nurses' station would normally contain one or more of the following with associated furniture and furnishings:

(1) Charting area
(2) Clerical area
(3) Nourishment station
(4) Storage of small amounts of medications, medical equipment and supplies, clerical supplies, and linens
(5) Patient monitoring and communication equipment

A.18.3.6.2 It is the intent of the *Code* that there be no required fire resistance or area limitations for vision panels in corridor walls and doors.

An architectural, exposed, suspended-grid acoustical tile ceiling with penetrating items, such as sprinkler piping and sprinklers; ducted HVAC supply and return-air diffusers; speakers; and recessed lighting fixtures, is capable of limiting the transfer of smoke.

A.18.3.6.2.3 While a corridor wall is required to form a barrier to limit the transfer of smoke, such a barrier is not required to be either a smoke barrier or a smoke partition — two terms for which specific *Code* definitions and requirements apply.

A.18.3.6.3 While it is recognized that closed doors serve to maintain tenable conditions in a corridor and adjacent patient rooms, such doors, which, under normal or fire conditions, are self-closing, might create a special hazard for the personal safety of a room occupant. Such closed doors might present a problem of delay in discovery, confining fire products beyond tenable conditions.

Because it is critical for responding staff members to be able to immediately identify the specific room involved, it is recommended that approved automatic smoke detection that is interconnected with the building fire alarm be considered for rooms having doors equipped with closing devices. Such detection is permitted to be located at any approved point within the room. When activated, the detector is required to provide a warning that indicates the specific room of involvement by activation of a fire alarm annunciator, nurse call system, or any other device acceptable to the authority having jurisdiction.

Where a nurse server penetrates a corridor wall, the access opening on the corridor side of the nurse server must be protected as is done for a corridor door.

A.18.3.6.3.1 Gasketing of doors should not be necessary to achieve resistance to the passage of smoke if the door is relatively tight-fitting.

A.18.3.6.3.10 Doors should not be blocked open by furniture, door stops, chocks, tie-backs, drop-down or plunger-type devices, or other devices that necessitate manual unlatching or releasing action to close. Examples of hold-open devices that release when the door is pushed or pulled are friction catches or magnetic catches.

A.18.3.6.3.12 It is not the intent of 18.3.6.3.12 to prohibit the application of push plates, hardware, or other attachments on corridor doors in health care occupancies.

A.18.3.6.5.1 It is not the intent of 18.3.6.5.1 to permit mail slots or pass-through openings in doors or walls of rooms designated as a hazardous area.

A.18.3.7 See A.18.2.2.

A.18.3.7.3(2) Where the smoke control system design requires dampers so that the system will function effectively, it is not the intent of the provision to permit the damper to be omitted.

This provision is not intended to prevent the use of plenum returns where ducting is used to return air from a ceiling plenum through smoke barrier walls. Short stubs or jumper ducts are not acceptable. Ducting is required to connect at both sides of the opening and to extend into adjacent spaces away from the wall. The intent is to prohibit open-air transfers at or near the smoke barrier walls.

A.18.3.7.6 Smoke barrier doors are intended to provide access to adjacent zones. The pair of cross-corridor doors are required to be opposite swinging. Access to both zones is required.

It is not the intent of 18.3.7.6 to prohibit the application of push plates, hardware, or other attachments on some barrier doors in health care occupancies. The provision of 18.3.7.6 requires the door leaves to be of substantial construction that is sufficient to resist fire for 20 minutes. Non-labeled 1¾ in. (44 mm) solid, bonded wood-core doors that are used in place of labeled 20-minute fire doors are not subject to the requirements of NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, therefore, nonrated factory or field-applied protective plates unlimited in height are permitted.

A.18.3.7.8 Smoke barriers might include walls having door openings other than cross-corridor doors. There is no restriction in the *Code* regarding which doors or how many doors form part of a smoke barrier. For example, doors from the corridor to individual rooms are permitted to form part of a smoke barrier. Split astragals (i.e., astragals installed on both door leaves) are also considered astragals.

A.18.3.7.9 It is not the intent to require the frame to be a listed assembly.

A.18.4.3 Extensive research, including fire modeling, has indicated that alcohol-based hand-rub solutions can be safely installed in corridors of health care facilities, provided that certain other precautions are taken. The total quantities of flammable liquids in any area should comply with the provisions of other recognized codes, including NFPA 1, *Fire Code*, and NFPA 30, *Flammable and Combustible Liquids Code*. In addition, special consideration should be given to the following:

(1) Obstructions created by the installation of hand-rub solution dispensers
(2) Location of dispensers with regard to adjacent combustible materials and potential sources of ignition, especially where dispensers are mounted on walls of combustible construction
(3) Requirements for other fire protection features, including complete automatic sprinkler protection, to be installed throughout the compartment
(4) Amount and location of the flammable solutions, both in use and in storage, particularly with respect to potential for leakage or failure of the dispenser

A.18.4.4.1 For example, the provisions of 18.1.1.4.3.1(2) and 18.1.1.4.3.4 do not require the installation of sprinklers if the modification involves less than 50 percent of the area of the smoke compartment and less than 4500 ft^2 (420 m^2) of the area of the smoke compartment.

A.18.5.2.2 For both new and existing buildings, it is the intent to permit the installation and use of fireplace stoves and room heaters utilizing solid fuel as defined in NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*, provided that all such devices are installed, maintained, and used in accordance with the appropriate provisions of that standard and all manufacturers' specifications. These requirements are not intended to permit freestanding solid fuel–burning appliances such as freestanding wood-burning stoves.

A.18.5.2.3(2)(d) The glass front of a direct-vent fireplace can become extremely hot. Barriers such as screens or mesh installed over the direct-vent glass help reduce the risk of burn from touching the glass.

A.18.5.2.3(2)(e) The intent of locating controls in a restricted location is to ensure staff is aware of use of the fireplace and to prevent unauthorized use. Examples of locked controls are a keyed switch or locating the switch in a staff-controlled location such as a staff station.

A.18.7 Health care occupants have, in large part, varied degrees of physical disability, and their removal to the outside, or even their disturbance caused by moving, is inexpedient or impractical in many cases, except as a last resort. Similarly, recognizing that there might be an operating necessity for the restraint of the mentally ill, often by use of barred windows and locked doors, fire exit drills are usually extremely disturbing, detrimental, and frequently impracticable.

In most cases, fire exit drills, as ordinarily practiced in other occupancies, cannot be conducted in health care occupancies. Fundamentally, superior construction, early discovery and extinguishment of incipient fires, and prompt notification need to be relied on to reduce the occasion for evacuation of buildings of this class to a minimum.

A.18.7.1.4 Many health care occupancies conduct fire drills without disturbing patients by choosing the location of the simulated emergency in advance and by closing the doors to patients' rooms or wards in the vicinity prior to initiation of the drill. The purpose of a fire drill is to test and evaluate the efficiency, knowledge, and response of institutional personnel in implementing the facility fire emergency action plan. Its purpose is not to disturb or excite patients. Fire drills should be scheduled on a random basis to ensure that personnel in health care facilities are drilled not less than once in each 3-month period.

Drills should consider the ability to move patients to an adjacent smoke compartment. Relocation can be practiced using simulated patients or empty wheelchairs.

A.18.7.2.1 Each facility has specific characteristics that vary sufficiently from other facilities to prevent the specification of a universal emergency procedure. The recommendations that follow, however, contain many of the elements that should be considered and adapted, as appropriate, to the individual facility.

Upon discovery of fire, personnel should immediately take the following action:

(1) If any person is involved in the fire, the discoverer should go to the aid of that person, calling aloud an established code phrase, which provides for both the immediate aid of any endangered person and the transmission of an alarm.
(2) Any person in the area, upon hearing the code called aloud, should activate the building fire alarm using the nearest manual fire alarm box.
(3) If a person is not involved in the fire, the discoverer should activate the building fire alarm using the nearest manual fire alarm box.
(4) Personnel, upon hearing the alarm signal, should immediately execute their duties as outlined in the facility fire safety plan.
(5) The telephone operator should determine the location of the fire as indicated by the audible signal.
(6) In a building equipped with an uncoded alarm system, a person on the floor of fire origin should be responsible for promptly notifying the facility telephone operator of the fire location.
(7) If the telephone operator receives a telephone alarm reporting a fire from a floor, the operator should regard that alarm in the same fashion as an alarm received over the fire alarm system and should immediately notify the fire department and alert all facility personnel of the place of fire and its origin.
(8) If the building fire alarm system is out of order, any person discovering a fire should immediately notify the telephone operator by telephone, and the operator should then transmit this information to the fire department and alert the building occupants.

A.18.7.3.3 The purpose of this requirement is to provide a means for building designers, occupants, and operators to clearly designate approved egress corridors that can be identified even though physical or other obvious barriers might not be present to indicate their location. Floor plans used to satisfy this requirement might incorporate more than one function and more than one smoke compartment of the building, provided egress corridors are clearly identified where no fixed barriers are present. Such plans should be accessible to the authority having jurisdiction but should not be required to be posted.

A.18.7.4 The most rigid discipline with regard to prohibition of smoking might not be nearly as effective in reducing incipient fires from surreptitious smoking as the open recognition of smoking, with provision of suitable facilities for smoking. Proper education and training of the staff and attendants in the ordinary fire hazards and their abatement is unquestionably essential. The problem is a broad one, varying with different types and arrangements of buildings; the effectiveness of rules of procedure, which need to be flexible, depends in large part on the management.

A.18.7.5.1 In addition to the provisions of 10.3.1, which deal with ignition resistance, additional requirements with respect to the location of cubicle curtains relative to sprinkler placement are included in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

A.18.7.5.6(2) The user should verify that the products meet the referenced test methods of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textile and Films,* and not the small-scale test procedure that was previously eliminated from NFPA 701.

A.18.7.5.6(4) The percentage of decorations should be measured against the area of any wall or ceiling, not the aggregate total of walls, ceilings, and doors. The door is considered part of the wall. The decorations must be located such that they do not interfere with the operation of any door, sprinkler, smoke detector, or any other life safety equipment. Other art might include hanging objects or three-dimensional items.

A.18.7.5.7.1(3) It is not the intent to permit collection receptacles with a capacity greater than 32 gal (121 L) to be positioned at or near a nurses' station based on the argument that such nurses' station is constantly attended. The large collection receptacle itself needs to be actively attended by staff. Staff might leave the large receptacle in the corridor outside a patient room while entering the room to collect soiled linen or trash, but staff is expected to return to the receptacle, move on to the next room, and repeat the collection function. Where staff is not actively collecting material for placement in the receptacle, the receptacle is to be moved to a room protected as a hazardous area.

A.18.7.5.7.2 It is the intent that this provision permits recycling of bottles, cans, paper and similar clean items that do not contain grease, oil, flammable liquids, or significant plastic materials using larger containers or several adjacent containers and not require locating such containers in a room protected as a hazardous area. Containers for medical records awaiting shredding are often larger than 32 gal (121 L). These containers are not to be included in the calculations and limitations of 18.7.5.7.1. There is no limit on the number of these containers, as FM Approval Standard 6921, *Containers for Combustible Waste,* ensures that the fire will not spread outside of the container. FM approval standards are written for use with FM Approvals. The tests can be conducted by any approved laboratory. The portions of the standard referring to FM Approvals are not included in this reference.

A.18.7.5.7.2(2) See 18.7.5.7.1(3).

A.18.7.8 Portable space heaters complying with 18.7.8 should be permitted to be located in office areas, nurses stations, and other similar nonpatient spaces within the same smoke compartment as patient sleeping rooms.

A.19.1.1.1.1 In determining equivalency for existing hospitals or nursing homes, the authority having jurisdiction is permitted to accept evaluations based on the health care occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, utilizing the parameters for existing buildings.

A.19.1.1.1.7 There are many reasons why doors in the means of egress in health care occupancies might need to be locked for the protection of the patients or the public. Examples of conditions that might justify door locking include dementia, mental health, infant care, pediatric care, or patients under court detention order requiring medical treatment in a health care facility. See 19.2.2.2.5 for details on door locking.

A.19.1.1.1.10 The *Code* recognizes that certain functions necessary for the life safety of building occupants — such as the detection of fire and associated products of combustion, the closing of corridor doors, the operation of manual fire alarm devices, and the removal of patients from the room of fire origin — require the intervention of facility staff. It is not the intent of 19.1.1.1.10 to specify the levels or locations of staff necessary to meet this requirement.

A.19.1.1.2 This objective is accomplished in the context of the physical facilities, the type of activities undertaken, the provisions for the capabilities of staff, and the needs of all occupants through requirements directed at the following:

(1) Prevention of ignition
(2) Detection of fire
(3) Control of fire development
(4) Confinement of the effects of fire
(5) Extinguishment of fire
(6) Provision of refuge or evacuation facilities, or both
(7) Staff reaction

A.19.1.1.4.3.3 For the purpose of this requirement, a floor that is not divided by a smoke barrier is considered one smoke compartment. Where automatic sprinklers are retrofitted into existing nonsprinklered buildings, the construction alternatives for sprinklers provided in this *Code* are intended to apply to the renovated area.

A.19.1.1.4.3.4 In minor rehabilitation, only the rehabilitation itself is required to be brought up to the requirements for new nonsprinklered facilities, not the entire smoke compartment or building.

A.19.1.3.4 Doctors' offices and treatment and diagnostic facilities that are intended solely for outpatient care and are physically separated from facilities for the treatment or care of inpatients, but that are otherwise associated with the management of an institution, might be classified as business occupancies rather than health care occupancies. Facilities that do not provide housing for patients on a 24-hour basis are required to be classified as other than health care occupancies per 19.1.1.1.9, except where services are provided routinely to four or more inpatients who are incapable of self-preservation.

A.19.1.3.5.1 It is the intent of the *Code* that these requirements apply to mobile, transportable, and relocatable structures (in accordance with 1.3.2) when such structures are used to provide shared medical services on an extended or a temporary basis. Where properly separated from the health care occupancy and intended to provide services simultaneously for three or fewer health care patients who are litterborne, the level of protection for such structures should be based on the appropriate occupancy classification of other chapters of this *Code*. Mobile, transportable, or relocatable structures that are not separated from a contiguous health care occupancy, or that are intended to provide services simultaneously for four or more health care patients who are litterborne, should be classified and designed as health care occupancies.

A.19.1.6.2 Unoccupied space, for the purposes of 19.1.6.2(3), is space not normally occupied by persons, fuel-fired equipment, or hazardous contents.

A.19.2.2.2.4(2) Where delayed-egress locks complying with 7.2.1.6.1 are used, the provisions of 19.2.2.2.5 are not required.

A.19.2.2.2.4(3) Where access-controlled egress doors complying with 7.2.1.6.2 are used, the provisions of 19.2.2.2.5 are not required.

A.19.2.2.2.5.1 Psychiatric units, Alzheimer units, and dementia units are examples of areas with patients who might have clinical needs that justify door locking. Forensic units and detention units are examples of areas with patients who might pose a security threat. Where Alzheimer or dementia patients in nursing homes are not housed in specialized units, the provisions of 19.2.2.2.5.1 should not apply. *(See 19.2.2.2.5.2.)*

A.19.2.2.2.5.2 Pediatric units, maternity units, and emergency departments are examples of areas where patients might have special needs that justify door locking. Door locking arrangements should be permitted to reduce the risk of abduction of infants and children who are patients.

A.19.2.2.2.5.2(3) Where locked doors in accordance with 19.2.2.2.5.2 are proposed for an existing building that is not sprinklered throughout, the authority having jurisdiction might consider permitting the installation based on an analysis of the extent of sprinkler protection provided. Sprinklered areas should include, at a minimum, the secured compartment and compartments that the occupants of the secured compartment must travel through to egress the building.

A.19.2.2.2.7 In some health care occupancies, especially nursing homes, the use of murals to disguise doors has been found to be beneficial for certain patient populations. This provision is intended to apply to disguising of egress doors by painting the doors or the use of wall paper on the doors. The marking of the means of egress such as required exit signs should be clearly visible and not disguised by the mural. Where decorations are applied to the door, the requirements of Section 19.7 would still apply and painting a mural on the door would not be considered a decoration. Such murals should not obscure required vision panels or affect the required fire resistance rating of fire-rated door assemblies.

A.19.2.2.2.7(2) It is intended that the door releasing hardware includes levers, locks, knobs, and panic bars that are directly operated or grasped by staff.

A.19.2.2.2.7(3) It is intended that the door hardware that is permitted to be covered (i.e., disguised by the mural) includes items such as hinges, closers, and magnets, which would normally not be directly operated or grasped by staff.

A.19.2.2.2.8 It is desirable to keep doors in exit passageways, stair enclosures, horizontal exits, smoke barriers, and required enclosures around hazardous areas closed at all times to impede the travel of smoke and fire gases. Functionally, however, this involves decreased efficiency and limits patient supervision by the staff of a facility. To accommodate such needs, it is practical to presume that such doors will be kept open, even to the extent of employing wood chocks and other makeshift devices. Doors in exit passageways, horizontal exits, and smoke barriers should, therefore, be equipped with automatic hold-open devices actuated by the methods described, regardless of whether the original installation of the doors was predicated on a policy of keeping them closed.

A.19.2.2.2.10 Doors to the enclosures of interior stair exits should be arranged to open from the stair side at not less than every third floor so that it will be possible to leave the stairway at such floor if fire renders the lower part of the stair unusable during egress or if occupants seek refuge on another floor.

A.19.2.2.5.3 The waiver of the requirement for doors to swing in the direction of egress travel is based on the assumption that, in this occupancy, there is no possibility of a panic rush that might prevent the opening of doors that swing against egress travel.

A desirable arrangement, which is possible with corridors 8 ft (2440 mm) or more in width, is to have two 42 in. (1070 mm) doors, normally closed, each swinging with the egress travel (in opposite directions).

A.19.2.3.4 It is not the intent that the required corridor width be maintained clear and unobstructed at all times. Projections into the required width are permitted by 7.3.2.2. It is not the intent that 19.2.3.4 supersede 7.3.2.2. Existing corridors more than 48 in. (1220 mm) in width are not permitted to be reduced in width, unless they exceed the width requirements of 18.2.3.4 or 18.2.3.5. *(See 4.6.7.4, 4.6.7.5, and 4.6.12.2.)*

A.19.2.3.4(2) The intent of 19.2.3.4(2) is to permit limited noncontinuous projections along the corridor wall. These include hand-rub dispensing units complying with 19.4.3, nurse charting units, wall-mounted computers, telephones, artwork, bulletin boards, display case frames, cabinet frames, fire alarm boxes, and similar items. It is not the intent to permit the narrowing of the corridor by the walls themselves. The provision of 7.3.2.2 permits projections up to 4½ in. (114 mm) to be present at and below the 38 in. (965 mm) handrail height, and it is not the intent of 19.2.3.4(2) to prohibit such projections.

Building codes and accessibility codes might require cane detection below projections that exceed 4 in. (102 mm).

A.19.2.3.4(4)(c) Wheeled equipment and carts in use include food service carts, housekeeping carts, medication carts, isolation carts, and similar items. Isolation carts should be permitted in the corridor only where patients require isolation precautions.

Unattended wheeled crash carts and other similar wheeled emergency equipment are permitted to be located in the corridor when "not in use," because they need to be immediately accessible during a clinical emergency. Note that "not in use" is not the same as "in storage." Storage is not permitted to be open to the corridor, unless it meets one of the provisions permitted in 19.3.6.1 and is not a hazardous area.

Wheeled portable patient lift or transport equipment needs to be readily available to clinical staff for moving, transferring, toileting, or relocating patients. These devices are used daily for safe handling of patients and to provide for worker safety. This equipment might not be defined as "in use" but needs to be convenient for the use of caregivers at all times.

A.19.2.3.4(5) The means for affixing the furniture can be achieved with removable brackets to allow cleaning and maintenance. Affixing the furniture to the floor or wall prevents the furniture from moving, so as to maintain a minimum 6 ft (1830 mm) corridor clear width. Affixing the furniture to the floor or wall also provides a sturdiness that allows occupants to safely transfer in and out.

A.19.2.3.4(5)(f) Examples of building service and fire protection equipment include fire extinguishers, manual fire alarm boxes, shutoff valves, and similar equipment.

A.19.2.4.4 An exit is not necessary for each individual smoke compartment if there is access to an exit through other smoke compartments without passing through the smoke compartment of fire origin.

A.19.2.5.2 Every exit or exit access should be arranged, if practical and feasible, so that no corridor has a dead end exceeding 30 ft (9.1 m).

A.19.2.5.4 The term *intervening rooms or spaces* means rooms or spaces serving as a part of the required means of egress from another room.

A.19.2.5.6.1 For the purposes of this paragraph, it is the intent that the term *habitable rooms* not include individual bathrooms, closets, and similar spaces, as well as briefly occupied work spaces, such as control rooms in radiology and small storage rooms in a pharmacy.

A.19.2.5.7.1.2 Two or more contiguous suites with an aggregate area not exceeding the suite size limitation of 19.2.5.7.2.3 and 19.2.5.7.3.3 are permitted to be considered a single suite, so as not to require separation from each other. The intent of 19.2.5.7.1.2(2) is to continue to permit suites that have smoke-resisting walls separating them from the rest of the building, even though the walls might not have a fire resistance rating. This requirement includes walls that comply with 19.3.6.2.4, even though sprinkler protection is not provided.

A.19.2.5.7.1.3(A) The term *intervening room* means a room serving as a part of the required means of egress from another room.

A.19.2.5.7.1.3(C) Examples of suites that might be hazardous areas are medical records and pharmaceutical suites.

A.19.2.5.7.1.3(D) It is the intent that the provision of 19.2.5.7.1.3(D) apply only where the quantities of combustibles occupy an area exceeding 50 ft^2 (4.6 m^2) so as to be a hazardous contents area. Where quantities of combustibles occupy less than 50 ft^2 (4.6 m^2), there is no restriction on quantity.

A.19.2.5.7.2.1(B) Supervision of existing sleeping suites is accomplished by direct supervision by staff, automatic smoke detection, or a combination of direct supervision and smoke detection. The following three options are available for meeting the supervision requirements for patient sleeping suites having an area not exceeding 5000 ft^2 (460 m^2):

(1) Direct supervision of all sleeping rooms by staff from a normally attended location within the suite [in accordance with 19.2.5.7.2.1(B)(1)(a)].
(2) Supervision of those sleeping rooms that can be directly supervised [in accordance with 19.2.5.7.2.1(B)(1)(a)] and automatic smoke detection provided in the sleeping rooms that cannot be directly supervised [in accordance with 19.2.5.7.2.1(B)(1)(b)] as depicted in Figure A.19.2.5.7.2.1(B)(a).

(3) Total (complete) coverage automatic smoke detection throughout the sleeping suite [in accordance with 19.2.5.7.2.1(B)(2)] as depicted in Figure A.19.2.5.7.2.1(B)(b).

Where the option for total (complete) coverage automatic smoke detection is used, the provision of 9.6.2.9 requires detectors in all occupiable areas that are suitable for smoke detector operation. For example, an area subject to shower steam would not require a smoke detector.

For patient sleeping suites having an area greater than 5000 ft^2 (460 m^2) but not greater than 7500 ft^2 (700 m^2), sprinkler protection is required throughout the suite and the supervision requirements of 19.2.5.7.2.1 also apply. Such protection might take the form of standard-response sprinklers in accordance with 19.3.5.7 or quick-response sprinklers in accordance with 19.3.5.8. Where standard-response sprinklers are used in accordance with 19.3.5.7, the suite must be protected by total (complete) automatic smoke detection [in accordance with 19.2.5.7.2.3(B)(1)] as depicted in Figure A.19.2.5.7.2.1(B)(c).

For patient sleeping suites having an area greater than 7500 ft^2 (700 m^2), the suite must be protected by quick-response sprinklers in accordance with 19.3.5.8, direct supervision of all sleeping rooms must be provided by staff, and total (complete) coverage automatic smoke detection must be provided throughout the sleeping suite [in accordance with 19.2.5.7.2.3(C)] as depicted in Figure A.19.2.5.7.2.1(B)(d).

A.19.2.5.7.2.1(B)(1) The interior partitions or walls might extend full height to the ceiling, provided that they do not obscure visual supervision of the suite. Where they do obscure visual supervision, see 19.2.5.7.2.1(B)(2).

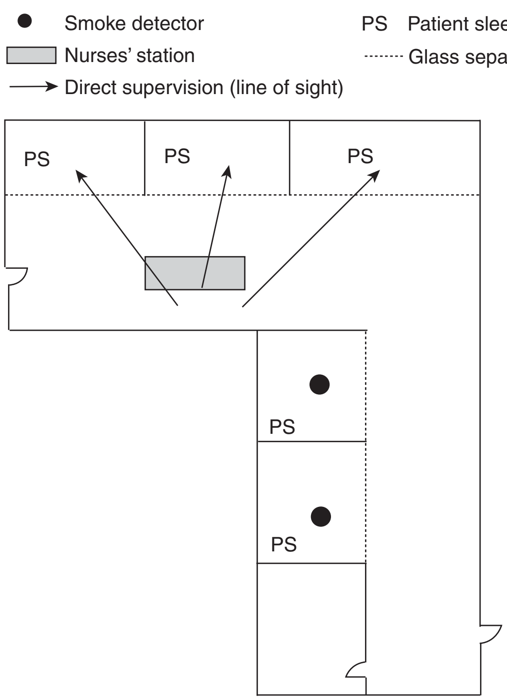


FIGURE A.19.2.5.7.2.1(B)(a) All Sleeping Rooms Provided Either with Direct Supervision by Staff or Smoke Detection.

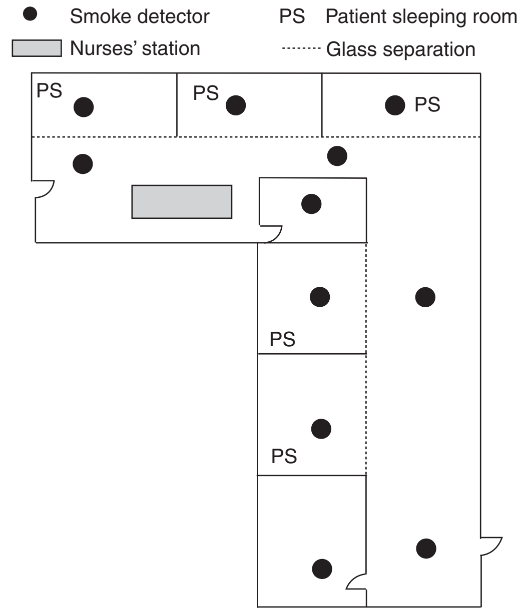


FIGURE A.19.2.5.7.2.1(B)(b) Supervision Provided by Total (Complete) Smoke Detection Throughout the Sleeping Suite.

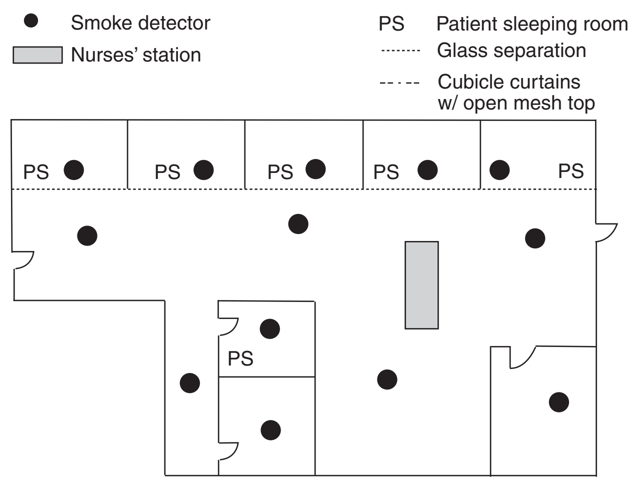


FIGURE A.19.2.5.7.2.1(B)(c) For Suites >5000 ft^2 (>460 m^2) and ≤7500 ft^2 (≤700 m^2) Protected by Standard Response Sprinklers, Total (Complete) Smoke Detection Required Throughout the Sleeping Suite.

A.19.2.5.7.2.2(A) Where only one means of egress is required from the suite, it needs to be provided by a door opening directly to a corridor complying with 19.3.6 or to a horizontal exit.

A.19.2.5.7.2.2(C) Where the second exit access for a sleeping suite is through an adjacent suite, it is the intent that the 100 ft (30 m) travel distance limitation in the suite be applied only to the suite under consideration.

A.19.2.5.7.2.3(C)(1) The alternative of 19.2.5.7.2.1(D)(1)(b) is not to be applied, since 19.2.5.7.2.3 requires total coverage automatic smoke detection for the suite that exceeds 7500 ft^2 (700 m^2) but does not exceed 10,000 ft^2 (930 m^2).

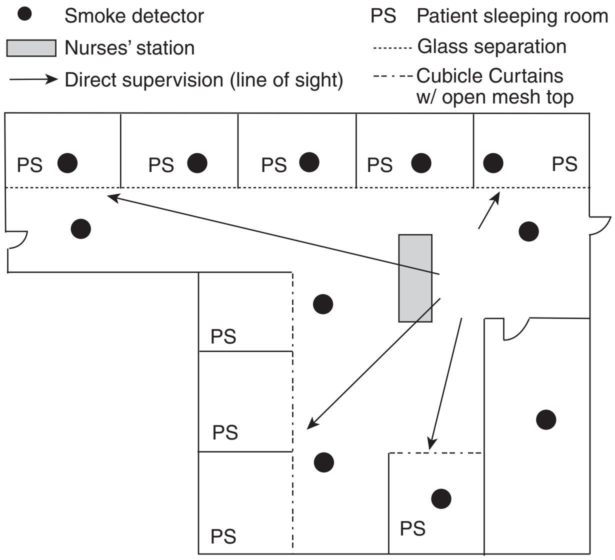


FIGURE A.19.2.5.7.2.1(B)(d) For Suites >7500 ft^2 (>700 m^2), All Sleeping Rooms Must Be Provided with Direct Supervision by Staff and Total (Complete) Smoke Detection Installed Throughout the Sleeping Suite.

A.19.2.5.7.3.1(C) Where the second exit access for a non-sleeping suite is through an adjacent suite, it is the intent that the adjacent suite not be considered an intervening room.

A.19.3.2.1.2 Penetrations of hazardous area walls located above ceilings that comply with Section 8.4 are not required to be sealed to comply with 19.3.2.1.2.

A.19.3.2.5.2 This provision is intended to permit appliances used for reheating, limited cooking, and food preparation, such as microwave ovens, hot plates, electric skillets, toasters, and nourishment centers, tobe exempt from the requirements for commercial cooking equipment and hazardous area protection. Limited quantities of butter, cooking spray, or oil can be used.

A.19.3.2.5.3 The intent of 19.3.2.5.3 is to limit the number of persons for whom meals are routinely prepared to not more than 30. Staff and feeding assistants are not included in this number.

A.19.3.2.5.3(3) The minimum airflow of 500 cfm (14,000 L/m) is intended to require the use of residential hood equipment at the higher end of equipment capacities. It is also intended to draw a sufficient amount of the cooking vapors into the grease baffle and filter system to reduce migration beyond the hood.

A.19.3.2.5.3(6) The intent of this provision is to limit cooking fuel to gas or electricity. The prohibition of solid fuels for cooking is not intended to prohibit charcoal grilling on grills located outside the facility.

A.19.3.2.5.3(9) The intent of this requirement is that the fuel source for the cooktop or range is to be turned on only when staff is present or aware that the kitchen is being used. The timer function is meant to provide an additional safeguard if the staff forgets to deactivate the cooktop or range. If a cooking activity lasts longer than 120 minutes, the timer would be required to be manually reset.

A.19.3.2.5.3(11) Protection of the cooktop or range is accomplished by the sprinklers that are required in the space and the required cooktop hood fire suppression system. The smoke alarms are intended to notify staff who might not be in the immediate area. Smoke alarms should be maintained a minimum of 20 ft (6.1 m) away from the cooktop or range as studies have shown this distance to be the threshold for significantly reducing nuisance alarms caused by cooking. The intent of the interconnected smoke alarms, with silence feature, is that while the devices would alert staff members to a potential problem, if it is a nuisance alarm, the staff members can use the silence feature instead of disabling the alarm. The referenced study indicates that nuisance alarms are reduced with photoelectric smoke alarms. Providing two interconnected alarms provides a safety factor since they are not electrically supervised by the fire alarm system. *(Smoke Alarms – Pilot Study of Nuisance Alarms Associated with Cooking)*

A.19.3.2.5.3(12) The provision of 19.3.2.5.3 recognizes that it is more important to maintain the 20 ft (6.1 m) minimum spacing criterion between the smoke alarm and the cooktop or range, to minimize nuisance alarms, than to assure that the smoke alarm is located within the kitchen area itself.

A.19.3.2.5.3(13) The requirements of 19.3.2.5.3(13) are intended to allow the local staff to silence and reset the system smoke detector without the assistance of the engineering or maintenance personnel. This provision is not intended to require the system smoke detector to initiate a building-wide occupant alarm signal or to notify the emergency forces.

A.19.3.2.5.4 The provisions of 19.3.2.5.4 differ from those of 19.3.2.5.3, as they apply to cooking equipment that is separated from the corridor.

A.19.3.2.5.5 The provision of 19.3.2.5.5 clarifies that protected commercial cooking equipment does not require an enclosure (separation) as a hazardous area in accordance with Section 8.7, as is required by 19.3.2.1.

A.19.3.3.2 The reduction in class of interior finish prescribed by 10.2.8.1 is permitted to be used.

A.19.3.4.2 It is not the intent of this *Code* to require single-station smoke alarms, which might be required by local codes, to be connected to or to initiate the building fire alarm system.

A.19.3.4.3.1(1) It is the intent of this provision to permit a visible fire alarm signal instead of an audible signal to reduce interference between the fire alarm and medical equipment monitoring alarms.

A.19.3.5.4 It is not the intent to require existing standard sprinklers in existing sprinkler systems to be replaced with listed quick-response or listed residential sprinklers. It is the intent that new sprinkler systems installed in existing buildings comply with the requirements of Chapter 18, including 18.3.5.6.

A.19.3.5.7 It is intended that any valve that controls automatic sprinklers in the building or portions of the building, including sectional and floor control valves, be electrically supervised. Valves that control isolated sprinkler heads, such as in laundry and trash chutes, are not required to be electrically supervised. Appropriate means should be provided to ensure that valves that are not electrically supervised remain open.

A.19.3.5.8 The provisions of 19.3.5.8(6) and (7) are not intended to supplant NFPA 13, *Standard for the Installation of Sprinkler Systems*, which requires that residential sprinklers with more than a 10°F (5.6°C) difference in temperature rating not be mixed within a room. Currently there are no additional prohibitions in NFPA 13 on the mixing of sprinklers having different thermal response characteristics. Conversely, there are no design parameters to make practical the mixing of residential and other types of sprinklers.

Residential sprinklers are considered acceptable in patient sleeping rooms of all health care facilities, even though not specifically listed for this purpose in all cases.

A.19.3.5.8(6) It is not the intent of the *Code* to permit standard-response sprinklers to meet the criteria of 19.3.5.8 just because the sprinklers were installed before quick-response sprinklers were invented or listed. The intent of 19.3.5.8(6) is to permit older quick-response systems to be credited, even though there might be some standard-response sprinklers in existence due to the fact that quick-response sprinklers were unavailable for those specific locations at the time. For example, in the early days of quick-response sprinklers, there were no high-temperature quick-response sprinklers available.

A.19.3.5.10 This exception is limited to hospitals, as nursing homes and many limited care facilities might have more combustibles within the closets. The limited amount of clothing found in the small clothes closets in hospital patient rooms is typically far less than the amount of combustibles in casework cabinets that do not require sprinkler protection, such as nurse servers. In many hospitals, especially new hospitals, it is difficult to make a distinction between clothes closets and cabinet work. The exception is far more restrictive than similar exceptions for hotels and apartment buildings. NFPA 13, *Standard for the Installation of Sprinkler Systems,* already permits the omission of sprinklers in wardrobes [see 8.1.1(7) of NFPA 13]. It is not the intent of 19.3.5.10 to affect the wardrobe provisions of NFPA 13. It is the intent that the sprinkler protection in the room covers the closet as if there were no door on the closet. *(See 8.5.3.2.3 of NFPA 13.)*

A.19.3.5.11 For the proper operation of sprinkler systems, cubicle curtains and sprinkler locations need to be coordinated. Improperly designed systems might obstruct the sprinkler spray from reaching the fire or might shield the heat from the sprinkler. Many options are available to the designer including, but not limited to, hanging the cubicle curtains 18 in. (455 mm) below the sprinkler deflector; using ½ in. (13 mm) diagonal mesh or a 70 percent open weave top panel that extends 18 in. (455 mm) below the sprinkler deflector; or designing the system to have a horizontal and minimum vertical distance that meets the requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems.* The test data that forms the basis of the NFPA 13 requirements is from fire tests with sprinkler discharge that penetrated a single privacy curtain.

A.19.3.6.1(1)(a) The presence of stored combustible materials in a room or space open to the corridor does not necessarily result in the room or space being classified as a hazardous area. In some circumstances, the amount and type of combustibles might result in the room or space being classified as a hazardous area by the authority having jurisdiction.

A.19.3.6.1(3) A typical nurses' station would normally contain one or more of the following with associated furniture and furnishings:

(1) Charting area
(2) Clerical area
(3) Nourishment station
(4) Storage of small amounts of medications, medical equipment and supplies, clerical supplies, and linens
(5) Patient monitoring and communication equipment

A.19.3.6.1(7)(b) A fully developed fire (flashover) occurs if the rate of heat release of the burning materials exceeds the capability of the space to absorb or vent that heat. The ability of common lining (wall, ceiling, and floor) materials to absorb heat is approximately 0.75 Btu/ft^2 (0.07 kJ/m^2) of lining. The venting capability of open doors or windows is in excess of 20 Btu/ft^2 (1.95 kJ/m^2) of opening. In a fire that has not reached flashover conditions, fire will spread from one furniture item to another only if the burning item is close to another furniture item. For example, if individual furniture items have a heat release rate of 500 Btu/s (525 kW) and are separated by 12 in. (305 mm) or more, the fire is not expected to spread from item to item, and flashover is unlikely to occur. *(See also the NFPA Fire Protection Handbook.)*

A.19.3.6.1(8) This provision permits waiting areas to be located across the corridor from each other, provided that neither area exceeds the 600 ft^2 (55.7 m^2) limitation.

A.19.3.6.2.2 The intent of the minimum ½-hour fire resistance rating for corridor partitions is to require a nominal fire rating, particularly where the fire rating of existing partitions cannot be documented. Examples of acceptable partition assemblies would include, but are not limited to, ½ in. (13 mm) gypsum board, wood lath and plaster, gypsum lath, or metal lath and plaster.

A.19.3.6.2.3 The purpose of extending a corridor wall above a lay-in ceiling or through a concealed space is to provide a barrier to limit the passage of smoke. Such a barrier is not required to be either a smoke barrier or a smoke partition — two terms for which specific *Code* definitions and requirements apply. The intent of 19.3.6.2.3 is not to require light-tight barriers above lay-in ceilings or to require an absolute seal of the room from the corridor. Small holes, penetrations, or gaps around items such as ductwork, conduit, or telecommunication lines should not affect the ability of this barrier to limit the passage of smoke.

A.19.3.6.2.4 An architectural, exposed, suspended-grid acoustical tile ceiling with penetrating items, such as sprinkler piping and sprinklers; ducted HVAC supply and return-air diffusers; speakers; and recessed lighting fixtures, is capable of limiting the transfer of smoke.

A.19.3.6.2.6 Monolithic ceilings are continuous horizontal membranes composed of noncombustible or limited-combustible materials, such as plaster or gypsum board, with seams or cracks permanently sealed.

A.19.3.6.3 The provision of 19.3.6.3 requires the door leaves to be of substantial construction that is sufficient to resist fire for 20 minutes. These doors, described as 1¾ in. (44 mm) thick, solid-bonded wood-core doors, are nonrated doors and are not subject to the requirements of NFPA 80, *Standard for Fire Doors and Other Opening Protectives.*

A.19.3.6.3.1 Gasketing of doors should not be necessary to achieve resistance to the passage of smoke if the door is relatively tight-fitting.

A.19.3.6.3.5 While it is recognized that closed doors serve to maintain tenable conditions in a corridor and adjacent patient rooms, such doors, which, under normal or fire conditions, are self-closing, might create a special hazard for the personal safety of a room occupant. Such closed doors might present a problem of delay in discovery, confining fire products beyond tenable conditions.

Because it is critical for responding staff members to be able to immediately identify the specific room involved, it is recommended that approved automatic smoke detection that is interconnected with the building fire alarm be considered for rooms having doors equipped with closing devices. Such detection is permitted to be located at any approved point within the room. When activated, the detector is required to provide a warning that indicates the specific room of involvement by activation of a fire alarm annunciator, nurse call system, or any other device acceptable to the authority having jurisdiction.

In existing buildings, use of the following options reasonably ensures that patient room doors will be closed and remain closed during a fire:

(1) Doors should have positive latches, and a suitable program that trains staff to close the doors in an emergency should be established.
(2) It is the intent of the *Code* that no new installations of roller latches be permitted; however, repair or replacement of roller latches is not considered a new installation.
(3) Doors protecting openings to patient sleeping or treatment rooms, or spaces having a similar combustible loading, might be held closed using a closer exerting a closing force of not less than 5 lbf (22 N) on the door latch stile.

A.19.3.6.3.10 Doors should not be blocked open by furniture, door stops, chocks, tie-backs, drop-down or plunger-type devices, or other devices that necessitate manual unlatching or releasing action to close. Examples of hold-open devices that release when the door is pushed or pulled are friction catches or magnetic catches.

A.19.3.6.3.12 It is not the intent of 19.3.6.3.12 to prohibit the application of push plates, hardware, or other attachments on corridor doors in health care occupancies.

A.19.3.6.5.1 It is not the intent of 19.3.6.5.1 to permit mail slots or pass-through openings in doors or walls of rooms designated as a hazardous area.

A.19.3.7.3(2) Where the smoke control system design requires dampers in order that the system functions effectively, it is not the intent of the exception to permit the damper to be omitted.

This provision is not intended to prevent the use of plenum returns where ducting is used to return air from a ceiling plenum through smoke barrier walls. Short stubs or jumper ducts are not acceptable. Ducting is required to connect at both sides of the opening and to extend into adjacent spaces away from the wall. The intent is to prohibit open-air transfers at or near the smoke barrier walls.

A.19.3.7.6.1 It is not the intent of 19.3.7.6.1 to prohibit the application of push plates, hardware, or other attachments on smoke barrier doors in health care occupancies.

A.19.3.7.8 Smoke barriers might include walls having door openings other than cross-corridor doors. There is no restriction in the *Code* regarding which doors or how many doors form part of a smoke barrier. For example, doors from the corridor to individual rooms are permitted to form part of a smoke barrier.

A.19.4.2.2 The provision of 19.4.2.2 is intended to prevent the phase-in period for the installation of sprinklers from being reset to 12 years upon adoption of the 2015 edition of the *Code* in jurisdictions where the 12-year period had already begun via the adoption of the 2012 edition.

A.19.4.2.3 The provision of 19.4.2.3 is intended to prevent the phase-in period for the installation of sprinklers from being reset to 12 years upon adoption of the 2015 edition of the *Code* in jurisdictions where the 12-year period had already begun via the adoption of the 2009 edition.

A.19.4.3 Extensive research, including fire modeling, has indicated that alcohol-based hand-rub solutions can be safely installed in corridors of health care facilities, provided that certain other precautions are taken. The total quantities of flammable liquids in any area should comply with the provisions of other recognized codes, including NFPA 1, *Fire Code*, and NFPA 30, *Flammable and Combustible Liquids Code*. In addition, special consideration should be given to the following:

(1) Obstructions created by the installation of hand-rub solution dispensers
(2) Location of dispensers with regard to adjacent combustible materials and potential sources of ignition, especially where dispensers are mounted on walls of combustible construction
(3) Requirements for other fire protection features, including complete automatic sprinkler protection, to be installed throughout the compartment
(4) Amount and location of the flammable solutions, both in use and in storage, particularly with respect to potential for leakage or failure of the dispenser

A.19.5.2.2 For both new and existing buildings, it is the intent to permit the installation and use of fireplace stoves and room heaters using solid fuel as defined in NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*, provided that all such devices are installed, maintained, and used in accordance with the appropriate provisions of that standard and all manufacturers' specifications. These requirements are not intended to permit freestanding solid fuel–burning appliances such as freestanding wood-burning stoves.

A.19.5.2.3(2)(d) The glass front of a direct-vent fireplace can become extremely hot. Barriers such as screens or mesh installed over the direct-vent glass help reduce the risk of burn from touching the glass.

A.19.5.2.3(2)(e) The intent of locating controls in a restricted location is to ensure staff is aware of use of the fireplace and to prevent unauthorized use. Examples of locked controls are a keyed switch or locating the switch in a staff-controlled location such as a staff station.

A.19.7 Health care occupants have, in large part, varied degrees of physical disability, and their removal to the outside, or even their disturbance caused by moving, is inexpedient or impractical in many cases, except as a last resort. Similarly, recognizing that there might be an operating necessity for the restraint of the mentally ill, often by use of barred windows and locked doors, fire exit drills are usually extremely disturbing, detrimental, and frequently impracticable.

In most cases, fire exit drills, as ordinarily practiced in other occupancies, cannot be conducted in health care occupancies. Fundamentally, superior construction, early discovery and extinguishment of incipient fires, and prompt notification need to be relied on to reduce the occasion for evacuation of buildings of this class to a minimum.

A.19.7.1.4 Many health care occupancies conduct fire drills without disturbing patients by choosing the location of the simulated emergency in advance and by closing the doors to patients' rooms or wards in the vicinity prior to initiation of the drill. The purpose of a fire drill is to test and evaluate the efficiency, knowledge, and response of institutional personnel in implementing the facility fire emergency action plan. Its purpose is not to disturb or excite patients. Fire drills should be scheduled on a random basis to ensure that personnel in health care facilities are drilled not less than once in each 3-month period.

Drills should consider the ability to move patients to an adjacent smoke compartment. Relocation can be practiced using simulated patients or empty wheelchairs.

A.19.7.2.1 Each facility has specific characteristics that vary sufficiently from other facilities to prevent the specification of a universal emergency procedure. The recommendations that follow, however, contain many of the elements that should be considered and adapted, as appropriate, to the individual facility.

Upon discovery of fire, personnel should immediately take the following action:

(1) If any person is involved in the fire, the discoverer should go to the aid of that person, calling aloud an established code phrase, which provides for both the immediate aid of any endangered person and the transmission of an alarm.
(2) Any person in the area, upon hearing the code called aloud, should activate the building fire alarm using the nearest manual fire alarm box.
(3) If a person is not involved in the fire, the discoverer should activate the building fire alarm using the nearest manual fire alarm box.
(4) Personnel, upon hearing the alarm signal, should immediately execute their duties as outlined in the facility fire safety plan.
(5) The telephone operator should determine the location of the fire as indicated by the audible signal.
(6) In a building equipped with an uncoded alarm system, a person on the floor of fire origin should be responsible for promptly notifying the facility telephone operator of the fire location.
(7) If the telephone operator receives a telephone alarm reporting a fire from a floor, the operator should regard that alarm in the same fashion as an alarm received over the fire alarm system and should immediately notify the fire department and alert all facility personnel of the place of fire and its origin.
(8) If the building fire alarm system is out of order, any person discovering a fire should immediately notify the telephone operator by telephone, and the operator should then transmit this information to the fire department and alert the building occupants.

A.19.7.3.3 The purpose of this requirement is to provide a means for building designers, occupants, and operators to clearly designate approved egress corridors that can be identified even though physical or other obvious barriers might not be present to indicate their location. Floor plans used to satisfy this requirement might incorporate more than one function and more than one smoke compartment of the building, provided egress corridors are clearly identified where no fixed barriers are present. Such plans should be accessible to the authority having jurisdiction but should not be required to be posted.

A.19.7.4 The most rigid discipline with regard to prohibition of smoking might not be nearly as effective in reducing incipient fires from surreptitious smoking as the open recognition of smoking, with provision of suitable facilities for smoking. Proper education and training of the staff and attendants in the ordinary fire hazards and their abatement is unquestionably essential. The problem is a broad one, varying with different types and arrangements of buildings; the effectiveness of rules of procedure, which need to be flexible, depends in large part on the management.

A.19.7.5.1 In addition to the provisions of 10.3.1, which deal with ignition resistance, additional requirements with respect to the location of cubicle curtains relative to sprinkler placement are included in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

A.19.7.5.6(2) The user should verify that the products meet the referenced test methods of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, and not the small-scale test procedure that was previously eliminated from NFPA 701.

A.19.7.5.6(4) The percentage of decorations should be measured against the area of any wall or ceiling, not the aggregate total of walls, ceilings, and doors. The door is considered part of the wall. The decorations must be located such that they do not interfere with the operation of any door, sprinkler, smoke detector, or any other life safety equipment. Other art might include hanging objects or three-dimensional items.

A.19.7.5.6(5) When determining if the hazard for fire development or spread is present, consideration should be given to whether the building or area being evaluated is sprinklered.

A.19.7.5.7.1(3) It is not the intent to permit collection receptacles with a capacity greater than 32 gal (121 L) to be positioned at or near a nurses' station based on the argument that such nurses' station is constantly attended. The large collection receptacle itself needs to be actively attended by staff. Staff might leave the large receptacle in the corridor outside a patient room while entering the room to collect soiled linen or trash, but staff is expected to return to the receptacle, move on to the next room, and repeat the collection function. Where staff is not actively collecting material for placement in the receptacle, the receptacle is to be moved to a room protected as a hazardous area.

A.19.7.5.7.2 It is the intent that this provision permits recycling of bottles, cans, paper, and similar clean items that do not contain grease, oil, flammable liquids, or significant plastic materials, using larger containers or several adjacent containers, and not require locating such containers in a room protected as a hazardous area. Containers for medical records awaiting shredding are often larger than 32 gal (121 L). These containers are not to be included in the calculations and limitations of 19.7.5.7.1. There is no limit on the number of these containers, as FM Approval Standard 6921, *Containers for Combustible Waste*, ensures that the fire will not spread outside of the container. FM approval standards are written for use with FM Approvals. The tests can be conducted by any approved laboratory. The portions of the standard referring to FM Approvals are not included in this reference.

A.19.7.5.7.2(2) See 19.7.5.7.1(3).

A.19.7.7 A document that provides recognized engineering principles for the testing of smoke control systems is NFPA 92, *Standard for Smoke Control Systems*.

A.19.7.8 Portable space heaters complying with 19.7.8 should be permitted to be located in office areas, nurses stations, and other similar nonpatient spaces within the same smoke compartment as patient sleeping rooms.

A.20.1.1.1.6 The *Code* recognizes that certain functions necessary for the life safety of building occupants, such as the closing of corridor doors, the operation of manual fire alarm devices, and the removal of patients from the room of fire origin, require the intervention of facility staff. It is not the intent of 20.1.1.1.6 to specify the levels or locations of staff necessary to meet this requirement.

A.20.1.1.2 This objective is accomplished in the context of the physical facilities, the type of activities undertaken, the provisions for the capabilities of staff, and the needs of all occupants through requirements directed at the following:

(1) Prevention of ignition
(2) Detection of fire
(3) Control of fire development
(4) Confinement of the effects of fire
(5) Extinguishment of fire
(6) Provision of refuge or evacuation facilities, or both
(7) Staff reaction

A.20.1.3.2 Doctors' offices and treatment and diagnostic facilities that are intended solely for outpatient care and are physically separated from facilities for the treatment or care of inpatients, but are otherwise associated with the management of an institution, might be classified as business occupancies rather than health care occupancies.

A.20.2.2.2.4 The words "principal entrance/exit doors" describe doors that the authority having jurisdiction can reasonably expect to be unlocked in order for the facility to do business.

A.20.2.3.3 Building codes and accessibility codes might require cane detection below projections that exceed 4 in. (102 mm).

A.20.3.2.1 It is not the intent of this provision that rooms inside individual tenant spaces that are used to store routine office supplies for that tenant be required to be either separated or sprinklered.

A.20.3.2.3 The requirement for separating high-hazard contents areas from other parts of the building is intended to isolate the hazard, and 8.2.3.3 is applicable.

A.20.3.6.1 The intent of 38.3.6(1) through (3) is to permit spaces to be open to the exit access corridor without separation.

A.20.3.6.1(1) Where exits are available from an open floor area, such as open plan buildings, corridors are not required to be separated. An example of an open plan building is a building in which the work spaces and accesses to exits are delineated by the use of tables, desks, bookcases, or counters, or by partitions that are less than floor-to-ceiling height.

A.20.3.6.1(2) It is the intent of this provision that a single tenant be limited to an area occupied under a single management and work the same hours. The concept is that people under the same employ working the same hours would likely be familiar with their entire tenant space. It is not the intent to apply this provision simply because tenants are owned by the same organization. For example, in a government-owned office building, the offices of different federal agencies would be considered multiple tenants, because an employee normally works for one agency. The agencies might work various hours. Another example of multiple tenancy would be a classroom building of a university, because some classrooms might be in use at times when other classrooms are not being used.

A.20.3.7.10 Smoke barriers might include walls having door openings other than cross-corridor doors. There is no restriction in the *Code* regarding which doors or how many doors form part of a smoke barrier. For example, doors from the corridor to individual rooms are permitted to form part of a smoke barrier.

A.20.3.7.14 Split astragals (i.e., astragals installed on both door leaves) are also considered astragals.

A.20.4.3 Extensive research, including fire modeling, has indicated that alcohol-based hand-rub solutions can be safely installed in corridors of health care facilities, provided that certain other precautions are taken. The total quantities of flammable liquids in any area should comply with the provisions of other recognized codes, including NFPA 1, *Fire Code*, and NFPA 30, *Flammable and Combustible Liquids Code*. In addition, special consideration should be given to the following:

(1) Obstructions created by the installation of hand-rub solution dispensers
(2) Location of dispensers with regard to adjacent combustible materials and potential sources of ignition, especially where dispensers are mounted on walls of combustible construction
(3) Requirements for other fire protection features, including complete automatic sprinkler protection, to be installed throughout the compartment
(4) Amount and location of the flammable solutions, both in use and in storage, particularly with respect to potential for leakage or failure of the dispenser

A.20.7 Ambulatory health care occupants have, in large part, varied degrees of physical disability, and their removal to the outside, or even their disturbance caused by moving, is inexpedient or impractical in many cases, except as a last resort. Similarly, recognizing that there might be an operating necessity for the restraint of the mentally ill, often by use of barred windows and locked doors, fire exit drills are usually extremely disturbing, detrimental, and frequently impracticable.

In most cases, fire exit drills, as ordinarily practiced in other occupancies, cannot be conducted in ambulatory health care occupancies. Fundamentally, superior construction, early discovery and extinguishment of incipient fires, and prompt notification need to be relied on to reduce the occasion for evacuation of buildings of this class to a minimum.

A.20.7.1.4 Many ambulatory health care occupancies conduct fire drills without disturbing patients by choosing the location of the simulated emergency in advance and by closing the doors in the vicinity prior to the initiation of the drill. The purpose of a fire drill is to test and evaluate the efficiency, knowledge, and response of personnel in implementing the facility fire emergency plan. Its purpose is not to disturb or excite patients. Fire drills should be scheduled on a random basis to ensure that personnel in ambulatory health care facilities are drilled not less than once in each 3-month period.

Drills should consider the ability to move patients to an adjacent smoke compartment. Relocation can be practiced using simulated patients or empty wheelchairs.

A.20.7.2.1 Each facility has specific characteristics that vary sufficiently from other facilities to prevent the specification of a universal emergency procedure. The recommendations that follow, however, contain many of the elements that should be considered and adapted, as appropriate, to the individual facility.

Upon discovery of fire, personnel should immediately take the following action:

(1) If any person is involved in the fire, the discoverer should go to the aid of that person, calling aloud an established code phrase, which provides for both the immediate aid of any endangered person and the transmission of an alarm.
(2) Any person in the area, upon hearing the code called aloud, should activate the building fire alarm using the nearest manual fire alarm box.
(3) If a person is not involved in the fire, the discoverer should activate the building fire alarm using the nearest manual fire alarm box.
(4) Personnel, upon hearing the alarm signal, should immediately execute their duties as outlined in the facility fire safety plan.
(5) The telephone operator should determine the location of the fire as indicated by the audible signal.
(6) In a building equipped with an uncoded alarm system, a person on the floor of fire origin should be responsible for promptly notifying the facility telephone operator of the fire location.
(7) If the telephone operator receives a telephone alarm reporting a fire from a floor, the operator should regard that alarm in the same fashion as an alarm received over the fire alarm system and should immediately notify the fire department and alert all facility personnel of the place of fire and its origin.
(8) If the building fire alarm system is out of order, any person discovering a fire should immediately notify the telephone operator by telephone, and the operator should then transmit this information to the fire department and alert the building occupants.

A.20.7.4 The most rigid discipline with regard to prohibition of smoking might not be nearly as effective in reducing incipient fires from surreptitious smoking as the open recognition of smoking, with provision of suitable facilities for smoking. Proper education and training of the staff and attendants in the ordinary fire hazards and their abatement is unquestionably essential. The problem is a broad one, varying with different types and arrangements of buildings; the effectiveness of rules of procedure, which need to be flexible, depends in large part on the management.

A.20.7.5.1 In addition to the provisions of 10.3.1, which deal with ignition resistance, additional requirements with respect to the location of cubicle curtains relative to sprinkler placement are included in NFPA 13, *Standard for the Installation of Sprinkler Systems.*

A.20.7.5.4(4) The percentage of decorations should be measured against the area of any wall or ceiling, not the aggregate total of walls, ceilings, and doors. The door is considered part of the wall. The decorations must be located such that they do not interfere with the operation of any door, sprinkler, smoke detector, or any other life safety equipment. Other art might include hanging objects or three-dimensional items.

A.20.7.5.5.2 It is the intent that this provision permits recycling of bottles, cans, paper, and similar clean items that do not contain grease, oil, flammable liquids, or significant plastic materials using larger containers or several adjacent containers and not require locating such containers in a room protected as a hazardous area. Containers for medical records awaiting shredding are often larger than 32 gal (121 L). These containers are not to be included in the calculations and limitations of 20.7.5.5.1. There is no limit on the number of these containers, as FM Approval Standard 6921, *Containers for Combustible Waste,* ensures that the fire will not spread outside of the container. FM approval standards are written for use with FM Approvals. The tests can be conducted by any approved laboratory. The portions of the standard referring to FM Approvals are not included in this reference.

A.20.7.5.5.2(2) See 20.7.5.5.1(3).

A.20.7.7 A document that provides recognized engineering principles for the testing of smoke control systems is NFPA 92, *Standard for Smoke Control Systems.*

A.21.1.1.1.6 The *Code* recognizes that certain functions necessary for the life safety of building occupants, such as the closing of corridor doors, the operation of manual fire alarm devices, and the removal of patients from the room of fire origin, require the intervention of facility staff. It is not the intent of 21.1.1.1.6 to specify the levels or locations of staff necessary to meet this requirement.

A.21.1.1.2 This objective is accomplished in the context of the physical facilities, the type of activities undertaken, the provisions for the capabilities of staff, and the needs of all occupants through requirements directed at the following:

(1) Prevention of ignition
(2) Detection of fire
(3) Control of fire development
(4) Confinement of the effects of fire
(5) Extinguishment of fire
(6) Provision of refuge or evacuation facilities, or both
(7) Staff reaction

A.21.1.3.3 Doctors' offices and treatment and diagnostic facilities that are intended solely for outpatient care and are physically separated from facilities for the treatment or care of inpatients, but that are otherwise associated with the management of an institution, might be classified as business occupancies rather than health care occupancies.

A.21.2.2.2.4 The words "principal entrance/exit doors" describe doors that the authority having jurisdiction can reasonably expect to be unlocked in order for the facility to do business.

A.21.2.2.2.12 The waiver of the requirement for doors to swing in the direction of egress travel is based on the assumption that, in this occupancy, there is little possibility of a panic rush that might prevent the opening of doors that swing against egress travel.

A desirable arrangement, which is possible with corridors 6 ft (1830 mm) or more in width, is to have two 32 in. (810 mm) doors, normally closed, each swinging with the egress travel (in opposite directions).

A.21.2.3.3 Building codes and accessibility codes might require cane detection below projections that exceed 4 in. (102 mm).

A.21.3.2.1 It is not the intent of this provision that rooms inside individual tenant spaces that are used to store routine office supplies for that tenant be required to be either separated or sprinklered.

A.21.3.2.3 The requirement for separating high-hazard contents areas from other parts of the building is intended to isolate the hazard, and 8.2.3.3 is applicable.

A.21.3.7.10 Smoke barriers might include walls having door openings other than cross-corridor doors. There is no restriction in the *Code* regarding which doors or how many doors form part of a smoke barrier. For example, doors from the corridor to individual rooms are permitted to form part of a smoke barrier.

A.21.4.2.2 In some cases, appreciable cost might be involved in bringing an existing occupancy into compliance. Where this is true, it would be appropriate for the authority having jurisdiction to prescribe a schedule determined jointly with the facility, allowing suitable periods of time for the correction of the various deficiencies and giving due weight to the ability of the owner to secure the necessary funds.

A.21.4.3 Extensive research, including fire modeling, has indicated that alcohol-based hand-rub solutions can be safely installed in corridors of health care facilities, provided that certain other precautions are taken. The total quantities of flammable liquids in any area should comply with the provisions of other recognized codes, including NFPA 1, *Fire Code*, and NFPA 30, *Flammable and Combustible Liquids Code*. In addition, special consideration should be given to the following:

(1) Obstructions created by the installation of hand-rub solution dispensers
(2) Location of dispensers with regard to adjacent combustible materials and potential sources of ignition, especially where dispensers are mounted on walls of combustible construction
(3) Requirements for other fire protection features, including complete automatic sprinkler protection, to be installed throughout the compartment
(4) Amount and location of the flammable solutions, both in use and in storage, particularly with respect to potential for leakage or failure of the dispenser

A.21.7 Ambulatory health care occupants have, in large part, varied degrees of physical disability, and their removal to the outside, or even their disturbance caused by moving, is inexpedient or impractical in many cases, except as a last resort. Similarly, recognizing that there might be an operating necessity for the restraint of the mentally ill, often by use of barred windows and locked doors, fire exit drills are usually extremely disturbing, detrimental, and frequently impracticable.

In most cases, fire exit drills, as ordinarily practiced in other occupancies, cannot be conducted in ambulatory health care occupancies. Fundamentally, superior construction, early discovery and extinguishment of incipient fires, and prompt notification need to be relied on to reduce the occasion for evacuation of buildings of this class to a minimum.

A.21.7.1.4 Many ambulatory health care occupancies conduct fire drills without disturbing patients by choosing the location of the simulated emergency in advance and by closing the doors in the vicinity prior to initiation of the drill. The purpose of a fire drill is to test and evaluate the efficiency, knowledge, and response of personnel in implementing the facility fire emergency plan. Its purpose is not to disturb or excite patients. Fire drills should be scheduled on a random basis to ensure that personnel in ambulatory health care facilities are drilled not less than once in each 3-month period.

Drills should consider the ability to move patients to an adjacent smoke compartment. Relocation can be practiced using simulated patients or empty wheelchairs.

A.21.7.2.1 Each facility has specific characteristics that vary sufficiently from other facilities to prevent the specification of a universal emergency procedure. The recommendations that follow, however, contain many of the elements that should be considered and adapted, as appropriate, to the individual facility.

Upon discovery of fire, personnel should immediately take the following action:

(1) If any person is involved in the fire, the discoverer should go to the aid of that person, calling aloud an established code phrase, which provides for both the immediate aid of any endangered person and the transmission of an alarm.
(2) Any person in the area, upon hearing the code called aloud, should activate the building fire alarm using the nearest manual fire alarm box.
(3) If a person is not involved in the fire, the discoverer should activate the building fire alarm using the nearest manual fire alarm box.
(4) Personnel, upon hearing the alarm signal, should immediately execute their duties as outlined in the facility fire safety plan.
(5) The telephone operator should determine the location of the fire as indicated by the audible signal.
(6) In a building equipped with an uncoded alarm system, a person on the floor of fire origin should be responsible for promptly notifying the facility telephone operator of the fire location.
(7) If the telephone operator receives a telephone alarm reporting a fire from a floor, the operator should regard that alarm in the same fashion as an alarm received over the fire alarm system and should immediately notify the fire department and alert all facility personnel of the place of fire and its origin.
(8) If the building fire alarm system is out of order, any person discovering a fire should immediately notify the telephone operator by telephone, and the operator should then transmit this information to the fire department and alert the building occupants.

A.21.7.4 The most rigid discipline with regard to prohibition of smoking might not be nearly as effective in reducing incipient fires from surreptitious smoking as the open recognition of smoking, with provision of suitable facilities for smoking. Proper education and training of the staff and attendants in the ordinary fire hazards and their abatement is unquestionably essential. The problem is a broad one, varying with different types and arrangements of buildings; the effectiveness of rules of procedure, which need to be flexible, depends in large part on the management.

A.21.7.5.1 In addition to the provisions of 10.3.1, which deal with ignition resistance, additional requirements with respect to the location of cubicle curtains relative to sprinkler placement are included in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

A.21.7.5.4(4) The percentage of decorations should be measured against the area of any wall or ceiling, not the aggregate total of walls, ceilings, and doors. The door is considered part of the wall. The decorations must be located such that they do not interfere with the operation of any door, sprinkler, smoke detector, or any other life safety equipment. Other art might include hanging objects or three-dimensional items.

A.21.7.5.5.2 It is the intent that this provision permits recycling of bottles, cans, paper, and similar clean items that do not contain grease, oil, flammable liquids, or significant plastic materials using larger containers or several adjacent containers and not require locating such containers in a room protected as a hazardous area. Containers for medical records awaiting shredding are often larger than 32 gal (121 L). These containers are not to be included in the calculations and limitations of 21.7.5.5.1. There is no limit on the number of these containers, as FM Approval Standard 6921, *Containers for Combustible Waste,* ensures that the fire will not spread outside of the container. FM approval standards are written for use with FM Approvals. The tests can be conducted by any approved laboratory. The portions of the standard referring to FM Approvals are not included in this reference.

A.21.7.5.5.2(2) See 21.7.5.5.1(3).

A.21.7.7 A document that provides recognized engineering principles for the testing of smoke control systems is NFPA 92, *Standard for Smoke Control Systems.*

A.22.1.1.1.4(2) In determining equivalency for conversions, modernizations, renovations, or unusual design concepts of detention and correctional facilities, the authority having jurisdiction is permitted to accept evaluations based on the detention and correctional occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, utilizing the parameters for new construction.

A.22.1.1.1.6 It is not the intent to classify as detention and correctional occupancies the areas of health care occupancies in which doors are locked against patient egress where needed for the clinical needs of the patients. For example, a dementia treatment center can be adequately protected by the health care occupancies requirements of Chapter 18. *[See 18.1.1.1.7, 18.2.2.2.2, 18.2.2.2.4(1), and 18.2.2.2.6.]*

The one-resident threshold requirement of 22.1.1.1.6 is not meant to force a residential occupancy, where security is imposed on one or more occupants, to be reclassified as a detention and correctional occupancy.

A.22.1.1.1.7 Lockups in which persons are detained with some degree of security imposed on them are common in many occupancies. Examples include the following:

(1) Immigration and naturalization facilities at border crossings
(2) Customs facilities at international airports
(3) Prisoner holding facilities at courthouses
(4) Local police department holding areas
(5) Security offices at sports stadia
(6) Security offices at shopping mall complexes

A.22.1.2.1 Users and occupants of detention and correctional facilities at various times can be expected to include staff, visitors, and residents. The extent and nature of facility utilization vary according to the type of facility, its function, and its programs.

Figure A.22.1.2.1 illustrates the five use conditions.

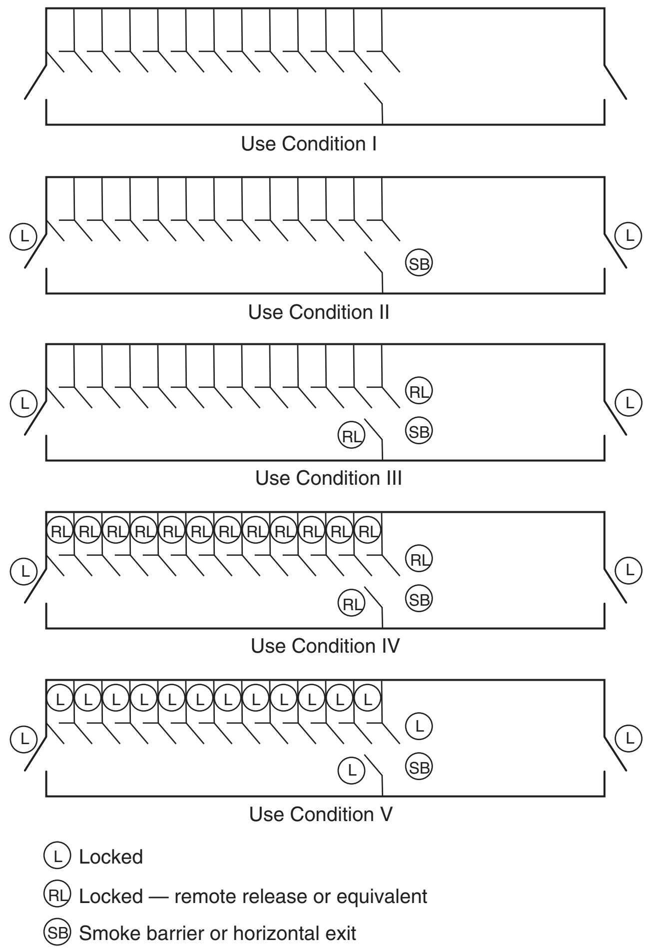


FIGURE A.22.1.2.1 Detention and Correctional Use Conditions.

A.22.1.2.2 Prompt operation is intended to be accomplished in the period of time between detection of fire, either by the smoke detector(s) required by 22.3.4.4 or by other means, whichever occurs first, and the advent of intolerable conditions forcing emergency evacuation. Fire tests have indicated that the time available is a function of the volume and height of the space involved and the rate of fire development. In traditional one-story corridor arrangements, the time between detection by smoke detectors and the advent of lethal conditions down to head height can be as short as approximately 3 minutes. In addition, it should be expected that approximately 1 minute will be required to evacuate all the occupants of a threatened smoke compartment once the locks are released. In such a case, a prompt release time would be 2 minutes.

A.22.1.2.3(2) If the Use Condition I facility conforms to the requirements of residential occupancies under this *Code*, there are no staffing requirements. If the Use Condition I facility conforms to the requirements of Use Condition II facilities as permitted by this provision, staffing is required in accordance with 22.7.1.

A.22.1.3 Detention and correctional facilities are a complex of structures, each serving a definite and usually different purpose. In many institutions, all, or almost all, the occupancy-type classifications found in this *Code* are represented. Means of egress and other features are governed by the type of occupancy classification and the hazard of occupancy, unless specific exemptions are made.

All buildings and structures are to be classified using Chapter 22 and Section 6.1 as a guide, subject to the ruling of the authority having jurisdiction where a question arises concerning the proper classification of any individual building or structure.

Use condition classification of the institution, as well as of individual areas within the complex, is always to be considered by the authority having jurisdiction.

A.22.1.3.2.2 Key-operated locking hardware of a lesser grade than institutional grade hardware might not be suitable for the heavy use to which such locks are expected to be subjected.

A.22.2.2.5.2 An exit is not necessary from each individual fire compartment or smoke compartment if there is access to an exit through other fire compartments or smoke compartments without passing through the fire compartment or smoke compartment of fire origin.

A.22.2.11.4 It might be necessary to provide a certain number of resident sleeping rooms with doors providing a clear width of not less than 32 in. (810 mm) *(see 7.2.1.2)* in order to comply with the requirements for the physically handicapped. Such sleeping rooms should be located where there is a direct accessible route to the exterior or to an area of safe refuge. *(See 22.3.7.)*

A.22.2.11.8 A remote position is generally a control point where a number of doors can be unlocked simultaneously, either mechanically or electrically. In areas where there are a number of sleeping rooms, it is impractical for attendants to unlock doors individually. Doors in an exit should be unlocked prior to unlocking sleeping room doors. Sight and sound supervision of resident living areas can be by means of camera and communications systems.

This section of the *Code* does not intend to prohibit Use Condition V facilities, nor does it intend to limit Use Condition V facilities to 10 manually released locks.

A.22.3.1(2) For purposes of providing control valves and waterflow devices, multilevel residential housing areas complying with this provision are considered to be one story.

A.22.3.2.1 Combustible loading in any room opening onto a residential housing area should be limited to reduce the potential for room flashover. Rooms in which fuel loads are not controlled, thereby creating a potential for flashover, should be considered hazardous areas. Where fire-rated separation is provided, doors to such rooms, including sleeping rooms, should be self-closing.

It is strongly recommended that padded cells not be used due to their fire record. However, recognizing that they will be used in some cases, provisions for the protection of padded cells are provided. It is recognized that the minimum ¾-hour fire protection–rated fire door will be violated with the "plant on" of the padding, but a minimum ¾-hour fire protection–rated fire door should be the base of the assembly.

A.22.3.4.3.1(2) The staff at the constantly attended location should have the capability to promptly initiate the general alarm function and contact the fire department or have direct communication with a control room or other location that can initiate the general alarm function and contact the fire department.

A.22.3.4.4 Examples of contiguous common spaces are galleries and corridors.

A.22.3.4.4.3 An open dormitory is a dormitory that is arranged to allow staff to observe the entire dormitory area at one time.

A.22.3.5.4(1) Where access to portable fire extinguishers is locked, staff should be present on a 24-hour basis and should have keys readily available to unlock access to the extinguishers. Where supervision of sleeping areas is from a 24-hour attended staff location, portable fire extinguishers are permitted to be provided at the staff location in lieu of the sleeping area.

A.22.3.5.4(2) It is recognized that locating portable fire extinguishers only at staff locations might result in travel distances to extinguishers being in excess of those permitted by NFPA 10, *Standard for Portable Fire Extinguishers*.

A.22.3.7.1(2) A door to the outside, by itself, does not meet the intent of this provision if emergency operating procedures do not provide for the door to be unlocked when needed. In cases where use of the door is not ensured, a true smoke barrier per the base requirement of 22.3.7.1 would be needed.

A.22.3.7.5 Structural fire resistance is defined as the ability of the assembly to stay in place and maintain structural integrity without consideration of heat transmission. Twelve-gauge steel plate suitably framed and stiffened meets this requirement.

A.22.3.7.6(1) As an example, a smoke barrier is permitted to consist of fire-rated glazing panels mounted in a security grille arrangement.

A.22.3.8 The requirements in Table 22.3.8 for smoke-resistant separations include taking the necessary precautions to restrict the spread of smoke through the air-handling system. However, the intent is not that smoke dampers are required to be provided for each opening. Smoke dampers would be one acceptable method; however, other techniques, such as allowing the fans to continue to run with 100 percent supply and 100 percent exhaust, would be acceptable.

A.22.4.4.3 This provision is intended to promote the use of horizontal exits in detention and correctional occupancies. Horizontal exits provide an especially effective egress system for an occupancy in which the occupants, due to security concerns, are not commonly released to the outside. This provision offers a *Code*-specified equivalent alternative to the requirement of 7.2.4.3.5 that horizontal exits are not to be penetrated by ducts in nonsprinklered buildings. The intended continuity of the fire resistance–rated and smoke-resisting barrier is maintained by requiring that duct penetrations of horizontal exits be protected by combination fire damper/smoke leakage–rated dampers that will close upon activation of a smoke detector and a heat-actuated mechanism before the barrier's ability to resist the passage of smoke and fire is compromised.

A.22.4.4.6.2 It is not the intent of this requirement to restrict room face separations, which restrict visibility from the common space into individual sleeping rooms.

A.22.4.4.6.4 The vertical separation between the lowest floor level and the uppermost floor level is not to exceed 13 ft (3960 mm). Figure A.22.4.4.6.4 illustrates how the height is to be determined.

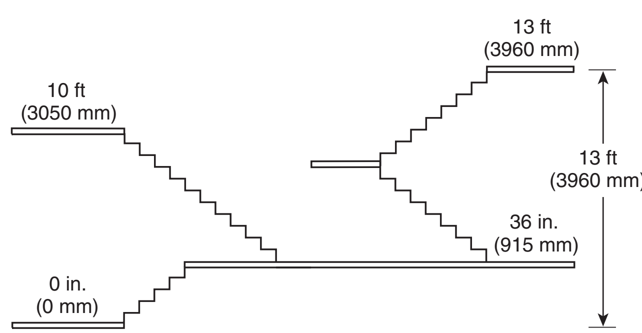


FIGURE A.22.4.4.6.4 Vertical Height Measurement.

A.22.4.4.11 The requirements in Table 22.4.4.11 for smoke-resistant and fire-rated separations include taking the necessary precautions to restrict the spread of smoke through the air-handling system. However, the intent is that smoke dampers are required to be provided for each opening. Smoke dampers would be one acceptable method; however, other techniques, such as allowing the fans to continue to run with 100 percent supply and 100 percent exhaust, would be acceptable.

A.22.4.4.12.2(2) The automatic smoke venting should be in accordance with NFPA 204, *Standard for Smoke and Heat Venting*, for light hazard occupancies.

A.22.4.4.13.2 Mattresses used in detention and correctional facilities should be evaluated with regard to the fire hazards of the environment. The potential for vandalism and excessive wear and tear also should be taken into account when evaluating the fire performance of the mattress. ASTM F 1870, *Standard Guide for Selection of Fire Test Methods for the Assessment of Upholstered Furnishings in Detention and Correctional Facilities*, provides guidance for this purpose.

A.22.4.5.1.4(1) The term *other physical restraints* is meant to include the use of personal restraint devices, such as handcuffs or shackles, where occupants are secured to the structure or furnishings to restrict movement.

A.22.4.6 The health, security, and fire safety implications should be reviewed by the detention and correction facility prior to installation.

A.22.7.1.2 This requirement is permitted to be met by electronic or oral monitoring systems, visual monitoring, call signals, or other means.

A.22.7.1.3 Periodic, coordinated training should be conducted and should involve detention and correctional facility personnel and personnel of the fire department legally committed to serving the facility.

A.22.7.2 Personal property provides combustible contents for fire development. Therefore, adequate controls are needed to limit the quantity and combustibility of the fuels available to burn to reduce the probability of room flashover. The provisions of 22.7.4 will not, by themselves, prevent room flashover if personal property controls are not provided.

A.22.7.4 The type, quantity, and arrangement of furniture and other combustibles are important factors in determining how fast the fire will develop. Furnishings, including upholstered items and wood items, such as wardrobes, desks, and bookshelves, might provide sufficient fuel to result in room flashover, which is the full fire involvement of all combustibles within a room once sufficient heat has been built up within the room.

A.23.1.1.1.4(2) In determining equivalency for existing detention and correctional facilities, the authority having jurisdiction is permitted to accept evaluations based on the detention and correctional occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, utilizing the parameters for existing buildings.

A.23.1.1.1.6 It is not the intent to classify as detention and correctional occupancies the areas of health care occupancies in which doors are locked against patient egress where needed for the clinical needs of the patients. For example, a dementia treatment center can be adequately protected by the health care occupancies requirements of Chapter 19. *[See 19.1.1.1.7, 19.2.2.2.2, 19.2.2.2.4(1), and 19.2.2.2.6.]*

The one-resident threshold requirement of 23.1.1.1.6 is not meant to force a residential occupancy, where security is imposed on one or more occupants, to be reclassified as a detention and correctional occupancy.

A.23.1.1.1.7 Lockups in which persons are detained with some degree of security imposed on them are common in many occupancies. Examples include the following:

(1) Immigration and naturalization facilities at border crossings
(2) Customs facilities at international airports
(3) Prisoner holding facilities at courthouses
(4) Local police department holding areas
(5) Security offices at sports stadia
(6) Security offices at shopping mall complexes

A.23.1.2.1 Users and occupants of detention and correctional facilities at various times can be expected to include staff, visitors, and residents. The extent and nature of facility utilization will vary according to the type of facility, its function, and its programs.

Figure A.23.1.2.1 illustrates the five use conditions.

A.23.1.2.2 Prompt operation is intended to be accomplished in the period of time between detection of fire, either by the smoke detector(s) required by 23.3.4.4 or by other means, whichever

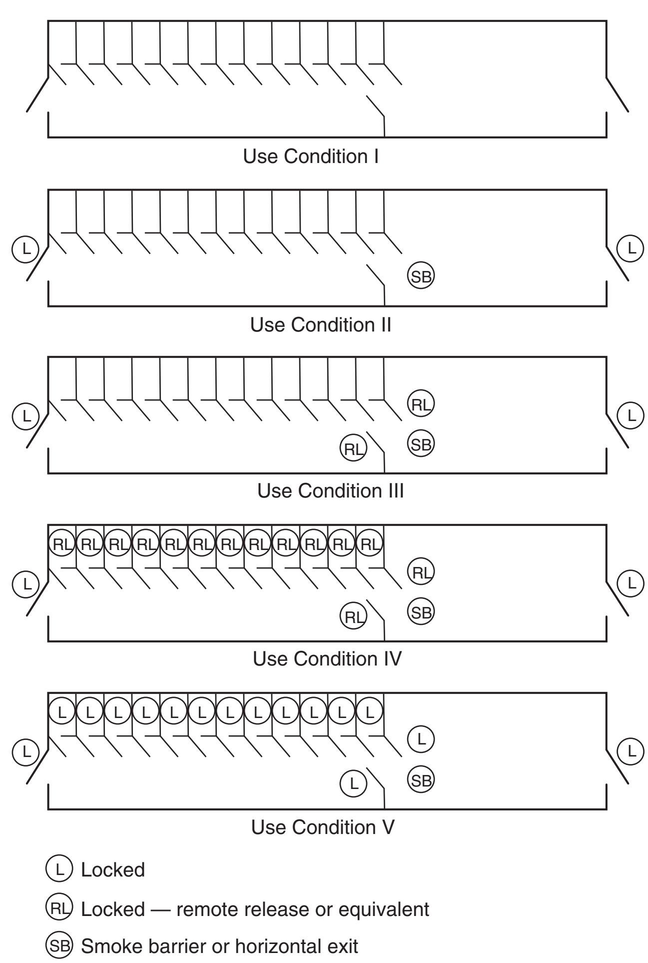


FIGURE A.23.1.2.1 Detention and Correctional Use Conditions.

occurs first, and the advent of intolerable conditions forcing emergency evacuation. Fire tests have indicated that the time available is a function of the volume and height of the space involved and the rate of fire development. In traditional one-story corridor arrangements, the time between detection by smoke detectors and the advent of lethal conditions down to head height can be as short as approximately 3 minutes. In addition, it should be expected that approximately 1 minute will be required to evacuate all the occupants of a threatened smoke compartment once the locks are released. In such a case, a prompt release time would be 2 minutes.

A.23.1.2.3(2) If the Use Condition I facility conforms to the requirements of residential occupancies under this *Code*, there are no staffing requirements. If the Use Condition I facility conforms to the requirements of Use Condition II facilities as permitted by this exception, staffing is required in accordance with 23.7.1.

A.23.1.3 Detention and correctional facilities are a complex of structures, each serving a definite and usually different purpose. In many institutions, all, or almost all, of the occupancy-type classifications found in this *Code* are represented. Means of egress and other features are governed by the type of occupancy classification and the hazard of occupancy, unless specific exemptions are made.

All buildings and structures are to be classified using Chapter 23 and Section 6.1 as a guide, subject to the ruling of the authority having jurisdiction where there is a question as to the proper classification of any individual building or structure.

Use condition classification of the institution, as well as of individual areas within the complex, is always to be considered by the authority having jurisdiction.

A.23.1.3.2.1 Key-operated locking hardware should be of institutional grade. Lesser grade hardware might not be suitable for the heavy use to which such locks are expected to be subjected.

A.23.2.2.5.2 An exit is not necessary from each individual fire compartment if there is access to an exit through other fire compartments without passing through the fire compartment of fire origin.

A.23.2.2.5.3 This provision is intended to promote the use of horizontal exits in detention and correctional occupancies. Horizontal exits provide an especially effective egress system for an occupancy in which the occupants, due to security concerns, are not commonly released to the outside. This provision offers a *Code*-specified equivalent alternative to the requirement of 7.2.4.3.5 that horizontal exits are not to be penetrated by ducts. The intended continuity of the fire resistance–rated and smoke-resisting barrier is maintained by requiring that duct penetrations of horizontal exits be protected by combination fire damper/smoke leakage–rated dampers that close upon activation of a smoke detector and a heat-actuated mechanism before the barrier's ability to resist the passage of smoke and fire is compromised.

A.23.2.4.2 Multilevel and multitiered residential housing areas meeting the requirements of 23.3.1.2 and 23.3.1.3 are considered one story. Therefore, two exits are not required from each level; only access to two exits is required.

A.23.2.4.3 An exit is not necessary from each individual fire compartment and smoke compartment if there is access to an exit through other fire compartments or smoke compartments without passing through the fire compartment or smoke compartment of fire origin.

A.23.2.5.2 Every exit or exit access should be arranged, if feasible, so that no corridor or aisle has a pocket or dead end exceeding 50 ft (15 m) for Use Conditions II, III, and IV and 20 ft (6100 mm) for Use Condition V.

A.23.2.5.3(3) In determining whether to approve the existing common path of travel that exceeds 50 ft (15 m), the authority having jurisdiction should ensure that the common path is not in excess of the travel distance permitted by 23.2.6.

A.23.2.11.4 It might be necessary to provide a certain number of resident sleeping rooms with doors providing a clear width of not less than 32 in. (810 mm) *(see 7.2.1.2)* in order to comply with the requirements for the physically handicapped. Such sleeping rooms should be located where there is a direct accessible route to the exterior or to an area of safe refuge. *(See 23.3.7.)*

A.23.2.11.8 A remote position is generally a control point where a number of doors can be unlocked simultaneously, either mechanically or electrically. In areas where there are a number of sleeping rooms, it is impractical for attendants to unlock doors individually. Doors in an exit should be unlocked prior to unlocking sleeping room doors. Sight and sound supervision of resident living areas can be by means of camera and communications systems.

This section of the *Code* does not intend to prohibit Use Condition V facilities, nor does it intend to limit Use Condition V facilities to 10 manually released locks.

A.23.3.1.2.1 It is not the intent of this requirement to restrict room face separations, which restrict visibility from the common space into individual sleeping rooms.

A.23.3.1.2.3 The vertical separation between the lowest floor level and the uppermost floor level is not to exceed 13 ft (3960 mm). Figure A.23.3.1.2.3 illustrates how the height is to be determined.

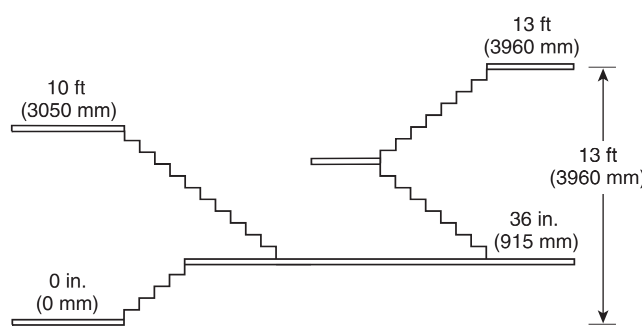


FIGURE A.23.3.1.2.3 Vertical Height Measurement.

A.23.3.1.3 A recommended method of calculating the expected level of smoke in a smoke removal–equipped cell block follows.

This method for calculating the expected level of smoke has been developed from data experimentally produced in full-scale burnouts of test cells. The test cells were sized, loaded with fuel, and constructed to represent severe conditions of heavily fuel-loaded [approximately 6 lb/ft^2 (29 kg/m^2)] cells as found in prison locations. The filling rate and temperature of the effluent gas and smoke have been calculated using the data from these tests and established formulae from plume dynamics.

The application of the method described in A.23.3.1.3 should be limited to situations where there is not less than 10 ft (3050 mm) from the floor level to the lowest acceptable level of smoke accumulation *(Z)*; the reservoir above the lowest acceptable level for *Z* is at least 20 percent of the *Z* dimension; the length of the cell block is not less than *Z*; and the fan is not less than 10 ft (3050 mm) higher than the floor of the highest cell.

The determination of smoke removal requirements is based on the dimensions of the cell opening. Where more than one cell opening is involved, the larger size on the level being calculated should be used.

The fan size, temperature rating, and operations means can be determined by the procedure that follows.

Acceptable Smoke Level. Determine the lowest acceptable level of smoke accumulation in accordance with 23.3.1.3. The vertical distance between that level and the floor level of the lowest open cell is the value of *Z* to be used in connection with Figure A.23.3.1.3(a).

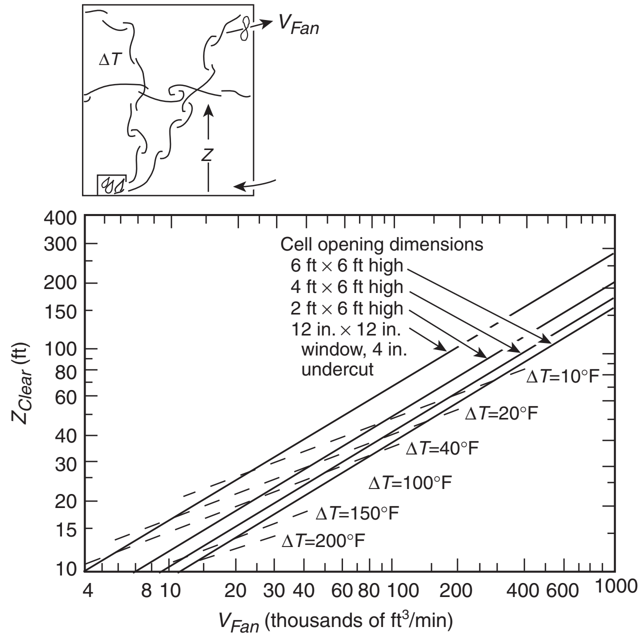
Characteristic Cell Opening. Determine the opening of the cell face. Where there is more than one size of cell opening, use the largest. Match the actual opening to those shown in Figure A.23.3.1.3(b), and use the corresponding curve from Figure A.23.3.1.3(a). If there is no match between the size and shape of the opening and Figure A.23.3.1.3(a), interpolate between the curves. If the opening exceeds 6 ft × 6 ft (1.8 m × 1.8 m), use the curve for a 6 ft × 6 ft (1.8 m × 1.8 m) opening. This curve represents the maximum burning situation, and increasing the size of the opening will not increase the actual burning rate.

Exhaust Fan Rate. Determine the exhaust fan capacity needed to extract smoke at a rate that will maintain the smoke level at a point higher than *Z*. This is the rate shown on the baseline of Figure A.23.3.1.3(a) corresponding to the level of *Z* on the vertical axis for the solid line (ventilation rate) curve appropriate to the cell door size. This exhaust capability needs to be provided at a point higher than *Z*.

Intake Air. Provide intake air openings that either exist or are automatically provided at times of emergency smoke removal. These openings are to be located at or near the baseline of the cell block to allow for intake air at the rate to be vented by the fan. The openings provided shall be sufficient to avoid a friction load that can reduce the exhaust efficiency. Standard air-handling design criteria are used in making this calculation.

Fan Temperature Rating. Determine the potential temperature of gases that the fan might be required to handle by measuring the distance from the floor of the highest cell to the centerline of the fan, or fan ports if the fan is in a duct or similar arrangement. Determine the intersection of the new *Z* value with the appropriate ventilation rate curve (solid line) from Figure A.23.3.1.3(a). Estimate the temperature rise by interpolating along the appropriate ventilation rate curve and between the constant temperature rise curves (dashed lines) from Figure A.23.3.1.3(a). Provide all elements of the exhaust system that are to be above the acceptable smoke level with the capability to effectively operate with the indicated increase in temperature.

Operation of Exhaust System. Arrange the emergency exhaust system to initiate automatically on detection of smoke, on operation of a manual fire alarm system, or by direct manual operation. The capability to manually start the automatic exhaust system should be provided in a guard post in the cell block, at another control location, or both. Where appropriate, the emergency exhaust fans are permitted to be used for comfort ventilation as well as for serving their emergency purposes.



For SI units, 1 ft = 0.3048 m; 1 in. = 25.4 mm; (°F −32) ÷ 1.8 = °C; 1 ft^3/min = 0.00047 m^3/s

ΔT = Temperature of upper layer gases above ambient
Z_{Clear} = Distance from cell floor to smoke layer
V_{Fan} = Fan discharge capacity (as installed)

Solid lines: Ventilation rate curves
Dashed lines: Constant temperature rise curves

FIGURE A.23.3.1.3(a) Cell Block Smoke Control Ventilation Curves.

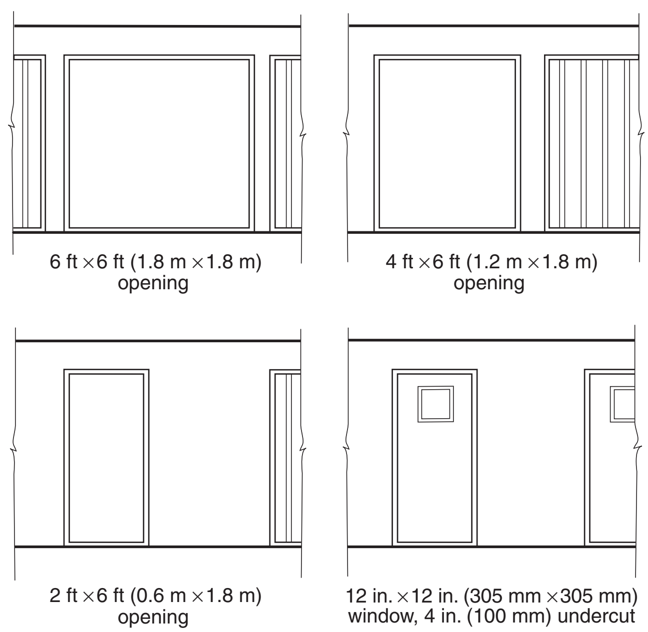


FIGURE A.23.3.1.3(b) Typical Cell Openings.

A.23.3.2.1 It is strongly recommended that padded cells not be used due to their fire record. However, recognizing that they will be used in some cases, provisions for the protection of padded cells are provided. It is recognized that the minimum ¾-hour fire protection–rated fire door will be violated with the "plant on" of the padding, but a minimum ¾-hour fire protection–rated fire door should be the base of the assembly.

A.23.3.4.3.1(2) The staff at the constantly attended location should have the capability to promptly initiate the general alarm function and contact the fire department or have direct communication with a control room or other location that can initiate the general alarm function and contact the fire department.

A.23.3.4.4.3 An open dormitory is a dormitory that is arranged to allow staff to observe the entire dormitory area at one time.

A.23.3.5.2 Where the openings in ceilings or partitions are ¼ in. (6.3 mm) or larger in the smallest dimension, where the thickness or depth of the material does not exceed the smallest dimension of the openings, and where such openings constitute not less than 70 percent of the area of the ceiling or partition material, the disruption of sprinkler spray patterns is permitted to be disregarded.

A.23.3.5.4(1) Where access to portable fire extinguishers is locked, staff should be present on a 24-hour basis and should have keys readily available to unlock access to the extinguishers. Where supervision of sleeping areas is from a 24-hour attended staff location, portable fire extinguishers are permitted to be provided at the staff location in lieu of the sleeping area.

A.23.3.5.4(2) It is recognized that locating portable fire extinguishers only at staff locations might result in travel distances to extinguishers being in excess of those permitted by NFPA 10, *Standard for Portable Fire Extinguishers*.

A.23.3.7.1 Consideration can be given for large open areas that might be permitted to function as smoke sinks as an alternative to the installation of more than one smoke barrier as required by 23.3.7.1. Vertical movement downward to an area of refuge might be permitted by the authority having jurisdiction in lieu of horizontal movement.

A.23.3.7.1(2) A door to the outside, by itself, does not meet the intent of this provision if emergency operating procedures do not provide for the door to be unlocked when needed. In cases where use of the door is not ensured, a true smoke barrier per the base requirement of 23.3.7.1 would be needed.

A.23.3.7.3(2) Consideration should be given to increasing the travel distance to a smoke barrier to coincide with existing range lengths and exits.

A.23.3.7.5 Structural fire resistance is defined as the ability of the assembly to stay in place and maintain structural integrity without consideration of heat transmission. Twelve-gauge steel plate suitably framed and stiffened meets this requirement.

A.23.3.7.6(1) As an example, a smoke barrier is permitted to consist of fire-rated glazing panels mounted in a security grille arrangement.

A.23.3.8 The requirements in Table 23.3.8 or smoke-resistant and fire-rated separations include taking the necessary precautions to restrict the spread of smoke through the air-handling system. However, the intent is not that smoke dampers are required to be provided for each opening. Smoke dampers would be one acceptable method; however, other techniques, such as allowing the fans to continue to run with 100 percent supply and 100 percent exhaust, would be acceptable.

A.23.4.1.2(2) The automatic smoke venting should be in accordance with NFPA 204, *Standard for Smoke and Heat Venting*, for light hazard occupancies.

A.23.4.5.1.4(1) The term *other physical restraints* is meant to include the use of personal restraint devices, such as handcuffs or shackles, where occupants are secured to the structure or furnishings to restrict movement.

A.23.4.6 The health, security, and fire safety implications should be reviewed by the detention and correction facility prior to installation.

A.23.7.1.2 This requirement is permitted to be met by electronic or oral monitoring systems, visual monitoring, call signals, or other means.

A.23.7.1.3 Periodic, coordinated training should be conducted and should involve detention and correctional facility personnel and personnel of the fire department legally committed to serving the facility.

A.23.7.2 Personal property provides combustible contents for fire development. Therefore, adequate controls are needed to limit the quantity and combustibility of the fuels available to burn to reduce the probability of room flashover. The provisions of 23.7.4 will not, by themselves, prevent room flashover if personal property controls are not provided.

A.23.7.4.3 Mattresses used in detention and correctional facilities should be evaluated with regard to the fire hazards of the environment. The potential for vandalism and excessive wear and tear also should be taken into account when evaluating the fire performance of the mattress. ASTM F 1870, *Standard Guide for Selection of Fire Test Methods for the Assessment of Upholstered Furnishings in Detention and Correctional Facilities*, provides guidance for this purpose.

A.24.1.1.2 The *Code* specifies that, wherever there are three or more living units in a building, the building is considered an apartment building and is required to comply with either Chapter 30 or Chapter 31, as appropriate. A townhouse unit is considered to be an apartment building if there are three or more units in the building. The type of wall required between units in order to consider them as separate buildings is normally established by the authority having jurisdiction. If the units are separated by a wall of sufficient fire resistance and structural integrity to be considered as separate buildings, the provisions of Chapter 24 apply to each townhouse. Condominium status is a form of ownership, not occupancy; for example, there are condominium warehouses, condominium apartments, and condominium offices.

The provisions of 24.1.1.2 state that, in one- and two-family dwellings, each dwelling unit can be "occupied by members of a single family with not more than three outsiders." The *Code* does not define the term *family*. The definition of *family* is subject to federal, state, and local regulations and might not be restricted to a person or a couple (two people) and their children. The following examples aid in differentiating between a single-family dwelling and a lodging or rooming house:

(1) An individual or a couple (two people) who rent a house from a landlord and then sublease space for up to three individuals should be considered a family renting to a maximum of three outsiders, and the house should be regulated as a single-family dwelling in accordance with Chapter 24.

(2) A house rented from a landlord by an individual or a couple (two people) in which space is subleased to 4 or more individuals, but not more than 16, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26.
(3) A residential building that is occupied by 4 or more individuals, but not more than 16, each renting from a landlord, without separate cooking facilities, should be considered and regulated as a lodging or rooming house in accordance with Chapter 26.

A.24.2 The phrase "means of escape" indicates a way out of a residential unit that does not conform to the strict definition of means of egress but does meet the intent of the definition by providing an alternative way out of a building. *(See the definition of means of escape in 3.3.172.)*

A.24.2.2.3.3 A window with dimensions of 20 in. × 24 in. (510 mm × 610 mm) has an opening of 3.3 ft^2 (0.31 m^2), which is less than the required 5.7 ft^2 (0.53 m^2). Therefore, either the height or width needs to exceed the minimum requirement to provide the required clear area *(see Figure A.24.2.2.3.3.* The current minimum width and height dimensions, as well as the minimum clear opening, became a requirement of this *Code* in the 1976 edition and were based on tests conducted to determine the minimum size of the wall opening required to allow a fire fighter wearing complete turnout gear and a self-contained breathing apparatus entry to the room from the exterior to effect search and rescue. Prior editions of the *Code* limited the width or height, or both, to not less than 22 in. (560 mm) and a clear opening of 5 ft^2 (0.47 m^2). For existing window frames and sash of steel construction, adherence to these dimensional criteria is essential to allow fire fighter entry. For existing window frames and sash of wood construction that can easily be removed prior to entry by fire fighters to achieve the 5 ft^2 (0.47 m^2) hole in the wall, the clear opening created by the occupant upon opening the window from the interior room side is required only to provide an opening measuring not less than 20 in. × 24 in. (510 mm × 610 mm) or 3.3 ft^2 (0.31 m^2).

A.24.2.4.7 It is the intent of this requirement that security measures, where installed, do not prevent egress.

A.24.3.4.1.1 Paragraph 11.5.1.3 of *NFPA 72, National Fire Alarm and Signaling Code*, contains related requirements. They specify that, where the interior floor area for a given level of a dwelling unit, excluding garage areas, is greater than 1000 ft^2 (93 m^2), smoke alarms are to be installed as follows:

(1) All points on the ceiling are to have a smoke alarm within a distance of 30 ft (9.1 m), measured along a path of travel, or to have one smoke alarm per 500 ft^2 (46.5 m^2) of floor area, which is calculated by dividing the total interior floor area per level by 500 ft^2 (46.5 m^2).
(2) Where dwelling units include great rooms or vaulted/cathedral ceilings extending over multiple floors, smoke alarms located on the upper floor that are intended to protect the aforementioned area are permitted to be considered as part of the lower floor(s) protection scheme used to meet the requirements of A.24.3.4.1.1(1).

A.24.3.4.1.1(2) Paragraphs 11.5.1.1(2) and 11.5.1.2 of *NFPA 72, National Fire Alarm and Signaling Code*, contain related requirements. The requirement of 11.5.1.1(2) specifies that an alarm is to be installed outside of each separate dwelling unit sleeping area, within 21 ft (6.4 m) of any door to a sleeping room, with the distance measured along a path of travel. The requirement in 11.5.1.2 specifies that, where the area addressed in 11.5.1.1(2) is separated from the adjacent living areas by a door, a smoke alarm is to be installed in the area between the door and the sleeping rooms, and additional alarms are to be installed on the living area side of the door.

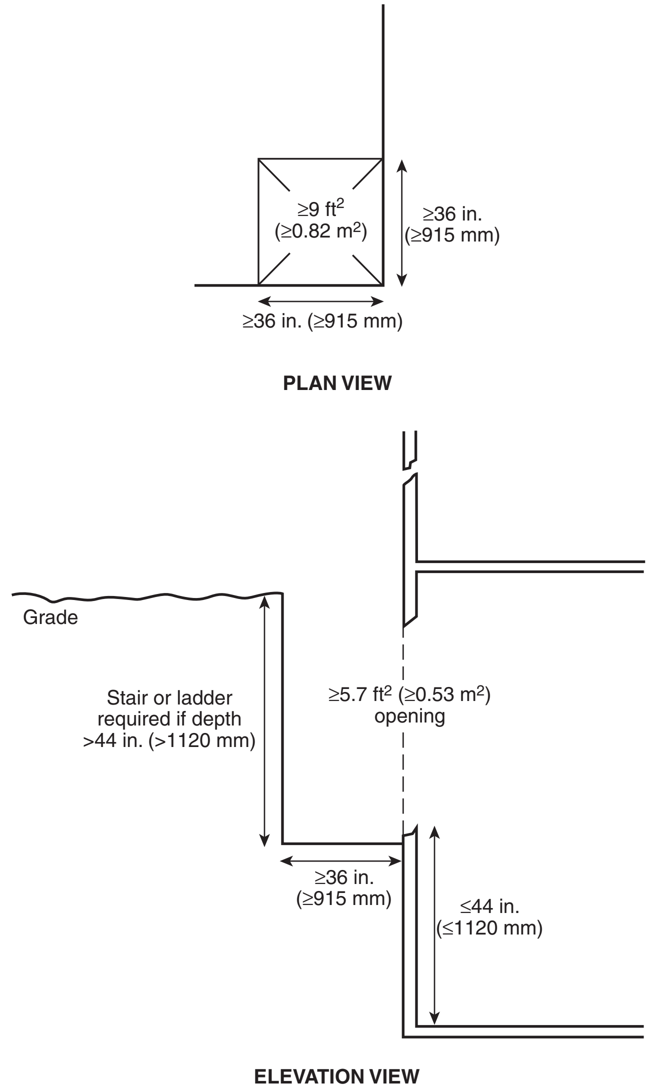


FIGURE A.24.2.2.3.3 Escape Window Utilizing a Window Well.

A.24.3.4.2.2 The placement requirements of NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*, are modified specifically for one- and two-family dwellings as required by this *Code* and do not affect other regulations within a jurisdiction.

A.24.3.5 Automatic sprinklers are recognized as an excellent addition to homes to enhance life safety and property protection. Automatic sprinklers can be part of a comprehensive package of fire protection and can assist in the overall master planning of a community. Where all of the buildings within an area are sprinklered, including the single-family dwellings, the response times and personnel of local fire departments can be established at different levels than if the buildings were not sprinklered, saving considerable amounts of tax dollars. When whole developments are sprinklered, water mains, hydrant spacing, road widths, and building density can be altered to help alleviate the economic impact of the sprinklers.

A.26.1.1.1 Bed and breakfast occupancies with more than 3, but fewer than 17, occupants are considered lodging and rooming houses.

A.26.2.3.5.1 It is the intent of this requirement that security measures, where installed, do not prevent egress.

A.26.3.1.2 Such protection can be accomplished by separation by physical distance, arrangement of the stairs, protection of the openings exposing the stairs, or a combination thereof.

A.26.3.4.3.1 The proprietor is the owner or owner's agent with responsible charge.

A.26.3.4.6.2 The placement requirements of NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*, are modified to accommodate lodging or rooming house occupancies that are part of multiple occupancy buildings (e.g., an on-call physicians' sleeping room in a hospital). The placement requirements of NFPA 720 are modified specifically for lodging or rooming houses as required by this *Code* and do not affect other regulations within a jurisdiction.

A.26.3.6.2.3 The decision to permit the use of the criteria from NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, in these occupancies is based on the following:

(1) The desire to obtain a level of fire suppression and control that is approximately equivalent to that delivered by residential facilities protected by such systems *(see A.1.1 in NFPA 13D)*
(2) The fact that potential fire exposure and challenge to the suppression system in a small lodging and rooming occupancy is of the same nature and no more severe than that found in residences

A.28.2.2.12.2 The provision of 28.2.2.12.2 permits the entire floor to serve as an area of refuge where it is protected in accordance with 28.3.5. The provision is acceptable because supervised automatic sprinkler systems have built-in signals for monitoring features of the system, such as the opening and closing of water control valves. Such systems also monitor pump power supplies, water tank levels, and conditions that will impair the satisfactory operation of the sprinkler system. Because of these monitoring features, supervised automatic sprinkler systems have a high level of satisfactory performance and response to fire conditions.

A.28.2.3.3 The exemption contained in 28.2.3.3 applies to corridors within an individual room or suite and does not apply where a suite can be subdivided and rented separately.

A.28.2.7.2 Where open stairways are permitted, they are considered as exit access to exits rather than as exits, and the requirements for travel distance to exits include the travel on such stairs. *(See 7.6.3.)*

A.28.3.4.3.1 Visible signaling appliances might be governed by provisions of federal regulations in 28 CFR 36, Appendix A, "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities," Section 4.28, Alarms.

A.28.3.4.3.3 A quantity of such rooms and suites might be required to be equipped to accommodate hearing-impaired individuals based on the total number of rooms in a transient lodging facility. *(See 28 CFR 36, Appendix A, "Americans with Disabilities Act Accessibility Guidelines for Buildings and Facilities.")*

A.28.3.4.5 Caution needs to be exercised in locating smoke alarms with regard to their proximity to bathrooms, cooking facilities, and HVAC outlets in order to prevent nuisance alarms.

A.28.4.1.2 See 4.8.2.1(4).

A.28.5.3.2 "Protected power supply" means a source of electrical energy of sufficient capacity to allow proper operation of the elevator and its associated control and communications systems. The power supply's point of origin, system of distribution, type and size of overcurrent protection, degree of isolation from other portions of the building electrical system, and degree of mechanical protection should be such that it is unlikely that the supply would be disrupted at any but the advanced stages of building fire involvement or by structural collapse.

A protected power supply might consist of, and should provide, not less than the level of reliability associated with an electrical distribution system with service equipment located and installed in accordance with 230.72(B) and 230.82(5) of *NFPA 70, National Electrical Code*. The distribution system is not to have any other connection to the building electrical distribution system. A protected power supply is not required to incorporate two sources of energy or automatic transfer capability from a normal to an emergency source; for example, an alternate set of service conductors.

The number and type of elevators to be connected to a protected power supply should be limited, or the characteristics of the protected power supply should be selected to ensure conformance to 230.95 of *NFPA 70*, without the provision of ground fault protection for the supply.

An elevator installation supplied by a protected power supply should comply with Article 620 of *NFPA 70* and ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*. The energy absorption means should always be connected on the load side of the disconnecting means. The energy absorption means should not consist of loads likely to become inoperative or disconnected under the conditions assumed to exist when the elevator is under the control of fire department personnel. Examples of such loads include light and power loads external to the elevator equipment room.

A.28.7.1.1 Employers are obligated to determine the degree to which employees are to participate in emergency activities. Regulations of the U.S. Department of Labor (OSHA) govern these activities and provide options for employers, from total evacuation to aggressive structural fire fighting by employee brigades. *(For additional information, see 29 CFR 1910, Subparts E and L, "OSHA Regulations for Emergency Procedures and Fire Brigades.")*

A.28.7.1.2 Emergencies should be assumed to have arisen at various locations in the occupancy in order to train employees in logical procedures.

A.28.7.4.1 Floor diagrams should reflect the actual floor arrangement and should be oriented with the actual direction to the exits.

A.28.7.4.2 Factors for developing the fire safety information include such items as construction type, suppression systems, alarm and detection systems, building layout, and building HVAC systems.

A.29.2.2.8 Due to the nature of escalators, they are no longer acceptable as a component in a means of egress. However, because many escalators have been used for exit access and exit discharge in the past, they are permitted to continue to be considered in compliance. Very few escalators have ever been installed in a manner to qualify as an exit. For information on escalator protection and requirements, see previous editions of the *Code*.

A.29.2.2.12.2 The provision of 29.2.2.12.2 permits the entire floor to serve as an area of refuge where it is protected in accordance with 29.3.5. The provision is acceptable because supervised automatic sprinkler systems have built-in signals for monitoring features of the system, such as the opening and closing of water control valves. Such systems also monitor pump power supplies, water tank levels, and conditions that will impair the satisfactory operation of the sprinkler system. Because of these monitoring features, supervised automatic sprinkler systems have a high level of satisfactory performance and response to fire conditions.

A.29.2.7.2 Where open stairways or escalators are permitted, they are considered as exit access to exits rather than as exits, and the requirements for travel distance to exits include the travel on such stairs and escalators. *(See 7.6.3.)*

A.29.3.4.3.6 The provision for immediate notification of the public fire department is intended to include, but is not limited to, all of the arrangements in 9.6.4.2. Other arrangements that depend on a clerk or other member of the staff to notify the fire department might also be permitted. In such cases, however, it is essential that a trained staff member and an immediately available means of calling the fire department are continuously available. If a telephone is to be used, it should not be of any type or arrangement that requires a coin or the unlocking of a device to contact the fire department.

A.29.3.4.5 Caution needs to be exercised in locating smoke alarms with regard to their proximity to bathrooms, cooking facilities, and HVAC outlets in order to prevent nuisance alarms.

A.29.3.5.3 Although not required by the *Code*, the use of residential sprinklers or quick-response sprinklers is encouraged for new installations of sprinkler systems within dwelling units, apartments, and guest rooms. Caution should be exercised, as the system needs to be designed for the sprinkler being used.

A.29.4.1.2 See 4.8.2.1(4).

A.29.7.1.1 Employers are obligated to determine the degree to which employees are to participate in emergency activities. Regulations of the U.S. Department of Labor (OSHA) govern these activities and provide options for employers, from total evacuation to aggressive structural fire fighting by employee brigades. *(For additional information, see 29 CFR 1910, Subparts E and L, "OSHA Regulations for Emergency Procedures and Fire Brigades.")*

A.29.7.1.2 Emergencies should be assumed to have arisen at various locations in the occupancy in order to train employees in logical procedures.

A.29.7.4.1 Floor diagrams should reflect the actual floor arrangement and should be oriented with the actual direction to the exits.

A.29.7.4.2 Factors for developing the fire safety information include such items as construction type, suppression systems, alarm and detection systems, building layout, and building HVAC systems.

A.30.2.2.2.2.1 It is the intent of this requirement that security measures, where installed, should not prevent egress.

A.30.2.2.12.2 The provision of 30.2.2.12.2 permits the entire floor to serve as an area of refuge where it is protected in accordance with 31.3.5. The provision is acceptable because supervised automatic sprinkler systems have built-in signals for monitoring features of the system, such as the opening and closing of water control valves. Such systems also monitor pump power supplies, water tank levels, and conditions that will impair the satisfactory operation of the sprinkler system. Because of these monitoring features, supervised automatic sprinkler systems have a high level of satisfactory performance and response to fire conditions.

A.30.3.4.5 Previous editions of the *Code* permitted the single-station smoke alarm required by 30.3.4.5 to be omitted from each apartment where a complete automatic smoke detection system was installed throughout the building. With such a system, when one detector is activated, an alarm is sounded throughout the building. Experience with complete smoke detection systems in apartment buildings has shown that numerous nuisance alarms are likely to occur. Where there is a problem with frequent nuisance alarms, occupants ignore the alarm, or the system is either disconnected or otherwise rendered inoperative.

A.30.3.5.3 The 12 ft^2 (1.1 m^2) closet sprinkler exemption differs from requirements in NFPA 13, *Standard for the Installation of Sprinkler Systems*, because fire loss data supports the long-standing position of the *Code*, since the 1976 edition, to omit sprinklers from such closets. The provision is further supported by the lack of losses in buildings protected in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, which permit the omission of sprinklers from closets not exceeding 24 ft^2 (2.2 m^2).

A.30.3.5.4 The provision of 30.3.5.4 differs from NFPA 13, *Standard for the Installation of Sprinkler Systems*, because fire data shows that in apartment fires where sprinklers were present, bathrooms were the area of origin in 1 percent of the total fires, and resulted in no civilian deaths, civilian injuries, or property loss.

A.30.4.1.2 See 4.8.2.1(4).

A.31.1 See Table A.31.1.

A.31.2.2.8 Due to the nature of escalators, they are no longer acceptable as a component in a means of egress. However, because many escalators have been used for exit access and exit discharge in the past, they are permitted to continue to be considered in compliance. Very few escalators have ever been installed in a manner to qualify as an exit. For information on escalator protection and requirements, see previous editions of the *Code*.

A.31.2.2.12.2 The provision of 31.2.2.12.2 permits the entire floor to serve as an area of refuge where it is protected in accordance with 31.3.5. The provision is acceptable because supervised automatic sprinkler systems have built-in signals for monitoring features of the system, such as the opening and closing of water control valves. Such systems also monitor pump power supplies, water tank levels, and conditions that will impair the satisfactory operation of the sprinkler system. Because of these monitoring features, supervised automatic sprinkler systems have a high level of satisfactory performance and response to fire conditions.

A.31.2.4.6 This single-exit exemption could be applied to an apartment building three stories in height with a basement.

Table A.31.1 Alternate Requirements for Existing Apartment Buildings According to Protection Provided

Feature	No Suppression or Detection System Option 1	Complete Automatic Fire Detection Option 2	Automatic Sprinkler Protection in Selected Areas Option 3	Automatic Sprinkler Protection Throughout per NFPA 13 (with exceptions) Option 4
Exit Access				
Travel distance from apartment door to exit	100 ft (30 m)	150 ft (46 m)	150 ft (46 m)	200 ft (61 m)
Travel distance within apartment	75 ft (23 m)	125 ft (38 m)	75 ft (23 m)	125 ft (38 m)
Smoke barrier required *(See 31.3.7.)*	R	R	R	NR
Maximum single path corridor distance	35 ft (10.7 m)	35 ft (10.7 m)	35 ft (10.7 m)	35 ft (10.7 m)
Maximum dead end	50 ft (15 m)	50 ft (15 m)	50 ft (15 m)	50 ft (15 m)
Corridor fire resistance				
Walls	½ hr	½ hr	½ hr	½ hr
Doors (fire protection rating)	20 min. or 1¾ in. (44 mm) thick	20 min. or 1¾ in. (44 mm) thick	Smoke resisting	Smoke resisting
Interior Finish				
Lobbies and corridors	A or B	A or B	A or B	A, B, or C
Other spaces	A, B, or C	A, B, or C	A, B, or C	A, B, or C
Floors in corridors	I or II	I or II	NR	NR
Exits				
Wall fire resistance				
1–3 stories†	1 hr	1 hr	1 hr	1 hr
>3 stories†	2 hr	2 hr	2 hr	1 hr
Smokeproof enclosures				
Not high-rise	NR	NR	NR	NR
High-rise	R	R	R	NR
Door fire resistance				
1–3 stories†	1 hr	1 hr	1 hr	1 hr
>3 stories†	1½ hr	1½ hr	1½ hr	1 hr
Interior finish				
Walls and ceilings	A or B	A or B	A or B	A, B, or C
Floors	I or II	I or II	I or II	NR
Within Living Unit (Apartment)				
Escape windows, per Section 24.2 *(See 31.2.1.)*	R	R	R	NR
Alarm System				
>3 stories or >11 units†	Manual initiation	Manual and auto initiation	Manual and auto initiation	Manual and auto initiation
>2 stories or >50 units†	Annunciator panel	Annunciator panel	Annunciator panel	Annunciator panel

R: Required *(see Code for details and exemptions)*. NR: No requirements.
† Number of stories in height.

A.31.2.11.1 The provision of 31.2.11 recognizes the need to provide smoke control in existing buildings. Smokeproof enclosures can be accomplished without the use of a vestibule in accordance with 7.2.3.

A.31.3.4.4.1 It is intended that a building compliant with Option 2 function as described in the paragraph that follows.

Occupants within a living unit become aware of a fire emergency, either through personal awareness or through being alerted by the smoke alarm(s) installed within the living unit. Other building occupants are alerted to the fire emergency by the building fire alarm system that is initiated by manual fire alarm boxes adjacent to the exits, heat detection within the living unit where the fire emergency exists, smoke detection in the common areas outside the living unit, or a combination thereof. The installation of system heat detectors versus smoke detectors within the living unit is intended to eliminate nuisance-type alarms and reduce occupant complacency from frequent false alarms. The installation of smoke detection within the living unit should only be contemplated after a careful analysis of the goals and with the approval of the authority having jurisdiction.

A.31.3.4.5.1 NFPA *101* provides adequate, balanced fire protection and takes into consideration the passive and active systems required in a given occupancy. The level of protection prescribed by *NFPA 72, National Fire Alarm and Signaling Code*, which includes smoke alarms in all sleeping rooms, without exception, does not necessarily take into consideration the complete protection package mandated by NFPA *101.*

A.31.3.5.2 Although not required by the *Code*, the use of residential sprinklers or quick-response sprinklers is encouraged for new installations of sprinkler systems within dwelling units, apartments, and guest rooms. Caution should be exercised, because the system needs to be designed for the sprinkler being used.

A.31.3.5.4 The provision of 31.3.5.4 differs from NFPA 13, *Standard for the Installation of Sprinkler Systems*, because fire data shows that in apartment fires where sprinklers were present, bathrooms were the area of origin in 1 percent of the total fires, and resulted in no civilian deaths, civilian injuries, or property loss.

A.31.3.5.11 For example, if an Option 3 sprinkler system were being used to justify use of Class C wall finish in an exit enclosure, the sprinkler system would need to be extended into the exit enclosure, even if the rest of the requirements for Option 3 did not require the sprinklers in the exit enclosure.

A.31.3.5.12.3 This system might consist of a combination of any or all of the following systems:

(1) Partial automatic sprinkler protection
(2) Smoke detection alarms
(3) Smoke control
(4) Compartmentation or other approved systems, or both

A.31.3.6.1 The intent is to recognize that existing partitions of sound wood lath and plaster, wire lath and plaster, or gypsum lath and plaster construction have demonstrated the ability to contain most room fires. Recent data on archaic construction methods have established the fire resistance rating of such construction at about 20 minutes. Such construction meets the intent of 31.3.6.1.

A.31.4.1.2 See 4.8.2.1(4).

A.32.1.6 The provisions of 8.3.1(4) address a ½-hour fire resistance rating. The information in A.8.3.1.1(4) addresses common materials used in barriers having a minimum ½-hour fire resistance rating.

A.32.2.2.3.1(3) A window with dimensions of 20 in. × 24 in. (510 mm × 610 mm) has an opening of 3.3 ft^2 (0.31 m^2), which is less than the required 5.7 ft^2 (0.53 m^2). Therefore, either the height or width needs to exceed the minimum requirement to provide the required clear area.

A.32.2.2.6.3 Exterior stair protection can be accomplished through separation by physical distance, arrangement of the stairs, protection of the openings exposing the stairs, or other means acceptable to the authority having jurisdiction.

A.32.2.3.2.1 Spaces containing approved, properly installed and maintained furnaces and heating equipment, furnace rooms, and cooking and laundry facilities should not be classified as hazardous areas solely on the basis of such equipment.

A.32.2.3.5 All sprinkler systems installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, are required to be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. However, systems installed in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, are historically exempt from applying NFPA 25. While there is a great deal of information in NFPA 25 that is not appropriate for NFPA 13D sprinkler systems, there are some basic concepts of inspection, testing, and maintenance that are critical to system performance and must be performed when an NFPA 13D sprinkler system is installed in a board and care occupancy. The frequencies mandated by this *Code* are slightly different from those required by NFPA 25. It is the intent of this *Code* to utilize the frequencies stated in Chapter 32, but to reference the purpose and the procedures for the inspections, tests, and maintenance from NFPA 25.

A.32.2.3.5.1 Where any provision requires the use of an automatic sprinkler system in accordance with 32.2.3.5, the provision of 32.2.3.5.2 is not permitted to be used.

A.32.2.3.5.2 Where a facility utilizing the provision of 32.2.3.5.2 is occupied by residents who can no longer comply with the 3-minute evacuation response, 33.1.8 requires the facility to comply with the requirements for new construction, including automatic sprinkler protection. *(See also A.33.1.8.)*

A.32.2.3.5.3.2 The decision to permit the use of the criteria from NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, in these occupancies is based on the following:

(1) The desire to obtain a level of fire suppression and control approximately equivalent to that delivered by residential facilities protected by such systems *(see A.1.1 in NFPA 13D)*
(2) The fact that potential fire exposure and challenge to the suppression system in a small board and care facility are of the same nature and are no more severe than those found in residences

Chapter 32 permits the use of NFPA 13D, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, outside of their scopes. This permission is based on a review of the occupancy and a recognition that the fires in board and care facilities are similar to those of other residential occupancies and that the level of protection is appropriate. The requirements of NFPA 13D and NFPA 13R have been supplemented with requirements for additional water supplies to compensate for the special needs of the board and care occupancy.

NFPA 13D contains additional requirements for a piping system serving both sprinkler and domestic needs.

A.32.3.3.3 The provisions in 10.2.8 to permit modifications to interior finish requirements where automatic sprinklers are provided are permitted.

A.32.3.3.4.6 Positive alarm sequence applies only to emergency forces notification. Occupant notification is required to occur immediately upon activation of the detection device or system.

A.32.3.3.6 It is not the intent to prohibit furniture in corridors and spaces open to corridors, provided that the minimum required width is maintained. Storage is not permitted in corridors or spaces open to corridors. It is also not the intent to require corridors to be defined by a change in flooring texture, material, or color to separate them from areas allowed to be open to corridors.

Cooking facilities complying with 32.3.3.8 are permitted to be open to corridors. Sleeping rooms are required to be separated from means of egress in accordance with 32.3.3.6.

A.32.3.3.7.10 Where the smoke control system design requires dampers in order that the system functions effectively, it is not the intent of 32.3.3.7.10 to permit the damper to be omitted.

The term *fully ducted* means the supply and return-air systems are provided with continuous ducts from all air registers to the air-handling unit.

A.32.3.3.7.13 Smoke barrier doors are intended to provide access to adjacent zones. The pair of cross-corridor doors are required to be opposite swinging. Access to both zones is required.

A.32.3.3.7.17 Smoke barriers might include walls having door openings other than cross-corridor doors. There is no restriction in the *Code* regarding which doors or how many doors form part of a smoke barrier. For example, doors from the corridor to individual rooms are permitted to form part of a smoke barrier.

A.32.3.3.7.18 It is not the intent to require the frame to be a listed assembly.

A.32.3.3.8.2 This provision is intended to permit small appliances used for reheating, such as microwave ovens, hot plates, toasters, and nourishment centers to be exempt from the requirements for commercial cooking equipment and hazardous area protection.

A.32.3.3.8.3 The intent of 32.3.3.8.3 is to limit the number of persons for whom meals are routinely prepared to not more than 30. Staff and feeding assistants are not included in this number.

A.32.3.3.8.3(4) The minimum airflow of 500 cfm (14,000 L/m) is intended to require the use of residential hood equipment at the higher end of equipment capacities. It is also intended to draw a sufficient amount of the cooking vapors into the grease baffle and filter system to reduce migration beyond the hood.

A.32.3.3.8.3(7) The intent of this provision is to limit cooking fuel to gas or electricity. The prohibition of solid fuels for cooking is not intended to prohibit charcoal grilling on grills located outside the facility.

A.32.3.3.8.3(8) Deep-fat frying is defined as a cooking method that involves fully immersing food in hot oil.

A.32.3.3.8.3(10) The intent of this requirement is that the fuel source for the cooktop or range is to be turned on only when staff is present or aware that the kitchen is being used. The timer function is meant to provide an additional safeguard if the staff forgets to deactivate the cooktop or range. If a cooking activity lasts longer than 120 minutes, the timer would be required to be manually reset.

A.32.3.3.8.3(12) The intent of requiring smoke alarms instead of smoke detectors is to prevent false alarms from initiating the building fire alarm system and notifying the fire department. Smoke alarms should be maintained a minimum of 20 ft (6.1 m) away from the cooktop or range as studies have shown this distance to be the threshold for significantly reducing false alarms caused by cooking. The intent of the interconnected smoke alarms, with silence feature, is that while the devices would alert staff members to a potential problem, if it is a false alarm, the staff members can use the silence feature instead of disabling the alarm. The referenced study indicates that nuisance alarms are reduced with photoelectric smoke alarms. Providing two interconnected alarms provides a safety factor since they are not electrically supervised by the the fire alarm system. *(Smoke Alarms – Pilot Study of Nuisance Alarms Associated with Cooking)*

A.32.3.3.8.4 The provisions of 32.3.3.8.4 differ from those of 32.3.3.8.3, as they apply to cooking equipment that is separated from the corridor.

A.32.3.3.8.5 The provision of 32.3.3.8.5 clarifies that protected commercial cooking equipment does not require an enclosure (separation) as a hazardous area in accordance with Section 8.7, as is required by 32.3.3.2.

A.32.3.6.3.2 "Protected power supply" means a source of electrical energy of sufficient capacity to allow proper operation of the elevator and its associated control and communications systems. The power supply's point of origin, system of distribution, type and size of overcurrent protection, degree of isolation from other portions of the building electrical system, and degree of mechanical protection should be such that it is unlikely that the supply would be disrupted at any but the advanced stages of building fire involvement or by structural collapse.

A protected power supply might consist of, and should provide, not less than the level of reliability associated with an electrical distribution system with service equipment located and installed in accordance with 230.72(B) and 230.82(5) of *NFPA 70, National Electrical Code*. The distribution system is not to have any other connection to the building electrical distribution system. A protected power supply is not required to incorporate two sources of energy or automatic transfer capability from a normal to an emergency source; for example, an alternate set of service conductors.

The number and type of elevators to be connected to a protected power supply should be limited, or the characteristics of the protected power supply should be selected to ensure conformance with 230.95 of *NFPA 70*, without the provision of ground fault protection for the supply.

An elevator installation supplied by a protected power supply should comply with Article 620 of *NFPA 70*, except that the energy absorption means required by 620.91 of *NFPA 70* should always be connected on the load side of the disconnecting means. The energy absorption means should not consist of loads likely to become inoperative or disconnected under the conditions assumed to exist when the elevator is under the control of fire department personnel. Examples of such loads include light and power loads external to the elevator equipment room.

A.32.4 Board and care occupancies in apartment buildings will usually be small facilities housing 16 or fewer residents. It is intended that the board and care occupancy conform to the requirements of Section 32.2 for small board and care facilities. In the unusual case where an apartment houses a large board and care facility, it would be reasonable for the authority having jurisdiction, using the requirement of 4.6.1, to apply the provisions of Section 32.3 to the apartment. In addition, the apartment building in which the facility is housed needs to comply with the requirements for apartment buildings in Chapters 30 and 31 and the additional criteria presented in Section 32.4.

A.32.4.1.3 In determining equivalency for conversions, modernizations, renovations, or unusual design concepts, the authority having jurisdiction might permit evaluations based on the residential board and care occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety.*

A.32.7.3.3 An assembly point can be located outside the building, in a separate building, or in an adjacent smoke compartment in the same building.

A.32.7.4.1 Smoking regulations should include the following:

(1) Smoking should be prohibited in any room, compartment, or area where flammable or combustible liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and the following also should apply:
   (a) Such areas should be posted with signs that read NO SMOKING or the international symbol for no smoking.
   (b) In residential board and care facilities where smoking is totally prohibited and signs so indicating are placed at all major entrances, secondary signs with language that prohibits smoking are not required.
(2) Smoking by residents classified as not responsible with regard to their ability to safely use and dispose of smoking materials should be prohibited.
(3) Where a resident, as specified in A.32.7.4.1(2), is under direct supervision by staff or by a person approved by the administration, smoking might be permitted.
(4) Smoking materials should not be provided to residents or maintained by residents without the approval of the administration.
(5) Areas where smoking is permitted should be clearly identified.
(6) Ashtrays of noncombustible material and safe design should be provided and required to be used in all areas where smoking is permitted.
(7) Self-closing cover devices into which ashtrays can be emptied should be made available to all areas where smoking is permitted and should be required to be used.

A.32.7.5 The requirements applicable to draperies/curtains, upholstered furniture, and mattresses apply only to new draperies/curtains, new upholstered furniture, and new mattresses. The term *new* means unused, normally via procurement from the marketplace, either by purchase or donation, of items not previously used. Many board and care facilities allow residents to bring into the board and care home upholstered furniture items from the resident's previous residence. Such items are not new and, thus, are not regulated. On the other hand, some of the larger board and care homes purchase contract furniture, as is done in hotels. Such new, unused furniture, whether purchased or received as a donation, is regulated by the requirements of 32.7.5.2. By federal law, mattresses manufactured and sold within the United States must pass testing per 16 CFR 1632, "Standard for the Flammability of Mattresses and Mattress Pads" (FF4-72).

A.32.7.5.2 New upholstered furniture within board and care homes should be tested for rates of heat release in accordance with 10.3.3.

A.32.7.5.3 New mattresses within board and care homes should be tested for rates of heat release in accordance with 10.3.4.

A.33.1.1 The requirements of Chapter 33 are designed to accommodate typical changes in the capabilities of the resident, such as those due to accidents, temporary illness, cyclical variations in capabilities, and gradual aging. This approach is based on the assumption that the capabilities of the resident will be evaluated not less than annually, and for residents with geriatric problems or degenerative diseases, not less than every 6 months. Also, residents should be re-evaluated after each accident or illness that requires hospitalization.

The requirements of Chapter 33 were developed on the assumption that the occupants will normally evacuate the building in fire emergencies. During fire exit drills, all occupants should evacuate the building with staff assistance, as needed. Exceptions can be made in facilities with an evacuation capability rating of impractical. Managers of board and care homes with nursing home backgrounds sometimes are not aware of the differences between the requirements of 19.7.1 and 33.7.3.

A.33.1.1.4 The provision of 33.1.1.4 was added after Chapter 32 was revised in its entirety to avoid potential conflicts between the two chapters. Occupancies meeting Chapter 32 requirements are deemed to comply with Chapter 33.

A.33.1.6 The provisions of 8.3.1(4) address a ½-hour fire resistance rating. The information in A.8.3.1.1(4)(4) addresses common materials used in barriers having a minimum ½-hour fire resistance rating.

A.33.1.8 When the group evacuation capability changes to a level of greater risk, the owner/operator of the facility needs to take such action as is necessary, within a reasonable time frame, to restore the evacuation capability of the facility to that for which it was approved. If subsequent evaluations indicate that the original evacuation capability of the facility cannot or is not being maintained at the original level of risk, the facility would be considered as having changed the occupancy subclassification to one of greater risk, and the safeguards required for the level of greater risk would apply. If a facility improves its original evacuation capability to one of less risk, a re-evaluation and upgrading to the requirements for new construction are not needed.

A.33.2.1.2.1.1 In determining equivalency for existing buildings, conversions, modernizations, renovations, or unusual design concepts, the authority having jurisdiction might permit evaluations based on the residential board and care occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety.*

A.33.2.2.3.1(3) A window with dimensions of 20 in. × 24 in. (510 mm × 610 mm) has an opening of 3.3 ft^2 (0.31 m^2), which is less than the required 5.7 ft^2 (0.53 m^2). Therefore, either the height or width needs to exceed the minimum requirement to provide the required clear area.

A.33.2.2.6.3 Exterior stair protection can be accomplished through separation by physical distance, arrangement of the stairs, protection of the openings exposing the stairs, or other means acceptable to the authority having jurisdiction.

A.33.2.3.4.3 Most often, smoke alarms sounding an alarm at 85 dBA or greater, installed outside the bedroom area, will meet the intent of this requirement. Smoke alarms remotely located from the bedroom might not be loud enough to awaken the average person. In such cases, it is recommended that smoke alarms be interconnected so that the activation of any smoke alarm will cause all smoke alarms to activate.

NFPA *101* provides adequate, balanced fire protection and takes into consideration the passive and active systems required in a given occupancy. The level of protection prescribed by *NFPA 72, National Fire Alarm and Signaling Code*, which includes smoke alarms in all sleeping rooms, without exception, does not necessarily take into consideration the complete protection package prescribed by NFPA *101*.

A.33.2.3.5 All sprinkler systems installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, are required to be inspected, tested, and maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*. However, systems installed in accordance with NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, are historically exempt from applying NFPA 25. While there is a great deal of information in NFPA 25 that is not appropriate for NFPA 13D sprinkler systems, there are some basic concepts of inspection, testing, and maintenance that are critical to system performance and must be performed when an NFPA 13D sprinkler system is installed in a board and care occupancy. The frequencies mandated by this *Code* are slightly different from those required by NFPA 25. It is the intent of this *Code* to utilize the frequencies stated in Chapter 32, but to reference the purpose and the procedures for the inspections, tests, and maintenance from NFPA 25.

A.33.2.3.5.3.1 The decision to permit the use of the criteria from NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, in these occupancies is based on the following:

(1) The desire to obtain a level of fire suppression and control approximately equivalent to that delivered by residential facilities protected by such systems *(see A.1.1 in NFPA 13D)*
(2) The fact that potential fire exposure and challenge to the suppression system in a small board and care facility are of the same nature and are no more severe than those found in residences

Chapter 33 permits the use of NFPA 13D and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, outside of their scopes. This permission is based on a review of the occupancy and a recognition that the fires in board and care facilities are similar to those of other residential occupancies and that the level of protection is appropriate. In some circumstances, such as those for impractical evacuation capabilities, the requirements of NFPA 13D and NFPA 13R have been supplemented with requirements for additional water supplies to compensate for the special needs of the board and care occupancy.

A.33.3.1.2.1.1 In determining equivalency for existing buildings, conversions, modernizations, renovations, or unusual design concepts, the authority having jurisdiction might permit evaluations based on the residential board and care occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety*.

A.33.3.3.4.6.1 See A.29.3.4.3.6.

A.33.3.3.5.1 It is intended that this requirement apply to existing small facilities that are converted to large facilities.

Chapter 33 permits the use of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, and NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, outside of their scopes. This permission is based on a review of the occupancy and a recognition that the fires in board and care facilities are similar to those of other residential occupancies and that the level of protection is appropriate. In some circumstances, such as those for impractical evacuation capabilities, the requirements of NFPA 13D and NFPA 13R have been supplemented with requirements for additional water supplies to compensate for the special needs of the board and care occupancy.

A.33.3.3.8.2 This provision is intended to permit small appliances used for reheating, such as microwave ovens, hot plates, toasters, and nourishment centers to be exempt from the requirements for commercial cooking equipment and hazardous area protection.

A.33.3.3.8.3 The intent of 33.3.3.8.3 is to limit the number of persons for whom meals are routinely prepared to not more than 30. Staff and feeding assistants are not included in this number.

A.33.3.3.8.3(4) The minimum airflow of 500 cfm (14,000 L/m) is intended to require the use of residential hood equipment at the higher end of equipment capacities. It is also intended to draw a sufficient amount of the cooking vapors into the grease baffle and filter system to reduce migration beyond the hood.

A.33.3.3.8.3(7) The intent of this provision is to limit cooking fuel to gas or electricity. The prohibition of solid fuels for cooking is not intended to prohibit charcoal grilling on grills located outside the facility.

A.33.3.3.8.3(8) Deep-fat frying is defined as a cooking method that involves fully immersing food in hot oil.

A.33.3.3.8.3(10) The intent of this requirement is that the fuel source for the cooktop or range is to be turned on only when staff is present or aware that the kitchen is being used. The timer function is meant to provide an additional safeguard if the staff forgets to deactivate the cooktop or range. If a cooking activity lasts longer than 120 minutes, the timer would be required to be manually reset.

A.33.3.3.8.3(12) The intent of requiring smoke alarms instead of smoke detectors is to prevent false alarms from initiating the building fire alarm system and notifying the fire department. Smoke alarms should be maintained a minimum of 20 ft (6.1 m) away from the cooktop or range as studies have shown this distance to be the threshold for significantly reducing false alarms caused by cooking. The intent of the interconnected smoke alarms, with silence feature, is that while the devices would alert staff members to a potential problem, if it is a false alarm, the staff members can use the silence feature instead of disabling the alarm. The referenced study indicates that nuisance alarms are reduced with photoelectric smoke alarms. Providing two interconnected alarms provides a safety factor since they are not electrically supervised by the fire alarm system *(Smoke Alarms — Pilot Study of Nuisance Alarms Associated with Cooking)*.

A.33.3.3.8.4 The provisions of 33.3.3.8.4 differ from those of 33.3.3.8.3, as they apply to cooking equipment that is separated from the corridor.

A.33.3.3.8.5 The provision of 33.3.3.8.5 clarifies that protected commercial cooking equipment does not require an enclosure (separation) as a hazardous area in accordance with Section 8.7, as is required by 33.3.3.2.

A.33.4 Board and care occupancies in apartment buildings will usually be small facilities housing 16 or fewer residents. It is intended that the board and care occupancy conform to the requirements of Section 33.2 for small board and care facilities. In the unusual case where an apartment houses a large board and care facility, it would be reasonable for the authority having jurisdiction, using the requirement of 4.6.1, to apply the provisions of Section 33.3 to the apartment. In addition, the apartment building in which the facility is housed needs to comply with the requirements for apartment buildings in Chapters 30 and 31 and the additional criteria presented in Section 33.4.

A.33.4.1.3.1 In determining equivalency for existing buildings, conversions, modernizations, renovations, or unusual design concepts, the authority having jurisdiction might permit evaluations based on the residential board and care occupancies fire safety evaluation system (FSES) of NFPA 101A, *Guide on Alternative Approaches to Life Safety*.

A.33.7.3.3 An assembly point can be located outside the building, in a separate building, or in an adjacent smoke compartment in the same building.

A.33.7.4.1 Smoking regulations should include the following:

(1) Smoking should be prohibited in any room, compartment, or area where flammable or combustible liquids, combustible gases, or oxygen is used or stored and in any other hazardous location, and the following also should apply:
   (a) Such areas should be posted with signs that read NO SMOKING or the international symbol for no smoking.
   (b) In residential board and care facilities where smoking is totally prohibited and signs so indicating are placed at all major entrances, secondary signs with language that prohibits smoking are not required.
(2) Smoking by residents classified as not responsible with regard to their ability to safely use and dispose of smoking materials should be prohibited.
(3) Where a resident, as specified in A.33.7.4.1(2), is under direct supervision by staff or by a person approved by the administration, smoking might be permitted.
(4) Smoking materials should not be provided to residents or maintained by residents without the approval of the administration.
(5) Areas where smoking is permitted should be clearly identified.
(6) Ashtrays of noncombustible material and safe design should be provided and required to be used in all areas where smoking is permitted.
(7) Self-closing cover devices into which ashtrays can be emptied should be made available to all areas where smoking is permitted and should be required to be used.

A.33.7.5 The requirements applicable to draperies/curtains, upholstered furniture, and mattresses apply only to new draperies/curtains, new upholstered furniture, and new mattresses. The term *new* means unused, normally via procurement from the marketplace, either by purchase or donation, of items not previously used. Many board and care facilities allow residents to bring into the board and care home upholstered furniture items from the resident's previous residence. Such items are not new and, thus, are not regulated. On the other hand, some of the larger board and care homes purchase contract furniture, as is done in hotels. Such new, unused furniture, whether purchased or received as a donation, is regulated by the requirements of 33.7.5.2. By federal law, mattresses manufactured and sold within the United States must pass testing per 16 CFR 1632, "Standard for the Flammability of Mattresses and Mattress Pads" (FF 4-72).

A.33.7.5.2 New upholstered furniture within board and care homes should be tested for rates of heat release in accordance with 10.3.3.

A.33.7.5.3 New mattresses within board and care homes should be tested for rates of heat release in accordance with 10.3.4.

A.36.1.3.2.2(4) Means to prevent spilled fuel from accumulating and entering the mercantile occupancy building can be by curbs, scuppers, special drainage systems, sloping the floor away from the door openings, or floor elevation differences of not less than 4 in. (100 mm).

A.36.2.2.2.2 The words "principal entrance/exit doors" describe doors that the authority having jurisdiction can reasonably expect to be unlocked in order for the facility to do business.

A.36.2.2.7.2 Egress from a mall building should be designed as follows:

(1) The mall/pedestrian way has been assigned no occupant load, but it is required to be provided with means of egress sized to accommodate the total occupant load of the mall building based on the gross leasable area.
(2) The exits for the mall/pedestrian way are permitted to be provided by a combination of exterior exit doors and exit passageways.
(3) After completion of A.36.2.2.7.2(1), each tenant space is to be judged individually for occupant load and egress capacity, and the following also apply:
   (a) The step specified in A.36.2.2.7.2(3) normally sends a portion or all (per 36.4.4.4.2) of the tenant space's occupant load into the mall.
   (b) Any remaining occupants are sent through the back of the tenant space into an exit passageway that might serve multiple tenant spaces and the mall.
(4) The width of the exit passageway is required to be sized for the most restrictive of the following:
   (a) Width of not less than 66 in. (1675 mm) per 36.4.4.4.2(3)
   (b) Portion of the egress capacity from the largest single tenant space being served by the exit passageway
   (c) Portion of the egress capacity from the mall being provided by the exit passageway

The concepts used in A.36.2.2.7.2(4)(a) through (c) include the following:

(1) After proper egress capacity is provided for the mall/pedestrian way, each tenant space is then required to independently provide egress capacity for its occupants.
(2) The mall required exit passageway width and the tenant space required exit passageway width are not required to be added together.
(3) The required exit passageway width for a tenant space is not required to be added to that of other tenant spaces using the same exit passageway.

A.36.2.5.10 To eliminate the obstruction to the means of egress of the interior exit access and the exterior exit discharge, it is the intent to provide adequate area for transit and parking of wheeled carts or buggies used by customers. This area includes corral areas adjacent to exits that are constructed to restrict the movement of wheeled carts or buggies therefrom.

A.36.2.7.2 The basis for the exemption to the general rule on complete enclosure of exits up to their point of discharge to the outside of the building is that, with the specified safeguards, reasonable safety is maintained.

A stairway is not considered to discharge through the street floor area if it leads to the street through a fire resistance–rated enclosure (exit passageway) separating it from the main area, even though there are doors between the first-floor stairway landing and the main area.

The provisions of 36.2.7.2 should not be confused with those for open stairways, as permitted by 36.3.1(1).

A.36.3.2.1 It is the intent to permit a suspended natural gas–fired unit heater that complies with the requirements of 9.2.2 to be installed and used in a mercantile occupancy without classifying the area in which it is located as hazardous.

A.36.3.2.1.1 These areas can include, but are not limited to, areas used for general storage, boiler or furnace rooms, and maintenance shops that include woodworking and painting areas.

A.36.3.2.2 The requirement for separating high hazard contents areas from other parts of the building is intended to isolate the hazard, and 8.2.3.3 is applicable.

A.36.3.2.3 It is not the intent to prohibit the use of equipment that is used less frequently and does not produce significant grease-laden vapors such as that equipment used for cooking demonstrations.

A.36.3.6.1 The intent of 36.3.6.1(2) and (3) is to permit spaces within single tenant spaces, or within buildings protected throughout by an approved, supervised automatic sprinkler system, to be open to the exit access corridor without separation.

A.36.4.4.2(5) A mall building might enclose one or more uses, such as retail and wholesale stores, drinking and dining establishments, entertainment and amusement facilities, transportation facilities, offices, and other similar uses.

A.36.4.4.4.2(3) The minimum requirement for terminating mall exit access in not less than 66 in. (1675 mm) of egress width relates to the minimum requirement for not less than one aisle in Class A mercantile occupancies with 30,000 ft^2 (2800 m^2) or greater sales area to be 60 in. (1525 mm) in width.

A.36.4.4.4.2(5) Walls providing tenant separations are only required to extend to the underside of the ceiling assembly, regardless of the ceiling's fire-resistive rating. If a ceiling is not provided in either of the tenant spaces, then the wall should extend to the underside of the roof or floor above.

A.36.4.4.4.2(6) Fire experience in mall shopping centers indicates that the most likely place of fire origin is in the tenant space, where the combustible fire load is far greater than in the mall. Furthermore, any fires resulting from the comparatively low fire load in the mall are more likely to be detected and extinguished in their incipient stages. Early detection is likely due to the nature of the mall as a high-traffic pedestrian way. Such fires produce less smoke development in a greater volume of space than fires in the more confined adjacent tenant space. Smoke control systems that address fire experience in malls are necessary to ensure the integrity of the mall as a pedestrian way by maintaining it reasonably free of the products of combustion for a duration not less than that required to evacuate the area of the building that is affected by the fire. Secondary considerations should include the following:

(1) Confinement of the products of combustion to the area of origin
(2) Removal of the products of combustion, with a minimum of migration of such products of combustion from one tenant space to another
(3) Achievement of evacuation without the need for smoke control in one- and two-level mall buildings protected by automatic sprinklers

Systems, or combinations of systems, that can be engineered to address fires in malls of three or more levels include the following:

(1) Separate mechanical exhaust or control systems
(2) Mechanical exhaust or control systems in conjunction with heating, ventilating, and air-conditioning systems
(3) Automatically or manually released gravity roof vent devices, such as skylights, relief dampers, or smoke vents
(4) Combinations of items (1), (2), and (3) in this list, or any other engineered system designed to accomplish the purpose of this section

A.36.4.4.6.5 It is not the intent of 36.4.4.6.5 to require that large tenant spaces be considered anchor stores. A tenant space not considered in determining the occupant load of the mall is required to be arranged so that all of its means of egress will be independent of the mall.

A.36.4.4.7.3.2 It is the intent to permit the omission of visible alarm notification appliances from the mall or pedestrian way in mall buildings. It is anticipated that occupants with hearing impairments will receive cues from other building occupants and respond accordingly. Visible signals should be provided in public restrooms and other adjunct spaces in the mall subject to occupancy solely by persons with hearing impairments.

A.36.4.4.9.2 Rooms opening onto the exit passageway are intended to include building service elevators, elevator machine rooms, electrical rooms, telephone rooms, janitor closets, restrooms, and similar normally unoccupied spaces not requiring hazardous area protection in accordance with Section 8.7.

A.36.4.4.12 Fire experience in mall shopping centers indicates that the most likely place of fire origin is in the tenant space where the combustible fire load is far greater than in the mall.

Furthermore, any fires resulting from the comparatively low fire load in the mall are more likely to be detected and extinguished in their incipient stages. Early detection is likely due to the nature of the mall as a high-traffic pedestrian way. Such fires produce less smoke development in a greater volume of space than fires in the more confined adjacent tenant space.

Smoke control systems that address fire experience in malls are necessary in order to achieve the following:

(1) Ensure the integrity of the mall as a pedestrian way by maintaining it reasonably free of the products of combustion for a duration not less than that required to evacuate the building
(2) Confine the products of combustion to the area of origin
(3) Remove the products of combustion with a minimum of migration of such products of combustion from one tenant to another

Systems, or combinations of systems, that can be engineered to address fires in malls include the following:

(1) Separate mechanical exhaust or control systems
(2) Mechanical exhaust or control systems in conjunction with heating, ventilating, and air-conditioning systems
(3) Automatically or manually released gravity roof vent devices, such as skylights, relief dampers, or smoke vents
(4) Combinations of items (1), (2), and (3) in this list, or any other engineered system designed to accomplish the purpose of this section

A.37.1.3.2.2(4) Means to prevent spilled fuel from accumulating and entering the mercantile occupancy building can be by curbs, scuppers, special drainage systems, sloping the floor away from the door openings, or elevation differences of not less than 4 in. (100 mm).

A.37.2.2.2.2 The words "principal entrance/exit doors" describe doors that the authority having jurisdiction can reasonably expect to be unlocked in order for the facility to do business.

A.37.2.2.7.2 Egress from a mall building should be designed as follows:

(1) The mall/pedestrian way has been assigned no occupant load, but it is required to be provided with means of egress sized to accommodate the total occupant load of the mall building based on the gross leasable area.
(2) The exits for the mall/pedestrian way are permitted to be provided by a combination of exterior exit doors and exit passageways.
(3) After completion of A.37.2.2.7.2(1), each tenant space is to be judged individually for occupant load and egress capacity, and the following also apply:
    (a) The step specified in A.37.2.2.7.2(3) normally sends a portion or all (per 37.4.4.4.2) of the tenant space's occupant load into the mall.
    (b) Any remaining occupants are sent through the back of the tenant space into an exit passageway that might serve multiple tenant spaces and the mall.
(4) The width of the exit passageway is required to be sized for the most restrictive of the following:
    (a) Width of not less than 66 in. (1675 mm) per 37.4.4.4.2(3)
    (b) Portion of the egress capacity from the largest single tenant space being served by the exit passageway
    (c) Portion of the egress capacity from the mall being provided by the exit passageway

The concepts used in A.37.2.2.7.2(4)(a) through (c) include the following:

(1) After proper egress capacity is provided for the mall/pedestrian way, each tenant space is then required to independently provide egress capacity for its occupants.
(2) The mall required exit passageway width and the tenant space required exit passageway width are not required to be added together.
(3) The required exit passageway width for a tenant space is not required to be added to that of other tenant spaces using the same exit passageway.

A.37.2.5.2 The purpose of 37.2.5.2 is to avoid pockets or dead ends of such size that they pose an undue danger of persons becoming trapped in case of fire.

It is recognized that dead ends exceeding the permitted limits exist and, in some cases, are impractical to eliminate. The authority having jurisdiction might permit such dead ends to continue to exist, taking into consideration any or all of the following:

(1) Tenant arrangement
(2) Automatic sprinkler protection
(3) Smoke detection
(4) Exit remoteness

A.37.2.5.3 It is recognized that common paths of travel exceeding the permitted limits exist and, in some cases, are impractical to eliminate. The authority having jurisdiction might permit such paths of travel to continue to exist, taking into consideration any or all of the following:

(1) Tenant arrangement
(2) Automatic sprinkler protection
(3) Smoke detection
(4) Exit remoteness

A.37.2.5.10 To eliminate the obstruction to the means of egress of the interior exit access and the exterior exit discharge, it is the intent to provide adequate area for transit and parking of wheeled carts or buggies used by customers. This area includes corral areas adjacent to exits that are constructed to restrict the movement of wheeled carts or buggies therefrom.

A.37.2.7.2 The basis for the exemption to the general rule on complete enclosure of exits up to their point of discharge to the outside of the building is that, with the specified safeguards, reasonable safety is maintained.

A stairway is not considered to discharge through the street floor area if it leads to the street through a fire resistance–rated enclosure (exit passageway) separating it from the main area, even though there are doors between the first floor stairway landing and the main area.

The provisions of 37.2.7.2 should not be confused with those for open stairways, as permitted by 37.3.1(1) and (2).

A.37.3.2.1 It is the intent to permit a suspended natural gas–fired unit heater that complies with the requirements of 9.2.2 to be installed and used in a mercantile occupancy without classifying the area in which it is located as hazardous.

A.37.3.2.1.1 These areas can include, but are not limited to, areas used for general storage, boiler or furnace rooms, and maintenance shops that include woodworking and painting areas.

A.37.3.2.2 The requirement for separating high hazard contents areas from other parts of the building is intended to isolate the hazard, and 8.2.3.3 is applicable.

A.37.3.2.3 It is not the intent to prohibit the use of equipment that is used less frequently and does not produce significant grease-laden vapors such as that equipment used for cooking demonstrations.

A.37.4.4.2(5) A mall building might enclose one or more uses, such as retail and wholesale stores, drinking and dining establishments, entertainment and amusement facilities, transportation facilities, offices, and other similar uses.

A.37.4.4.4.2(3) The minimum requirement for terminating mall exit access in not less than 66 in. (1675 mm) of egress width relates to the minimum requirement for not less than one aisle in Class A mercantile occupancies with 30,000 ft^2 (2800 m^2) or greater sales area to be 60 in. (1525 mm) in width.

A.37.4.4.4.2(6) Fire experience in mall shopping centers indicates that the most likely place of fire origin is in the tenant space, where the combustible fire load is far greater than in the mall. Furthermore, any fires resulting from the comparatively low fire load in the mall are more likely to be detected and extinguished in their incipient stages. Early detection is likely due to the nature of the mall as a high-traffic pedestrian way. Such fires produce less smoke development in a greater volume of space than fires in the more confined adjacent tenant space. Smoke control systems that address fire experience in malls are necessary to ensure the integrity of the mall as a pedestrian way by maintaining it reasonably free of the products of combustion for a duration not less than that required to evacuate the area of the building that is affected by the fire. Secondary considerations should include the following:

(1) Confinement of the products of combustion to the area of origin
(2) Removal of the products of combustion, with a minimum of migration of such products of combustion from one tenant space to another
(3) Achievement of evacuation without the need for smoke control in one- and two-level mall buildings protected by automatic sprinklers

Systems, or combinations of systems, that can be engineered to address fires in malls of three or more levels include the following:

(1) Separate mechanical exhaust or control systems
(2) Mechanical exhaust or control systems in conjunction with heating, ventilating, and air-conditioning systems
(3) Automatically or manually released gravity roof vent devices, such as skylights, relief dampers, or smoke vents
(4) Combinations of items (1), (2), and (3) in this list, or any other engineered system designed to accomplish the purpose of this section

A.37.4.4.6.5 It is not the intent of 37.4.4.6.5 to require that large tenant spaces be considered anchor stores. A tenant space not considered in determining the occupant load of the mall is required to be arranged so that all of its means of egress will be independent of the mall.

A.37.4.4.9.2 Rooms opening onto the exit passageway are intended to include building service elevators, elevator machine rooms, electrical rooms, telephone rooms, janitor closets, restrooms, and similar normally unoccupied spaces not requiring hazardous area protection in accordance with Section 8.7.

A.38.1.3.2.2(4) Means to prevent spilled fuel from accumulating and entering the business occupancy building can be by curbs, scuppers, special drainage systems, sloping the floor away from the door openings, or elevation differences not less than 4 in. (100 mm).

A.38.2.2.2.2 The words "principal entrance/exit doors" describe doors that the authority having jurisdiction can reasonably expect to be unlocked in order for the facility to do business.

A.38.2.3.2 It is not the intent that this provision apply to noncorridor or nonpassageway areas of exit access, such as the spaces between rows of desks created by office layout or low-height partitions.

A.38.3.2.1 It is not the intent of this provision that rooms inside individual tenant spaces that are used to store routine office supplies for that tenant be required to be either separated or sprinklered.

A.38.3.2.2 The requirement for separating high hazard contents areas from other parts of the building is intended to isolate the hazard, and 8.2.3.3 is applicable.

A.38.3.2.3 It is not the intent to prohibit the use of equipment that is used less frequently and does not produce significant grease-laden vapors such as that equipment used for cooking demonstrations.

A.38.3.6.1 The intent of 38.3.6(1) through (3) is to permit spaces to be open to the exit access corridor without separation.

A.38.3.6.1(1) Where exits are available from an open floor area, such as open plan buildings, corridors are not required to be separated. An example of an open plan building is a building in which the work spaces and accesses to exits are delineated by the use of tables, desks, bookcases, or counters, or by partitions that are less than floor-to-ceiling height.

A.38.3.6.1(2) It is the intent of this provision that a single tenant be limited to an area occupied under a single management and work the same hours. The concept is that people under the same employ working the same hours would likely be familiar with their entire tenant space. It is not the intent to apply this provision simply because tenants are owned by the same organization. For example, in a government-owned office building, the offices of different federal agencies would be considered multiple tenants, because an employee normally works for one agency. The agencies might work various hours. Another example of multiple tenancy would be a classroom building of a university, because some classrooms might be in use at times when other classrooms are not being used.

A.39.1.3.2.2(4) Means to prevent spilled fuel from accumulating and entering the business occupancy building can be by curbs, scuppers, special drainage systems, sloping the floor away from the door openings, or elevation differences not less than 4 in. (100 mm).

A.39.2.2.2.2 The words "principal entrance/exit doors" describe doors that the authority having jurisdiction can reasonably expect to be unlocked in order for the facility to do business.

A.39.2.5.2 It is recognized that dead ends exceeding the permitted limits exist and, in some cases, are impractical to eliminate. The authority having jurisdiction might permit such dead ends to continue to exist, taking into consideration any or all of the following:

(1) Tenant arrangement
(2) Automatic sprinkler protection
(3) Smoke detection
(4) Exit remoteness

A.39.2.5.3 It is recognized that common paths of travel exceeding the permitted limits exist and, in some cases, are impractical to eliminate. The authority having jurisdiction might permit such common paths of travel to continue to exist, taking into consideration any or all of the following:

(1) Tenant arrangement
(2) Automatic sprinkler protection
(3) Smoke detection
(4) Exit remoteness

A.39.3.2.1 It is not the intent of this provision that rooms inside individual tenant spaces that are used to store routine office supplies for that tenant be required to be separated or sprinklered.

A.39.3.2.2 The requirement for separating high hazard contents areas from other parts of the building is intended to isolate the hazard, and 8.2.3.3 is applicable.

A.39.3.2.3 It is not the intent to prohibit the use of equipment that is used less frequently and does not produce significant grease-laden vapors such as that equipment used for cooking demonstrations.

A.39.4.2.2 In some cases, appreciable cost might be involved in bringing an existing occupancy into compliance. Where this is true, it would be appropriate for the authority having jurisdiction to prescribe a schedule determined jointly with the facility, allowing suitable periods of time for the correction of the various deficiencies and giving due weight to the ability of the owner to secure the necessary funds.

A.40.1.2.1.3 Additional information on the definition of high hazard industrial occupancy can be found in A.3.3.190.8.2.

A.40.1.7 In most cases, the requirements for maximum travel distance to exits will be the determining factor, rather than number of occupants, because exits provided to satisfy travel distance requirements will be sufficient to provide egress capacity for all occupants, except in cases of an unusual arrangement of buildings or the high occupant load of a general manufacturing occupancy.

A.40.2.1.2 Horizontal and vertical utility chases in large industrial buildings used for routing of piping, ducts, and wiring must provide a reasonable level of access for occasional maintenance workers but do not warrant compliance with the comprehensive egress requirements of Chapter 7. Minimum access in these cases is governed by electrical and mechanical codes; 40.2.5.2, Industrial Equipment Access; and the Occupational Safety and Health Administration (OSHA) for facilities in the United States. Utility chases governed by 40.2.1.2 might involve tunnels or large open spaces located above or below occupied floors; however, such spaces differ from mechanical equipment rooms, boiler rooms, and furnace rooms, based on the anticipated frequency of use by maintenance workers. Portions of utility chases where the anticipated presence of maintenance workers is routine are not intended to be included by this paragraph.

A.40.2.2.5.2 The customary building code requirement for fire doors on both sides of an opening in a fire wall is permitted to be met by having an automatic-sliding fire door on one side and a self-closing fire door swinging out from the other side of the wall. This arrangement qualifies only as a horizontal exit from the sliding door side. For further information, see A.7.2.4.3.10.

A.40.2.5.2.1 Ancillary facilities located within industrial occupancies might include administrative office, laboratory, control, and employee service facilities that are incidental to the predominant industrial function and are of such size that separate occupancy classification is not warranted.

A.40.2.5.2.2 Occupants of ancillary facilities located within special-purpose industrial occupancies might be required by administrative controls to remain in the facility when a fire occurs in the predominant industrial area, so that they can perform an orderly shutdown of process equipment to control the spread of the fire and minimize damage to important equipment or perform other safety or security functions.

A.40.2.6.2 See NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, for protection recommendations.

A.40.2.9 The authority having jurisdiction should review the facility and designate the stairs, aisles, corridors, ramps, and passageways that should be required to be provided with emergency lighting. In large locker rooms or laboratories using hazardous chemicals, for example, the authority having jurisdiction should determine that emergency lighting is needed in the major aisles leading through those spaces.

A.40.3.2 Emergency lighting should be considered where operations require lighting to perform orderly manual emergency operation or shutdown, maintain critical services, or provide safe start-up after a power failure.

A.40.6 For further information on aircraft hangars, see NFPA 409, *Standard on Aircraft Hangars*.

A.42.1.7 There is no occupant load factor specified for storage occupancies. Rather, the probable maximum number of persons present needs to be considered in determining the occupant load.

A.42.2.1.2 Horizontal and vertical utility chases in large industrial buildings used for routing of piping, ducts, and wiring must provide a reasonable level of access for occasional maintenance workers but do not warrant compliance with the comprehensive egress requirements of Chapter 7. Minimum access in these cases is governed by the electrical and mechanical code; 40.2.5.2, Industrial Equipment Access; and the Occupational Safety and Health Administration (OSHA) for facilities in the United States. Utility chases governed by 42.2.1.2 might involve tunnels or large open spaces located above or below occupied floors; however, such spaces differ from mechanical equipment rooms, boiler rooms, and furnace rooms, based on the anticipated frequency of use by maintenance workers. Portions of utility chases where the anticipated presence of maintenance workers is routine are not intended to be included by this paragraph.

A.42.2.2.5.2 The customary building code requirement for fire doors on both sides of an opening in a fire wall is permitted to be met by having an automatic-sliding fire door on one side and a self-closing fire door swinging out from the other side of the wall. This arrangement qualifies only as a horizontal exit from the sliding door side. For further information, see A.7.2.4.3.10.

A.42.2.6 The travel distance to exits specified recognizes a low population density. Consideration should be given to locating areas that have a relatively high population, such as lunchrooms, meeting rooms, packaging areas, and offices, near the outside wall of the building to keep the travel distance to a minimum.

A.42.6 For further information on aircraft hangars, see NFPA 409, *Standard on Aircraft Hangars*.

A.42.7 For further information, see NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*. The egress requirements for storage elevators are based on the possibility of fire and are not based on the possibility of grain dust explosions.

A.42.8.1.1 For further information on garages, including a definition of the term *open garage*, see NFPA 88A, *Standard for Parking Structures*.

A.43.2.2.1.4 It is not the intent that a corridor, aisle, or circulation space within a suite be considered as a corridor that is shared by more than one occupant space. The suite should be considered as only one occupant space. The following situations should be considered to involve more than one occupant space:

(1) Work affecting a corridor that is common to multiple guest rooms on a floor of a hotel occupancy
(2) Work affecting a corridor that is common to multiple living units on a floor of an apartment building occupancy
(3) Work affecting a corridor that is common to multiple tenants on a floor of a business occupancy

A.43.2.2.2 Equipment or fixtures do not include manufacturing, production, or process equipment, but do include connections from building service to process equipment.

A.43.4.2(2) Some building codes have permitted an increase in egress capacity in buildings protected throughout by an approved automatic sprinkler system. The intent of 43.4.2(2) is that, during a renovation project, egress capacity is permitted to continue to be evaluated using the previously approved method.

A.43.6.2.2 The provisions for marking of means of egress are those addressed in Section 7.10.

A.43.7.2.1(2) It is not the intent of 43.7.2.1(2) to supersede the provision of 32.2.3.5.2 that exempts automatic sprinklers from small board and care facility conversions serving eight or fewer residents when all occupants have the ability as a group to move reliably to a point of safety within 3 minutes.

A.43.7.3 Table 43.7.3 groups all the residential occupancy classifications into the general category of residential. The category of residential includes one- and two-family dwellings, lodging or rooming houses, hotels and dormitories, and apartment buildings. A change from one residential occupancy, as defined in 6.1.8.1 through 6.1.8.1.5, to another residential occupancy is classified as the rehabilitation work category of *change of occupancy* and subject to the requirements of 43.7.2.

Annex B Supplemental Evacuation Equipment

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only. Information in this annex is intended to be adopted by the jurisdiction at the discretion of the adopting jurisdiction. Additionally, information in this annex is intended to be incorporated on a voluntary basis by building owners and developers who might have a desire to include supplemental evacuation equipment in their projects.

Although this annex is written in mandatory language, it is not intended to be enforced or applied unless specifically adopted by the jurisdiction or, if it is being applied on a voluntary basis, by the building owner or developer.

Note: Traditionally, supplemental evacuation equipment has not been regulated or recognized by the *Code*. Until recently, such equipment was considered to include only items such as chain ladders and rope fire escape ladders for use in single-family homes. The criteria specified in Annex B also provides no regulation or recognition for the private installation and use of such equipment by an owner and family, while providing a framework of regulations for the use of controlled descent devices and platform rescue systems in commercial and residential multistory buildings. The broader term *supplemental evacuation equipment* provides for subsets of equipment to be added as further technologies develop.

B.1 General.

B.1.1 Definitions.

B.1.1.1 Controlled Descent Device. A system operating on the exterior of a building or structure that lowers one or two people per descent, each wearing a rescue harness, at a controlled rate from an upper level to the ground or other safe location.

B.1.1.2 Platform Rescue System. An enclosed platform, or set of enclosed platforms, moving vertically along guides or other means on the exterior of a building or structure, intended for the evacuation of multiple occupants from an upper level or levels to the ground or other safe location, that has the capability of transporting emergency responders to upper levels of a building.

B.1.1.3 Supplemental Escape Device or System. Dedicated equipment that supplements the means of egress or means of escape for exiting a building or structure.

Note: Supplemental escape devices and systems are not a substitute for the required means of egress or means of escape. If properly installed, maintained, and used, controlled descent devices and platform rescue systems might provide an added means of escape for the occupants where the required means of egress or means of escape is not usable or accessible, and where the event that has caused failure of the required system has not also impaired the functionality of the device or system itself.

B.1.1.4 Supplemental Evacuation Equipment. Devices or systems that are not a part of the required means of egress or escape, but that might enhance use of the means of egress or escape, or provide an alternate to the means of egress or escape.

B.1.2 Reserved.

B.2 Supplemental Escape Devices or Systems. A supplemental escape device or system, other than that provided or installed for use by the owner and owner's family, and the installation of such device or system, shall comply with Section B.3 or Section B.4, as appropriate, and the following criteria:

Note: The provisions of Section B.2 are not intended to preclude the installation of supplemental escape devices or systems that do not meet these requirements where intended for personal use, such as by an owner and family.

It should be recognized that supplemental escape devices or systems addressed by these requirements are intended to be used only when all other means of egress are unusable and when remaining in place to await the restoration of the means of egress is considered untenable.

Generally, fire departments have the capability of providing external rescue of building occupants within reach of their portable ladders, aerial ladders, and aerial platform devices. Where a fire department responds to a building emergency and has the capability to provide timely assistance with external rescue, that assistance should be used instead of the supplemental escape devices or systems.

(1) Each supplemental escape device or system shall be of an approved type and shall comply with an approved product safety standard.
(2) The installation of escape devices or systems shall be approved. Note: Use of a supplemental escape device or system typically requires that a window or exterior door be opened. The window or door should be closed, except when it is in use for escape. Where the design of the building does not provide exterior doors or operable windows and a window must be broken to use the device or system, consideration should be given to the probable effect of that action, such as showering the emergency

response personnel and equipment below with sharp pieces of glass. In such a situation, to obtain approval, it might be appropriate to require tempered safety glass on windows that must be broken to deploy the supplemental escape device and access the system.

(3) The supplemental escape device or system shall be installed, inspected, tested, maintained, and used in accordance with the manufacturer's instructions.

(4) The location of each supplemental escape system access point shall be identified with a readily visible sign complying with the following:
   (a) The sign shall be in plainly legible letters that read SUPPLEMENTAL ESCAPE DEVICE.
   (b) The minimum height of the lettering shall be ¾ in. (19 mm), with a stroke width of ⅛ in. (3 mm).

(5) Each sign required by B.2(4) shall comply with the following:
   (a) The sign shall include the following in plainly legible letters: "Use only when exits are not accessible and building evacuation is imperative, as directed by authorized building personnel or emergency responders."
   (b) The minimum height of the lettering shall be ½ in. (13 mm).

(6) A sign with instructions for use of the escape device or system shall be provided and shall comply with the following:
   (a) The sign shall be posted at the equipment and the equipment's access location.
   (b) The minimum height of lettering on the instructions shall be ½ in. (13 mm).
   (c) Pictographs demonstrating use of the escape device or system shall be provided. Note: Given the nature of the probable circumstances surrounding its deployment, the proper use of the supplemental escape device or system should be readily apparent to the user or trained operator.

(7) The signs and instructions specified in B.2(4), (5), and (6) shall be illuminated as follows:
   (a) The signs shall be continuously illuminated while the building is occupied.
   (b) The level of illumination provided shall be in accordance with 7.10.6.3, 7.10.7.2, or an approved equivalent.

(8) Where emergency lighting is required by Chapters 11 through 43, it shall be provided as follows:
   (a) The illumination shall be in accordance with 7.9.1.
   (b) The level of illumination required by 7.9.2.1 shall be provided to illuminate the supplemental escape device or system at its access location and the required signage.

(9) The supplemental escape device or system and its installation shall accommodate persons with various disabilities and of all ages. Note: It is not the intent of B.2(9) that access ramps, doorways, controls, signage, and other features of the supplemental escape device or system meet all requirements for accessibility for persons with disabilities. The equipment is supplemental in nature and is not recognized as part of the required means of egress. A number of other occupants should be trained to assist persons with disabilities to access the equipment. In selecting the equipment and approving the installation, consideration should be given to how persons with mobility impairments will access the equipment. Even when exit stairs are usable, elevators might not be able to be used. Use of a supplemental escape device or system to evacuate persons with mobility impairments might be desirable. Such circumstances should be considered and incorporated into the facility's evacuation plan, which should also identify the trained operators authorized to deploy the equipment for such use.

(10) The installation shall be approved such that use of the supplemental escape device or system shall not cause any harm or injury to the user, operator, or others who might be in the vicinity of the equipment when in use.

(11) Where an evacuation plan is required by Chapters 11 through 43, or by other regulation, an approved, written evacuation plan shall be provided as follows:
   (a) The plan shall be in accordance with 4.8.2.
   (b) The plan shall not rely on the use of supplemental escape devices and systems but shall accommodate the use of such a system by specifying the following:
      i. Role of the supplemental escape device or system in the overall plan
      ii. Role and authority of emergency response personnel with respect to the supplemental escape device or system
      iii. Person or persons authorized to direct the deployment of, and to operate, the escape device or system
      iv. Special considerations, if any, that affect the usability of the supplemental escape device or system
      v. Training required for operators and users
   (c) Note: An evacuation plan can be a highly effective tool in determining who should be evacuated under various scenarios and how that evacuation will be accomplished. Even where none is required, an evacuation plan is recommended to identify, among other things, those persons who are authorized to deploy supplemental escape devices and systems. The more sophisticated the equipment and the greater the number of potential evacuees, the greater is the need to have a trained and authorized person decide which equipment to deploy and when it should be deployed, based on the circumstances at the time. Such a person would be the incident commander, typically the emergency response officer in charge, whether from a private brigade or public service. Even where a building or facility is not required to have an approved evacuation plan by the *Code*, the supplemental escape device or system operating procedures should be integrated into the building evacuation and emergency procedures to the extent provided.

(12) User and operator training shall be provided in conjunction with the installation of the supplemental escape device or system, and periodically thereafter.

(13) Where an approved evacuation plan is required, training shall be provided in accordance with the approved plan.

(14) The supplemental escape device or system shall be inspected and tested in accordance with the manufacturer's instructions but not less frequently than annually, and the following also shall apply:

(a) Notification of testing shall be provided to building occupants or the authority having jurisdiction, as appropriate.
(b) Written records of the inspection and testing shall be maintained by the owner for a minimum of 1 year after the next scheduled inspection and testing. Note: It is important that the supplemental escape device or system does not remain idle for many years in order to help ensure that it will be functional if it does need to be used. The manufacturer's instructions for the particular model of equipment involved should be followed.

(15) Supplemental escape devices and systems shall be listed, certified, or approved to operate as intended over the prevalent climatic conditions for the location in which they are installed.

B.3 Platform Rescue Systems. Where platform rescue systems are installed or provided, they shall comply with the following:

(1) The platform rescue system shall comply with ASTM E 2513, *Standard Specification for Multi-Story Building External Evacuation Platform Rescue Systems*, or an approved, equivalent product safety standard.
(2) The platform rescue system shall be deployed with trained operators to assist with evacuation of occupants.
(3) Where a fixed installation of electrical or other type power is required to operate the platform rescue system, a redundant source of power shall be provided.
(4) The installation shall be designed such that the vertical distance to be traversed by the platform rescue system shall not exceed the limit specified in the product's listing, certification, or approved installation.
(5) The platform access from within buildings shall be by ramps or stairs, and the following also shall apply:
   (a) Portable ramps and stairs shall be permitted.
   (b) The maximum slope of a ramp shall be as low as practical, but shall not be required to be less than 1 in 8.
   (c) The maximum riser height of stairs shall be 9 in. (230 mm).
   (d) The minimum tread depth of stairs shall be 9 in. (230 mm).
(6) The platform access opening shall be sized in accordance with the following:
   (a) For installations in new construction, the platform access opening shall be a minimum 32 in. (810 mm) in width and a minimum 48 in. (1220 mm) in height.
   (b) For installations in existing construction, the platform access opening shall be as large as practical but shall not be required to exceed 32 in. (810 mm) in width and 48 in. (1220 mm) in height.
(7) The platform access and egress shall not be by ladders.
(8) Rooftop operating equipment and systems shall be protected from accumulations of climatic ice or snow and fire suppression ice.

B.4 Controlled Descent Devices. Where controlled descent devices are installed or provided, they shall comply with the following:

(1) The controlled descent device shall comply with ASTM E 2484, *Standard Specification for Multi-Story Building External Evacuation Controlled Descent Devices*, or an approved, equivalent product safety standard.
(2) The installation shall be designed such that the vertical distance to be traversed by the controlled descent device shall not exceed the limit specified in the product's listing, certification, or approved installation.
(3) Where a fixed installation of electrical or other type power is required to operate the controlled descent device, a redundant source of power shall be provided.
(4) Rooftop operating equipment and systems shall be protected from accumulations of climatic ice or snow and fire suppression ice.
(5) Controlled descent device building access openings in new building installations shall be a minimum of 32 in. (810 mm) wide and 42 in. (1065 mm) high.
(6) Controlled descent device building access openings in existing buildings shall be a minimum of 20 in. (510 mm) wide and 24 in. (610 mm) high and shall provide a clear opening of not less than 5.7 ft^2 (0.53 m^2).
(7) The approved occupant load and weight limits shall be posted adjacent to the controlled descent device installation or building access opening in minimum ½ in. (13 mm) letters, with a minimum 1⁄16 in. (1.6 mm) stroke.
(8) The occupant load and weight limits shall not be exceeded in use.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this code and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

> Subsection C.1.1 was revised by a tentative interim amendment (TIA). See page 1.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code*, 2015 edition.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, 2013 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies*, 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2013 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2014 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages,* 2015 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA 61, *Standard for the Prevention of Fires and Dust Explosions in Agricultural and Food Processing Facilities*, 2013 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.

NFPA 70®, *National Electrical Code®*, 2014 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2013 edition.

NFPA 88A, *Standard for Parking Structures*, 2015 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2015 edition.

NFPA 92, *Standard for Smoke Control Systems*, 2012 edition.

NFPA 99, *Health Care Facilities Code*, 2015 edition.

NFPA 101A, *Guide on Alternative Approaches to Life Safety*, 2013 edition.

NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*, 2013 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2013 edition.

NFPA 170, *Standard for Fire Safety and Emergency Symbols*, 2012 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, 2012 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*, 2013 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations*, 2013 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies*, 2012 edition.

NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source*, 2011 edition.

NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies*, 2012 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2013 edition.

NFPA 260, *Standard Methods of Tests and Classification System for Cigarette Ignition Resistance of Components of Upholstered Furniture*, 2013 edition.

NFPA 261, *Standard Method of Test for Determining Resistance of Mock-Up Upholstered Furniture Material Assemblies to Ignition by Smoldering Cigarettes*, 2013 edition.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls*, 2011 edition.

NFPA 269, *Standard Test Method for Developing Toxic Potency Data for Use in Fire Hazard Modeling*, 2012 edition.

NFPA 275, *Standard Method of Fire Tests for the Evaluation of Thermal Barriers*, 2013 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth*, 2011 edition.

NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, 2013 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 2011 edition.

NFPA 409, *Standard on Aircraft Hangars*, 2011 edition.

NFPA 501A, *Standard for Fire Safety Criteria for Manufactured Home Installations, Sites, and Communities*, 2013 edition.

NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2013 edition.

NFPA 601, *Standard for Security Services in Fire Loss Prevention*, 2015 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2010 edition.

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NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*, 2015 edition.

NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2010 edition.

NFPA 914, *Code for Fire Protection of Historic Structures*, 2010 edition.

NFPA 1221, *Standard for the Installation, Maintenance, and Use of Emergency Services Communications Systems*, 2013 edition.

NFPA 1600®, *Standard on Disaster/Emergency Management and Business Continuity Programs*, 2013 edition.

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C.1.2.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036. www.ansi.org

ANSI/BHMA A156.10, *American National Standard for Power Operated Pedestrian Doors*, 1999.

ANSI/BHMA A156.19, *American National Standard for Power Assist and Low Energy Power Operated Doors*, 2002.

ICC/ANSI A117.1, *American National Standard for Accessible and Usable Buildings and Facilities*, 2009.

C.1.2.3 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400. www.asce.org

ASCE/SFPE 29, *Standard Calculation Methods for Structural Fire Protection*, 2005.

C.1.2.4 ASHRAE Publications. ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305. www.ashrae.org

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C.1.2.5 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990. www.asme.org

ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, 2006.

ASME A17.3, *Safety Code for Existing Elevators and Escalators*, 2005.

C.1.2.6 ASSE Publications. American Society of Sanitary Engineering, 901 Canterbury Road, Suite A, Westlake, OH 44145-1480.

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C.1.2.7 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959. www.astm.org

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ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

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ASTM E 2484, *Standard Specification for Multi-Story Building External Evacuation Controlled Descent Devices*, 2008.

ASTM E 2513, *Standard Specification for Multi-Story Building External Evacuation Platform Rescue Systems*, 2007.

ASTM E 2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials*, 2011.

ASTM F 1637, *Standard Practice for Safe Walking Surfaces*, 2010.

ASTM F 1870, *Standard Guide for Selection of Fire Test Methods for the Assessment of Upholstered Furnishings in Detention and Correctional Facilities*, 2011.

C.1.2.8 California Technical Bulletins. State of California, Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595.

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C.1.2.9 FM Publications. FM Global, 1301 Atwood Avenue, P.O. Box 7500, Johnston, RI 02919. www.fmglobal.com

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FM Approval Standard 6921, *Containers for Combustible Waste*, 2004.

C.1.2.10 NEMA Publications. National Electrical Manufacturers Association, 1300 North 17th Street, Suite 1847, Rosslyn, VA 22209.

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C.1.2.12 RESNA Publications. Rehabilitation Engineering and Assistive Technology Society of North America, 1700 N Moore St, Suite 1540, Arlingtron, VA 22209.

ANSI/RESNA ED-1, *Emergency Stair Travel Devices Used by Individuals with Disabilities, Volume 1*, 2013.

C.1.2.13 SFPE Publications. Society of Fire Protection Engineers, 7315 Wisconsin Avenue, Suite 1225 W, Bethesda, MD 20814. www.sfpe.org

SFPE Code Official's Guide to Performance-Based Design Review, 2004.

SFPE Engineering Guide — Evaluation of the Computer Fire Model DETACT-QS, 2002.

SFPE Engineering Guide to Human Behavior in Fire, 2003.

SFPE Engineering Guide to Performance-Based Fire Protection, 2007.

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C.1.2.14 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096. www.ul.com

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ANSI/UL 1479, *Standard for Fire Tests of Through-Penetration Firestops*, 2003, Revised 2012.

ANSI/UL 1715, *Standard for Fire Test of Interior Finish Material*, 1997, Revised 2013.

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C.1.2.15 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402. www.access.gpo.gov/

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C.3 References for Extracts in Informational Sections.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

NFPA 88A, *Standard for Parking Structures*, 2015 edition.

NFPA 5000®, *Building Construction and Safety Code®*, 2015 edition.

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NFPA®101A

Guide on

Alternative Approaches to Life Safety

2016 Edition

This edition of NFPA 101A, *Guide on Alternative Approaches to Life Safety*, was prepared by the Technical Committee on Alternative Approaches to Life Safety and released by the Correlating Committee on Safety to Life. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

A Tentative Interim Amendment (TIA) to Worksheet 7.5.4(A) was issued on May 26, 2015. For further information on tentative interim amendments, see Section 5 of the Regulations Governing the Development of NFPA Standards, available at: http://www.nfpa.org/regs.

This edition of NFPA 101A was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 101A

Prior to the development of the 1988 edition of this document, it was published as several appendixes to NFPA *101*®, *Life Safety Code*®. NFPA 101A is revised every three years on a schedule that lags that of NFPA *101* by one year so as to accurately reflect the requirements of NFPA *101*, against which the NFPA 101A Fire Safety Evaluation Systems (FSESs) measure equivalency.

Chapter 4 first appeared as Appendix C in the 1981 edition of the *Life Safety Code* and Chapters 5, 6, and 7 first appeared in the 1985 edition of the *Life Safety Code* as Appendixes E, F, and G. Chapter 8 was proposed as Appendix H for the 1988 edition of the *Life Safety Code* but instead was published as a chapter of the 1998 edition of NFPA 101A. These chapters were originally prepared by the Center for Fire Research of the National Institute of Standards and Technology (then the National Bureau of Standards). The Committees on Safety to Life have reviewed and modified the systems as appropriate for inclusion. Chapter 9 appeared first in the 2004 edition and provides an FSES for educational occupancies.

This document provides alternative approaches to life safety based on the 2012 *Life Safety Code*. It is intended to be used *with* the *Life Safety Code*, not as a substitute. Section 1.4 of the *Life Safety Code* permits alternative compliance with the *Code* under equivalency concepts where such equivalency is approved by the authority having jurisdiction. The methods contained in this guide can be used to help determine equivalency where used as part of the technical documentation submitted to the authority having jurisdiction.

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The 2016 edition includes changes to the mandatory safety values in the various fire safety evaluation systems so that equivalency is measured accurately against the requirements of the 2015 edition of NFPA *101, Life Safety Code.*

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the protection of human life from fire and other circumstances capable of producing similar consequences and for the nonemergency and emergency movement of people.

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Committee Scope: This Committee shall have primary responsibility for documents on alternative methods of protection of human life from fire and other circumstances capable of producing similar consequences and on the nonemergency and emergency movement of people.

NFPA 101A

Guide on

Alternative Approaches to Life Safety

2016 Edition

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A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in advisory sections of this document are given in Chapter 2 and those for extracts in the informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text should be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope. (Reserved)

1.2 Purpose. (Reserved)

1.3 Application.

1.3.1* This guide consists of a number of alternative approaches to life safety. Each chapter is a different system independent of the others and is to be used in conjunction with the 2015 edition of NFPA *101.*

1.3.2 This edition of NFPA 101A contains alternative approaches that are tied to NFPA *101.* Each of these systems is recognized by the *Life Safety Code,* in its Annex A, as a method that can be used to assist the authority having jurisdiction in determining equivalent compliance with various chapters of the *Code.*

1.3.3 The method described in this guide is an index method. Index methods are a type of qualitative risk assessment. Quantitative risk assessments can also be used to evaluate designs that are proposed as alternative approaches to life safety. For information on developing fire risk assessments, see the *SFPE Engineering Guide to Fire Risk Assessment.* Guidance on reviewing fire risk assessments can be found in NFPA 551.

1.3.4 For further information on alternative approaches to fire safety, see "Systems Approach to Fire-Safe Building Design," Section 1, Chapter 9, of the 20th edition of the NFPA *Fire Protection Handbook* and the *SFPE Handbook of Fire Protection Engineering,* 4th edition, Section 3, "Hazard Calculations," and Section 5, Chapter 10, "Fire Risk Indexing."

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this guide and should be considered part of the recommendations of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes,* 2013 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Low-Rise Residential Occupancies,* 2013 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.

NFPA 92, *Standard for Smoke Control Systems,* 2012 edition.

NFPA *101®, Life Safety Code®,* 2015 edition.

NFPA 204, *Standard for Smoke and Heat Venting,* 2012 edition.

NFPA 220, *Standard on Types of Building Construction,* 2015 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,* 2012 edition.

NFPA 257, *Standard on Fire Test for Window and Glass Block Assemblies,* 2012 edition.

NFPA 265, *Standard Methods of Fire Tests for Evaluating Room Fire Growth Contribution of Textile or Expanded Vinyl Wall Coverings on Full Height Panels and Walls,* 2011 edition.

NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2011 edition.

NFPA 551, *Guide for the Evaluation of Fire Risk Assessments,* 2013 edition.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

NFPA *Fire Protection Handbook,* 20th edition.

NFPA *SFPE Handbook of Fire Protection Engineering,* 4th edition.

2.3 Other Publications.

2.3.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959, www.astm.org.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2013.

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

2.3.2 SFPE Publications. Society of Fire Protection Engineers, 7315 Wisconsin Avenue, Suite 620E, Bethesda, MD 20814.

SFPE Engineering Guide to Fire Risk Assessment.

2.3.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096, www.ul.com.

ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, 2008, Revised 2010.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Advisory Sections.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter apply to the terms used in this guide. Where terms are not defined in this chapter or within another chapter, they should be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, is the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Guide. A document that is advisory or informative in nature and that contains only nonmandatory provisions. A guide may contain mandatory statements such as when a guide can be used, but the document as a whole is not suitable for adoption into law.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

3.2.7 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions. See Section 3.3 of NFPA *101.*

Chapter 4 Fire Safety Evaluation System for Health Care Occupancies

4.1 General.

4.1.1 This chapter is part of an NFPA guide and, therefore, is not mandatory. The term *shall* in this chapter is used to indicate that if the provisions of the chapter are applied, the procedures mandated are to be followed to ensure the effectiveness of the evaluation system.

4.1.2 The Fire Safety Evaluation System (FSES) is a measuring system. It compares the level of safety provided by an arrangement of safeguards that differ from those specified in NFPA *101* to the level of safety provided in a building that conforms exactly with the details of the *Code.*

4.1.3 This chapter is provided to assist in completion of Figure 4.7, Worksheets for Evaluating Fire/Smoke Zones. The step-by-step instructions for completion appear on the worksheets. They are not repeated within the chapter. This chapter provides expanded discussion and definition of the various items in the worksheet to assist the user when questions of definition or interpretation arise. The chapter is organized to follow the format of the worksheet progressively.

4.2 Procedure for Determining Equivalency.

4.2.1 Evaluate fire/smoke zones using Figure 4.7 (Worksheets 4.7.1 through 4.7.11). Use the text portion (Section 4.3 through 4.6.13.4.3) of this chapter as a guide.

4.2.2 The Facility Fire Safety Requirements Worksheet (Worksheet 4.7.10) is used to determine any nonconformance with the requirements on the worksheet.

4.2.3 Equivalency is achieved if the fire/smoke zone evaluations show equivalency or better in each and every fire/smoke zone and the requirements of the Facility Fire Safety Requirements Worksheet (Worksheet 4.7.10) are met.

4.3 Fire/Smoke Zone.

4.3.1 A fire/smoke zone is a space that is separated from all other spaces by floor assemblies, horizontal exits, or smoke barriers. Every zone on a story that is subdivided into two or more zones shall have exit routes in accordance with 18.2.4 or 19.2.4 of NFPA *101.* Compartments not meeting these requirements shall be evaluated as part of an adjacent zone. Where a story is not subdivided by horizontal exits or smoke barriers, the entire story is considered to be the zone.

4.3.2 Selection of Zones to Be Evaluated.

4.3.2.1 A story that is not subdivided by horizontal exits or smoke barriers is considered a single zone.

4.3.2.2 The entire facility shall be divided into zones. There shall be no areas that are not in a zone.

4.3.2.3 For a complete evaluation, evaluate every zone in the health care facility individually.

4.3.2.4 Where the system is used to evaluate conditions unique to a selected number of zones, the entire building should be evaluated for compliance with the *Life Safety Code* and the FSES evaluation shall be completed on the specific zones where the condition occurs.

4.3.2.5 Most health care facilities have repetitive arrangements so that a complete picture can be developed by evaluating typical zones until all combinations are evaluated. The zones selected should include the following:

(1) Each type of patient zone having a different type of mobility, density, or attendant ratio, as specified in Worksheet 4.7.2
(2) Each zone that represents a significantly different type of construction, finish, or protection system
(3) Zones containing special medical treatment or support activities (operating suites, intensive care units, laboratories)
(4) Zones not involving housing, treatment, or customary access for four or more inpatients simultaneously who are incapable of self-preservation; such zones should be evaluated as follows:

    (a) Any zone, whether or not used for patient egress, shall be permitted to be evaluated on the same basis as a patient use zone. In such case, the value of factor *F* in Worksheet 4.7.3 shall be assigned the value of factor *L* ("Zone Location") from Worksheet 4.7.2. In such cases, Safety Parameter 10, "Emergency Movement Routes," from Worksheet 4.7.6 shall be graded "deficient" if the exit capacity is less than that prescribed for the actual occupancy of the space and "<2 routes" if less than 75 percent of the prescribed exit capacity is present.
    (b) If the zone is separated by 2-hour fire-rated construction from all patient use zones (including any members that bear the load of a patient use zone) and if any communicating openings through the 2-hour fire-rated construction are protected by 1½-hour fire protection–rated fire doors, the zone shall be permitted to be excluded from evaluation. In such case, that space shall conform with the portion of the *Life Safety Code* appropriate to its use. In addition, appropriate charges under Safety Parameter 8, "Hazardous Areas," in Worksheet 4.7.6 shall be charged against other zones in the facility.
    (c) Evaluation of any unoccupied story or stories located above the highest floor used for health care occupancy is not required, provided each such unoccupied story meets the construction requirements of 18.1.6 (NFPA *101*) for new buildings or 19.1.6 (NFPA *101*) for existing buildings, or if each unoccupied story is protected by automatic sprinklers.

(5) Patient sleeping rooms or suites exceeding 1000 ft^2 (92.9 m^2) of floor area should be evaluated as follows:

    (a) If the room or suite has a single exit access door, it should be evaluated as a single dead-end zone.
    (b) A patient sleeping room or suite of sleeping rooms exceeding the 5000 ft^2 (460 m^2) limitation of 19.2.5.7.2.3(A) (NFPA *101*) should be evaluated as a separate zone that is not a suite.
    (c) A patient sleeping room or suite of sleeping rooms exceeding the 7500 ft^2 (700 m^2) limitation of 18.2.5.7.2.3(B) or 19.2.5.7.2.3(B) (NFPA *101*) should be evaluated as a separate zone that is not a suite.
    (d) A patient sleeping room or suite of sleeping rooms exceeding the 10,000 ft^2 (930 m^2) limitation of 18.2.5.7.2.3(C) or 19.2.5.7.2.3(C) (NFPA *101*) should be evaluated as a separate zone that is not a suite.

(6) Patient care nonsleeping rooms or suites exceeding 2500 ft^2 (230 m^2) of floor area should be evaluated as follows:

    (a) If the room or suite has a single exit access door, it should be evaluated as a single dead-end zone.
    (b) A patient care nonsleeping room or suite of nonsleeping rooms exceeding the 10,000 ft^2 (930 m^2) limitation of 19.2.5.7.3.2 (NFPA *101*) should be evaluated as a separate zone that is not a suite.
    (c) A patient care nonsleeping room or suite of nonsleeping rooms exceeding the 12,500 ft^2 (1160 m^2) limitation of 18.2.5.7.3.2(A) or 19.2.5.7.3.2(A) (NFPA *101*) should be evaluated as a separate zone that is not a suite.
    (d) A patient care nonsleeping room or suite of nonsleeping rooms exceeding the 15,000 ft^2 (1390 m^2) limitation of 18.2.5.7.3.2(B) or 19.2.5.7.3.2(B) (NFPA *101*) should be evaluated as a separate zone that is not a suite.

4.4 Maintenance. Any protection system, requirement, or arrangement that is not maintained in a dependable operating condition or that is used in such a manner that the intended fire safety function or hazard constraint is impaired should be considered defective and receive no credit in the evaluation.

4.5 Occupancy Risk (Worksheet 4.7.2). In establishing a system for evaluating occupancy risk, the following facts are recognized:

(1) There is a basic level of risk inherent in every health care facility.
(2) The fuel characteristics of furniture, equipment, and supplies vary with time.
(3) The arrangement of these items within the space available can vary with time.
(4) Consequently, these three factors are not included as parameters in a safety equivalency measurement; to account for these factors, the occupancy risk baseline is set at the inherent risk level, with the presumption that the furniture, equipment, and supplies are the most combustible and adversely located (from a fire safety standpoint) of those items normally found in health care facilities.

4.5.1 Patient Mobility.

4.5.1.1 The single most important factor controlling risk in a health care facility is the degree to which patients need assistance in taking the actions necessary for their safety. The level of capability in health care facilities varies from patients who, if informed or directed, are able to take positive, self-protecting actions to those patients who have no ability to move or even to take the simplest actions to safeguard themselves. In some cases, patients are directly connected to a fixed life-support system and are so dependent on it that, regardless of their physical condition or the availability of assistance, they cannot be moved without jeopardy of death or serious harm. In the measurement of occupancy risk factors, the least mobile category of patient expected in the zone determines the risk factor for that zone. The rationale for this approach is that, if a zone accepts any patient with a reduced mobility status, it might accept other such patients at any time. The impact of this approach is that most health care facilities should be rated in the "not mobile" risk category. Mobility status should be based on the minimum level of mobility in an average 24-hour period.

4.5.1.2 Mobility Status Factor. Patient mobility status is based on the capability of each patient to take actions necessary for self-protection. The four classes are defined as follows:

(1) *Mobile.* Capable of readily rising from bed and taking self-protecting actions at approximately the same rate as a healthy adult. To be classified as mobile, the patient must not need assistance in getting out of bed and must be able to open a closed or locked door. Persons shall be considered to be mobile if they are not restrained or in any other way limited in response capabilities so that the type of arousal mechanism that normally would awaken an adult is not effective.
(2) *Limited Mobility.* Those patients who have all of the capabilities of a mobile person except that their rate of travel is significantly slower.
(3) *Not Mobile.* Patients incapable of removing themselves from danger exclusively by their own efforts. Examples include persons who are totally bedridden; who need assistance getting out of bed or moving; and who are restrained, locked in their rooms, or otherwise prevented from taking complete emergency self-protection evacuation actions without assistance.
(4) *Not Movable.* Patients not capable of being moved from the room in which they are housed during the course of a fire. Examples include patients attached to life-support systems or involved in medical or surgical procedures that prohibit their immediate relocation without extreme danger of death or serious harm.

4.5.2 Patient Density.

4.5.2.1 The occupancy risk evaluation for occupancy density (number of patients within the zone) measures both the inherent increase in the maximum fire death potential that occurs as the number of patients in a zone increases and the problems involved for a limited staff in handling larger numbers of patients during an emergency.

4.5.2.2 Patient Factor. The density of patients is the number of patients who could potentially be housed in the zone. The patient count should be based on the number of assignable beds in the zone, assuming that they might all be occupied at the time of the fire emergency.

4.5.3 Zone Location.

4.5.3.1 This risk factor relates to fire department accessibility to a fire. The rating system recognizes the inherent advantages for the first story zone. It also recognizes the problems of evacuation from higher stories and the virtual impossibility of using external fire-fighting efforts above the sixth story in any building.

4.5.3.2 Story Factor. The measured zone's location shall be considered to be on the first story if the story has direct access to the exterior at or within less than one-half story height above or below grade. If a building is on a sloping grade, each story that has such exterior access shall be considered as a first story for the purpose of measuring fire zones on those stories. The measured zone shall be considered to be on the second to third story range and the fourth to sixth story range, based on the height of the zone above the nearest at-grade story. The zone shall be considered to be above the sixth story if it is more than six stories above the nearest at-grade story. The risk factor value for zones in basements is the same as for zones at or above the seventh story. The problems involved in emergency internal access, in fire fighting and rescue, and in the inability to make external attack in basements are approximately equivalent to those in the upper stories of buildings.

4.5.4 Ratio of Patients to Attendants.

4.5.4.1 This risk factor recognizes the importance to patient safety of a staff that is immediately available to respond in an emergency. The emergency actions that might be undertaken by the staff include detection, alarm, fire extinguishment, confinement of the fire, establishment of barriers between the patients and the fire (closing patient room doors), rescue, emergency medical aid, and other related functions. A few of these functions, such as detection and alarming, might not be critically related to the ratio of nursing staff to patients, while those related to rescue and the closing of patient room doors have a strong relationship to the staffing ratio. The staff ratio considered is based on the minimum staffing level immediately available (normally the night shift).

4.5.4.2 Patient–Attendant Factor. The ratio of patients to attendants is based on those patients in the fire/smoke zone and the immediately available attendant staff.

4.5.4.2.1 The ratio calculation shall be based on the minimum staffing level (usually occurring during the night shift). Where nursing stations or other positions of attendants are located at the junction of two or more zones and the location of the station is such that each of the zones has immediate access and is in view of the nursing station, the total staffing assigned to the nursing station can be credited to each of the zones. An exception occurs when staff members are bound by duty assignments (cardiac care units, infant nurseries, operating suites, etc.) that prevent them from responding to other than their assigned zone.

4.5.4.2.2 The evaluation system assesses this risk factor at 4.0 in any case involving periods where no attendants are immediately available to a zone that houses patients but where attendants are available within one story of all stories housing patients. This evaluation system is not intended to be used in cases where no staff are present in the building housing patients.

4.5.5 Patient Average Age.

4.5.5.1 This risk factor recognizes the increased susceptibility of the elderly and of infants up to one year old to physical harm by smoke particles, gaseous combustion products, and heated air. A larger risk factor is assigned to zones occupied by a population whose average age is above 65 years or below one year. Basically, imposition of this rating demands additional safety protection in nursing homes for the aged and in nurseries.

4.5.5.2 The mode value is used to arrive at the age factor for the patients in the zone. The calculation should be based on the past record of occupants assigned to the zone. Patients under one year old are classified at the same risk level as those over 65. This factor recognizes the susceptibility of infants to fire.

4.6 Safety Parameters (Worksheet 4.7.6). Safety parameters are a measure of those building factors that bear on or contribute to the safety of those persons (patients, staff, visitors, others) who might be in the particular zone at the time of a fire. Each of the safety parameters was analyzed. Where the current *Life Safety Code* requirements recognize several different approaches to the parameter, the most important alternatives were specified. Also specified were conditions likely to be encountered in situations failing to meet the explicit *Code* requirements and conditions exceeding those required by the *Code*, but available for increased protection.

4.6.1 Construction. Construction types are classified in accordance with the definitions of NFPA 220. Major revisions have been made in the categories and definitions in the recent editions of NFPA 220. Previously, NFPA 220 included requirements for "interior partitions enclosing stairs or other openings through floors." The current edition does not. This change is fully accounted for in this system. *(See 4.6.7.)*

4.6.1.1 Where the facility includes additions or connected structures of different construction, the rating and classification of the structure shall be based on one of the following:

(1) Separate buildings, if in accordance with 8.2.1.3 (NFPA *101*)
(2) Separate buildings, if the additions and connected structure conform to the provisions of applicable sections of Chapter 18 or 19 (NFPA *101*), whether or not separation is provided
(3) The lower safety parameter point score involved, if neither 4.6.1.1(1) nor 4.6.1.1(2) applies

4.6.1.2 The story used to determine the parameter value is the story of the fire/smoke zone being evaluated. The construction type of the building for all stories is based on the lowest construction type anywhere in the building. The story or zone is specified relative to, and beginning with, the level of exit discharge as defined in Section 3.3 (NFPA *101*).

4.6.1.3 Where the zone is on a story below the level of exit discharge, the construction value shall be based on the distance of that story from the level of exit discharge (i.e., one story below the level of exit discharge equals "second"; two stories below the level of exit discharge equals "third"; three or more stories below the level of exit discharge equals "fourth and above").

4.6.2 Interior Finish (Corridor and Exits). The classification of interior finish materials shall be in accordance with Section 10.2 (NFPA *101*). The flame-spread classification shall be based on the most combustible surface after deleting trim. No allowance is made in the safety parameter values for interior finish materials that fail to be classified as a minimum of Class C. It is not anticipated that such materials will be used in health care facilities. In the rare case that such high flame-spread interior finish materials are involved, an individual fire hazard assessment outside the capability of this evaluation system will be required. Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286, as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

4.6.3 Interior Finish (Rooms). See 4.6.2.

4.6.4 Corridor Partitions/Walls. For the purpose of this evaluation, the fire-rated partitions considered are as defined in 18.3.6 (NFPA *101*) for new buildings and 19.3.6 (NFPA *101*) for existing buildings. All elements of the partition, except the door (considered as a separate element in this evaluation), must be included in the determination of its time-rated fire resistance classification according to ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*. An exception to the general rule of evaluating doors separately from walls occurs where one or more rooms have no doors *(see 4.6.5)*. In this instance, it is considered that the worth of the fire resistance capabilities of the corridor partition wall is so reduced that the wall should be graded as having no fire resistance. *(See Worksheet 4.7.6.)*

4.6.4.1 Corridor partitions shall be graded as "none or incomplete" if they do not meet the requirements of 18.3.6 or 19.3.6 (NFPA *101*), as appropriate, including applicable exceptions. In existing buildings, partitions shall be permitted to be graded as "<½ hour," provided the ceiling within the fire/smoke zone is of a design and construction sufficient to resist the passage of smoke and the partition either extends through or terminates at the underside of the ceiling with a smoketight joint.

4.6.4.2 Corridor partitions shall be graded as "≥½ hour but <1 hour" or "≥1 hour" only where the partitions extend to the underside of the floor or roof construction above in accordance with 18.3.6 or 19.3.6 (NFPA *101*), as appropriate.

4.6.5 Doors to Corridor. The classification of doors and opening protectives to the corridor shall be based on the minimum quality of any door in the zone, and the classification shall be determined in accordance with NFPA 252 or NFPA 257. Doors for protection of vertical openings and hazardous areas that are covered separately in 4.6.7 and 4.6.8 are not included in this evaluation. Doors that do not latch and doors that have louvers shall not be considered in classifying doors to corridors if those doors open to toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials.

4.6.5.1 No Door. A room shall be considered as not having a door if there is no door or window in the opening or if there is some other mechanism that prevents closing of the door or otherwise leaves a significant opening between the patient room and the corridor. Doors with louvers or ordinary glass lights shall be classified as "no door." (Ordinary glass lights shall not be considered as making a partition incomplete in locations where both sides of the glass light are fully protected by automatic sprinkler systems.) Doors that have been blocked open by door stops, chocks, tiebacks, or other devices that necessitate manual unlatching or releasing action to close the door shall be classified as "no door." Hold-open devices that release when the door is pushed or pulled (such as friction catches or magnetic catches) shall be permitted, and the door shall be classified under 4.6.5.2, 4.6.5.3, and 4.6.5.4. Also, doors that are not provided with a latch in accordance with 18.3.6.3.5 through 18.3.6.3.8 or 19.3.6.3.5 through 19.3.6.3.7 (NFPA *101*) shall be classified as "no door."

4.6.5.2 Doors of Less Than 20-Minute Fire Protection Rating (<20 min FPR). Doors and windows that are not deficient as described in 4.6.5.1 but that do not meet the requirements of 4.6.5.3 shall be classified as less than 20-minute fire protection rating.

4.6.5.3 Doors of 20-Minute or More Fire Protection Rating (≥20 min FPR). Doors and windows shall be considered as having a 20-minute or greater fire protection rating when tested in accordance with 4.6.5,are of 1¾ in. (44 mm) thick, solid, bonded wood core construction, or any other arrangement of equal or greater stability and fire integrity. The thermal insulation capability of the door or window need not be considered. Hollow or sheet steel doors, therefore, meet the 20-minute requirement.

4.6.5.4 Twenty-Minute or More Fire Protection Rating and Automatic Closing (≥20 min FPR and Auto Clos.). Automatic-closing devices shall be considered to be present if the door has an arrangement that holds it open in a manner such that it is released by a smoke detector–operated device (e.g., a magnetic or pneumatic hold-open device) prior to the passage of significant smoke from a room of fire origin into the corridor or from the corridor into a room not involved in the fire. Smoke detectors for operation of such doors shall be permitted to be integral with the door closers, mounted at each opening, or operated from systems meeting the requirements for two or more points of credit under 4.6.12. The requirement for 20-minute fire protection rating is the same as in 4.6.5.3.

4.6.5.5 Self-Closing Patient Room Doors. Traditional self-closing doors on individual patient rooms shall be evaluated in the following manner:

(1) If it can be established that the doors are constantly kept in the normally closed position except when persons are actually passing through the openings, the self-closing device shall be considered as equivalent to an automatic-closing device and credited accordingly.
(2) If the self-closing doors are blocked open, they shall be classified as "no door" and a parameter value of −10 invoked.

4.6.6 Zone Dimensions. Zone dimension shall be as calculated per 18.3.7.1 or 19.3.7.1 (NFPA *101*).

4.6.6.1 The length of a corridor "dead end" shall be measured from the point at which a person egressing from the dead end would have an option of egressing in two separate directions.

4.6.6.2 In assessing the values for this parameter, a single value shall be chosen based on the worst safety level in the zone. For example, if one or more dead ends in excess of 50 ft (15 m) but not more than 100 ft (30 m) exist, the parameter value for dead ends (−4) shall be applied regardless of the actual corridor lengths.

4.6.6.3 Since dead-end corridors and single emergency movement routes *(see 4.6.10)* each confine the occupants of a fire zone to a single means of egress, the effect of these two factors on the parameter value is not cumulative. As indicated by Note b to Worksheet 4.7.6, the parameter value for dead-end corridors is to be 0 instead of either −2, −4, or −6 in the special case where a value of −8 is assessed under 4.6.10 for single emergency movement routes.

4.6.6.4 Zone length applies to the greater dimension of length or width of the zone.

4.6.7 Vertical Openings. These values apply to vertical openings and penetrations, including exit stairways, ramps, and other vertical exits of the type recognized by NFPA *101*, plus pipe shafts, ventilation shafts, duct penetrations, and laundry and incinerator chutes. Enclosures shall be of construction having a fire resistance rating not less than that prescribed for vertical openings *(see Safety Parameter 7 of Worksheet 4.7.6)*. In addition, they shall be equipped with fire doors or acceptable protection of openings into the shafts, all designed and installed to provide a complete barrier to the vertical spread of fire or smoke.

4.6.7.1 A vertical opening or penetration shall be considered open if it has any of the following characteristics:

(1) It is unenclosed.
(2) It is enclosed but does not have doors or opening protectives.
(3) It is enclosed but has openings other than doorways.
(4) It is enclosed with cloth, paper, or similar materials without any sustained flame-stopping capabilities.

4.6.7.2 Where vertical openings are located outside the fire/smoke zone and the separation between the zone and the vertical opening is of 1-hour or greater fire resistance rating and is of higher fire resistance rating than the protection of the vertical opening itself (for example, an open shaft separated from the zone by a 2-hour fire resistance–rated partition with 1½-hour fire protection–rated self-closing fire doors), the rating of this factor for the zone being measured shall be based on the higher of the two fire resistance categories. In this example, a safety parameter value of 3 would be given for the 2-hour fire resistance rating. Where this occurs, however, the space with the vertical opening cannot be considered an exit route or refuge area for that zone when evaluating the emergency movement route parameter addressed in 4.6.10.

4.6.7.3 A vertical opening shall be considered open for more than three stories if there is unprotected penetration of four or more stories on the same shaft without an intervening slab or other cutoff *(also see same area as an unprotected penetration in 4.6.13)*. If a shaft is enclosed at all stories except one and this results in an unprotected opening between the shaft and one, and only one, fire/smoke zone, the parameter value assigned for that shaft opening in the fire/smoke zone where the unprotected opening occurs shall be 0.

4.6.8 Hazardous Areas. Hazardous area protection is determined in accordance with Section 8.7 (NFPA *101*). The term *adjacent zone* as used in the evaluation form means any zone, either on the same story or on the story immediately below, that physically abuts the zone being evaluated and not separated by 2-hour fire resistance–rated construction. The term *outside zone* as used in the evaluation form means any place within the building other than the fire/smoke zone being measured and not separated by 2-hour fire resistance–rated construction.

4.6.8.1 In assessing the parameter value for hazardous areas, only one value shall be chosen. It shall be the most severe value corresponding to the deficiencies present. A double deficiency can exist only where the hazard is severe and the space is not sprinkler protected. Double protection consists of both a fire-rated enclosure and automatic sprinkler protection of the hazardous area. If both of these protections are lacking in a severe hazardous location, the double deficiency value shall be chosen. If double deficiencies exist both within the zone and outside the zone, the higher value (−11) for the condition inside the zone shall be chosen. The values are not cumulative, regardless of how many hazardous areas are present. Table 4.6.8.1 provides a matrix to be used to determine degree of deficiency to be assessed.

Table 4.6.8.1 Hazardous Areas Deficiencies

	Hazard	
Protection	**Severe**	**Not Severe**
None	Double	Single
Fire resistance–rated enclosures	Single	None
Automatic sprinklers and smoke partitions	Single	None
Automatic sprinklers and fire resistance–rated enclosures	None	None

4.6.8.2 Where the hazard is not severe, the maximum deficiency that can occur is a single deficiency, which shall be permitted to be countered by either of the following means:

(1) A fire resistance–rated enclosure
(2) Automatic extinguishing equipment and enclosure by smoke partitions

4.6.8.3 A single deficiency situation also is considered to exist where a severe hazard is protected by either of the following means, but not by both:

(1) A fire resistance–rated enclosure
(2) Automatic extinguishing equipment and enclosure by smoke partitions

4.6.9 Smoke Control. Smoke control definitions are provided in 4.6.9.1 through 4.6.9.3.

4.6.9.1 No Control. There are no smoke barriers (or horizontal exits) on the story, and there is no mechanical smoke control system.

4.6.9.2 Smoke Barrier Serves Zone. A smoke barrier consists of a partition extending across the entire width of the zone equipped with doors that either are self-closing or are closed upon detection by smoke detectors located at the door arches or other release mechanisms as described in 7.2.1.8 (NFPA *101*). To be credited as a smoke barrier, an existing partition also shall conform with the requirements of 19.3.7.2 through 19.3.7.10 (NFPA *101*). New smoke barriers in either new or existing buildings shall meet the more stringent requirements of 18.3.7.2 through 18.3.7.10 (NFPA *101*). A horizontal exit that also complies with 8.5 (NFPA *101*) will act as a smoke barrier and is credited as both a smoke barrier *(see 4.6.9)* and an emergency movement route *(see 4.6.10)*.

4.6.9.3 Mechanically Assisted Systems — by Zone. Mechanically assisted smoke control on a zone basis shall include a smoke barrier, as in 4.6.9.2, supported by a tested and accepted smoke control system that obstructs the leakage of smoke between zones. One method of judging the acceptability of smoke control systems is found in NFPA 92.

4.6.10 Emergency Movement Routes. A movement route is any means of egress meeting the requirements for such means specified in 7.2.2 through 7.2.6 (NFPA *101*). Horizontal exits also shall meet the requirements specified in 4.6.10.4. Doors exiting directly to the exterior also shall constitute a movement route from the room containing such a door.

4.6.10.1 Fewer Than Two Routes. The means of emergency movement from a zone is classified as fewer than two routes if there are not at least two remote movement routes serving the zone. Movement routes shall be permitted to be outside the physical limits of the zone.

4.6.10.2 Multiple Routes. The emergency movement route is multiple if the zone occupants have the choice of two or more distinctly separated movement routes from the zone.

4.6.10.3 Deficient. The choice of parameter value for deficient emergency movement routes is independent of any values determined in 4.6.7.

4.6.10.3.1 An emergency movement route of a type described by 18.2.2 or 19.2.2 (NFPA *101*) is deficient if the door widths or corridor widths do not conform to the requirements of 18.2.3 or 19.2.3 (NFPA *101*).

4.6.10.3.2 Emergency movement routes also shall be considered deficient if they fail to meet the requirements of 18.2.1 through 18.2.7 or 19.2.1 through 19.2.7 (NFPA *101*) for the egress route involved. However, any route where the doors from rooms or through partitions or walls are less than 32 in. (810 mm) in the clear, the corridor(s) involved is less than 34 in. (865 mm) wide, or stair access is less than 28 in. (710 mm) in the clear shall not be credited as an egress route.

4.6.10.3.3 Emergency movement routes shall be considered deficient if the route does not otherwise conform to the requirements of Section 7.1 through 7.2.6 (NFPA *101*), even if the routes have been or are acceptable to the authority having jurisdiction.

4.6.10.3.4 Emergency movement routes shall be considered deficient if the capacity of the exits serving the story containing the zone being evaluated is insufficient for the calculated occupant load of the story. For buildings not protected throughout by automatic sprinklers, use the capacity factor of 0.6 in. (15 mm) per person for stairs.

4.6.10.4 Horizontal Exits. The presence of a single horizontal exit from the zone being evaluated shall be assigned a parameter value of 1, provided the space on the opposite side of the horizontal exit is capable of handling all of the patients from affected zones.

4.6.10.4.1 To be credited as a horizontal exit, the existing arrangement also shall conform with the requirements of 19.2.2.5 (NFPA *101*). New horizontal exits in new or existing buildings shall meet the more stringent requirements of 18.2.2.5 (NFPA *101*).

4.6.10.4.2 To receive credit for horizontal exits, the zone credited shall conform to the requirements of 7.5.1.1 through 7.5.1.1.4 (NFPA *101*) with the zone served considered a separate portion of the building.

4.6.10.4.3 To receive credit for horizontal exits, the travel distance from within each patient sleeping or treatment room in the zone to a horizontal exit door or exit to grade shall not exceed 150 ft (46 m) or where Parameter 13 is scored as 10 shall not exceed 200 ft (61 m).

4.6.10.5 Direct Exits. To be credited for direct exits, each patient-use space (except bathrooms, restrooms, and corridors) in the zone shall have a door that is operable by the room occupant(s) and opens directly to the exterior at grade or onto an exterior balcony with direct access to an exterior exit or a smokeproof enclosure. The direct exit shall be ramped or otherwise without steps or changes in elevation that could prevent or obstruct the movement of wheelchairs or wheellittered patients through the direct exits to a place of safety and refuge.

4.6.11 Manual Fire Alarm. The manual alarm systems for new construction shall be in accordance with the requirements of 18.3.4 other than 18.3.4.3.2 (NFPA *101*). Existing construction shall be in accordance with 19.3.4 other than 19.3.4.3.2 (NFPA *101*). Connection to the fire department shall be considered as being met if the fire alarm system is connected directly to the fire department through an approved central station or through other means acceptable to the authority having jurisdiction.

4.6.12 Smoke Detection and Alarm. A detection system as used herein is one based on the use of automatic smoke detectors installed in accordance with Section 9.6 (NFPA *101*). Notification shall be in accordance with 18.3.4.3 other than 18.3.4.3.2 or 19.3.4.3 other than 19.3.4.3.2 (NFPA *101*). No recognition is given for thermal detectors; however, credit is given for the use of quick-response sprinklers per Note g of Worksheet 4.7.6. The detection system categories are described in 4.6.12.1 through 4.6.12.5.

4.6.12.1 None. There are no smoke detectors in the zone, or, if present, they are not included in any of the categories of 4.6.12.2 through 4.6.12.5.

4.6.12.2 Corridor Only. Smoke detectors are installed throughout the corridors of the zone involved in accordance with Section 9.6 (NFPA *101*).

4.6.12.3 Rooms Only. Smoke detectors are installed throughout the rooms of the zone involved. These smoke detectors shall be considered as meeting this requirement where there is at least one smoke detector in each room occupied or used by patients. Detectors are not required in restrooms or closets.

4.6.12.4 Corridor and Habitable Spaces. Detection systems installed throughout the corridors of the zone involved and in the habitable spaces (patient rooms, nurses stations, and other areas basically used for human occupancy) shall be considered as meeting the requirements for a corridor and habitable spaces detection system. Closets, toilet rooms, and other auxiliary spaces, as well as ceiling voids, interstitials, and other building spaces not used by humans as a normal part of their regular occupancy, are not required to have detectors.

4.6.12.5 Total Spaces in Zone. Total space provision of detectors includes detector coverage of all spaces, except noncombustible building voids that contain no combustible materials. The total space credit is to be given if the zone measured meets this criterion, regardless of the presence or lack of detectors in other portions of the building.

4.6.13 Automatic Sprinklers.

4.6.13.1 Wherever sprinkler protection is involved in an area having an unprotected vertical opening, the sprinkler protection around that vertical opening shall conform to Chapter 8 (NFPA *101*). This protection is required to allow the credit for sprinkler protection but shall in no way reduce any assessed value under Safety Parameter 7 in Worksheet 4.7.6 resulting from an unprotected vertical opening.

4.6.13.2 In Worksheet 4.7.7, the value for sprinkler protection credited to the people movement safety (S_3) category is divided by 2. This produces a safety parameter value of only one-half the value credited in other categories.

4.6.13.3 Each sprinkler system shall be provided with supervision. Each sprinkler system shall be interconnected electrically with the fire alarm system, and sprinkler control valves shall be supervised electrically so that at least a local alarm shall sound in a constantly attended location when a valve is not in the fully open position.

4.6.13.4 In evaluating sprinkler protection within the zone, the protection or lack of protection of hazardous areas is considered separately and covered under 4.6.8. For all other areas in the zone, sprinklers shall be graded based on the categories specified in 4.6.13.4.1 through 4.6.13.4.3.

4.6.13.4.1 None. No credit is applied if there are no sprinklers or if sprinklers, though present, are not sufficient to qualify for one of the other categories specified.

4.6.13.4.2 Corridor and Habitable Space. Habitable space includes patient rooms, nurses' stations, and other areas used basically for human occupancy. Habitable space does not include closets, bathrooms, toilets, elevators, and similar spaces. This safety parameter value is based on standard sprinkler spacings in the areas covered and is conditional, based on the classification of construction type as covered in 4.6.1.

4.6.13.4.2.1 Safety Parameter 1, "Construction" *(see 4.6.1)*, in Worksheet 4.7.6 is based on a "protected" or "fire-resistive" type of construction. Protected or fire-resistive types of construction include Types I, II(222), II(111), III(211), and V(111). This credit is based on a system that effectively provides coverage for all corridor and habitable space in the zone, plus the establishment of water distribution patterns or other protection in a manner to prevent the advance of fire from nonsprinklered spaces into the sprinklered spaces. In buildings of protected or fire-resistive construction, the credit is to be applied to any zone where these conditions are met, whether or not areas outside the zone are protected similarly.

4.6.13.4.2.2 Safety Parameter 1, "Construction" *(see 4.6.1)*, is based on an "unprotected" type of construction. Unprotected types of construction include Types II(000), III(200), and V(000). In any unprotected type of construction, the credit for corridor and habitable space protection is to be given only if, in addition to the conditions described in 4.6.13.4.2.1, sprinkler protection also is provided in all spaces in the building (including attic or loft spaces) with construction elements that are not sheathed, enclosed, or otherwise protected with fire-resistive materials such as gypsum board, plaster, or masonry block.

4.6.13.4.3 Entire Building. Total space automatic sprinkler protection is to be credited only if the entire structure is protected by automatic sprinklers in accordance with 18.3.5 or 19.3.5 (NFPA *101*). This credit also is given where a smoke zone in an existing hospital is renovated to install quick-response or residential sprinklers in accordance with 18.1.1.4.3 (NFPA *101*); however, the mandatory safety requirements values of Worksheet 4.7.8C for nonsprinklered existing hospitals must be used. Wherever quick-response automatic sprinklers are provided for zones as part of the entire building sprinkler system, additional credit shall be permitted to be taken under Safety Parameter 12, "Smoke Detection and Alarm." *(See 4.6.12 and Worksheet 4.7.6.)*

4.7 Worksheets for Evaluating Fire/Smoke Zones. The worksheets for evaluating fire/smoke zones use a 10-step process found in Figure 4.7.

WORKSHEET 4.7.1 COVER SHEET

Fire/Smoke Zone* Evaluation Worksheet for Health Care Facilities

Facility ______________________ Building ______________________

Zone(s) evaluated ______________________

Evaluator ______________________ Date ______________________

Complete this worksheet for each zone. Where conditions are the same in several zones, one worksheet can be used for those zones.

*Fire/smoke zone is a space separated from all other spaces by floors, horizontal exits, or smoke barriers.

WORKSHEET 4.7.2 OCCUPANCY RISK PARAMETER FACTORS

Risk Parameters	Risk Factor Values					
1. Patient Mobility (M)	Mobility Status	Mobile	Limited Mobility		Not Mobile	Not Movable
	Risk Factor	1.0	1.6		3.2	4.5
2. Patient Density (D)	No. of Patients	1–5	6–10		11–30	>30
	Risk Factor	1.0	1.2		1.5	2.0
3. Zone Location (L)	Story	1st	2nd or 3rd	4th to 6th	7th and Above	Basements
	Risk Factor	1.1	1.2	1.4	1.6	1.6
4. Ratio of Patients to Attendants (T)	$\frac{\text{Patients}}{\text{Attendant}}$	$\frac{1\text{–}2}{1}$	$\frac{3\text{–}5}{1}$	$\frac{6\text{–}10}{1}$	$\frac{>10}{1}$	$\frac{\text{One or More*}}{\text{None}}$
	Risk Factor	1.0	1.1	1.2	1.5	4.0
5. Patient Average Age (A)	Age	<65 Years and >1 Year			≥65 Years or ≤1 Year	
	Risk Factor	1.0			1.2	

*A risk factor of 4.0 is charged to any zone that houses patients without any staff in immediate attendance.

WORKSHEET 4.7.3 OCCUPANCY RISK FACTOR CALCULATION

Occupancy Risk $\underset{M}{\boxed{}} \times \underset{D}{\boxed{}} \times \underset{L}{\boxed{}} \times \underset{T}{\boxed{}} \times \underset{A}{\boxed{}} = \underset{F}{\boxed{}}$

WORKSHEET 4.7.4 ADJUSTED OCCUPANCY RISK FACTOR — NEW BUILDINGS

$1.0 \times \underset{F}{\boxed{}} = \underset{R}{\boxed{}}$

WORKSHEET 4.7.5 ADJUSTED OCCUPANCY RISK FACTOR — EXISTING BUILDINGS

$0.6 \times \underset{F}{\boxed{}} = \underset{R}{\boxed{}}$

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FIGURE 4.7 Worksheets for Evaluating Fire/Smoke Zones.

WORKSHEET 4.7.6 SAFETY PARAMETER VALUES

Safety Parameters | **Parameter Values**

1. Construction

Story or Zone	Building Construction Type: V(000)	V(111)	III(200)	III(211), IV(2HH)	II(000)	II(111)	II(222), I(332), I(442)
First	−2	0	−2	0	0	2	2
Second	−7	−2	−4	−2	−2	2	4
Third	−9	−7	−9	−7	−7	2	4
4th and Above	−13	−7	−13	−7	−9	−7	4

Safety Parameters					
2. Interior Finish (Corridors and Exits)	Class C	Class B	Class A		
	−5(0)[f]	0(3)[f]	3		
3. Interior Finish (Rooms)	Class C	Class B	Class A		
	−3(1)[f]	1(3)[f]	3		
4. Corridor Partitions/Walls	None or Incomplete	<½ hr	≥½ hr to <1 hr	≥1 hr	
	−10(0)[a]	0	1(0)[a]	2(0)[a]	
5. Doors to Corridor	No Door	<20 min FPR	≥20 min FPR	≥20 min FPR and Auto Clos.	
	−10	0	1(0)[d]	2(0)[d]	

6. Zone Dimensions

Dead End: >100 ft	Dead End: >50 ft to 100 ft	Dead End: 30 ft to 50 ft	No Dead Ends >30 ft and Zone Length Is: >150 ft	No Dead Ends >30 ft and Zone Length Is: 100 ft to 150 ft	No Dead Ends >30 ft and Zone Length Is: <100 ft
−6(0)[b]	−4(0)[b]	−2(0)[b]	−2(0)[c](0)[h]	0(0)[h]	1

7. Vertical Openings

Open 4 or More Stories	Open 2 or 3 Stories	Enclosed with Indicated Fire Resist.: <1 hr	Enclosed with Indicated Fire Resist.: ≥1 hr to <2 hr	Enclosed with Indicated Fire Resist.: ≥2 hr
−14	−10	0	2(0)[e]	3(0)[e]

8. Hazardous Areas

Double Deficiency: In Zone	Double Deficiency: Outside Zone	Single Deficiency: In Zone	Single Deficiency: In Adjacent Zone	No Deficiencies
−11	−5	−6	−2	0

9. Smoke Control

No Control	Smoke Barrier Serves Zone	Mech. Assisted Systems by Zone
−5(0)[c]	0	3

10. Emergency Movement Routes

<2 Routes	Multiple Routes: Deficient	Multiple Routes: W/O Horizontal Exit(s)	Multiple Routes: Horizontal Exit(s)	Direct Exit(s)
−8	−2	0	1	5

11. Manual Fire Alarm

No Manual Fire Alarm	Manual Fire Alarm: W/O F.D. Conn.	Manual Fire Alarm: W/ F.D. Conn.
−4	1	2

12. Smoke Detection and Alarm

None	Corridor Only	Rooms Only	Corridor and Habit. Spaces	Total Spaces in Zone
0(3)[g]	2(3)[g]	3(3)[g]	4	5

13. Automatic Sprinklers

None	Corridor and Habit. Space	Entire Building
0	8	10

[a] Use (0) where Parameter 5 is −10.

[b] Use (0) where Parameter 10 is −8.

[c] Use (0) on story with fewer than 31 patients (existing buildings only).

[d] Use (0) where Parameter 4 is −10.

[e] Use (0) where Parameter 1 is based on first story zone or on an unprotected type of construction (columns marked “000” or “200”).

For SI units, 1 ft = 0.3048 m; 1 ft² = 0.092 m².

[f] Use ( ) if the area of Class B or C interior finish in the corridor and exit or room is protected by automatic sprinklers and Parameter 13 is 0; use ( ) if the room with existing Class C interior finish is protected by automatic sprinklers, Parameter 4 is greater than or equal to 1, and Parameter 13 is 0.

[g] Use this value in addition to Parameter 13 if the entire zone is protected with quick-response automatic sprinklers.

[h] Use (0) where zone area does not exceed limitations of 18.3.7.1 or 19.3.7.1 (NFPA *101*) and distance from any point to reach a door in smoke barrier ≤200 ft.

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FIGURE 4.7 ***Continued***

WORKSHEET 4.7.7 INDIVIDUAL SAFETY EVALUATIONS

Safety Parameters	Containment Safety (S_1)	Extinguishment Safety (S_2)	People Movement Safety (S_3)	General Safety (S_4)
1. Construction				
2. Interior Finish (Corr. and Exit)				
3. Interior Finish(Rooms)				
4. Corridor Partitions/Walls				
5. Doors to Corridor				
6. Zone Dimensions				
7. Vertical Openings				
8. Hazardous Areas				
9. Smoke Control				
10. Emergency Movement Routes				
11. Manual Fire Alarm				
12. Smoke Detection and Alarm				
13. Automatic Sprinklers			÷ 2 =	
Total Value	S_1 =	S_2 =	S_3 =	S_4 =

WORKSHEET 4.7.8A MANDATORY SAFETY REQUIREMENTS — NEW HOSPITALS, EXISTING HOSPITALS, OR NEW NURSING HOMES

Zone Location	Containment (S_a)		Extinguishment (S_b)		People Movement (S_c)	
	New	Exist.	New	Exist.	New	Exist.
1st story	11	5	15(12)[a]	4	8(5)[a]	1
2nd or 3rd story[b]	15	9	17(14)[a]	6	10(7)[a]	3
4th story or higher but not high rise	18	9	19(16)[a]	6	11(8)[a]	3
High rise	18	17	19(16)[a]	16	11(8)[a]	7

[a] Use ( ) in zones that do not contain patient sleeping rooms.

[b] For a 2nd-story zone location in a *sprinklered* EXISTING hospital, as an alternative to the mandatory safety requirement values set specified in the table, the following mandatory values set shall be permitted to be used: S_a = 7, S_b = 10, and S_c = 7.

WORKSHEET 4.7.8B MANDATORY SAFETY REQUIREMENTS — EXISTING NURSING HOMES

Zone Location	Containment (S_a)	Extinguishment (S_b)	People Movement (S_c)
1st story	0	10	0
2nd story	2	10	2
3rd story	6	14	2
4th story or higher	8	16	2

WORKSHEET 4.7.8C MANDATORY SAFETY REQUIREMENTS — MAJOR REHABILITATION IN NONSPRINKLERED EXISTING HOSPITALS

Zone Location	Containment (S_a)	Extinguishment (S_b)	People Movement (S_c)
1st story	13	17(14)*	8(5)*
2nd or 3rd story	17	19(16)*	10(7)*
4th story or higher	18	19(16)*	11(8)*

*Use ( ) in zones that do not contain patient sleeping rooms.

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FIGURE 4.7 *Continued*

WORKSHEET 4.7.9 ZONE FIRE SAFETY EQUIVALENCY EVALUATION

						Yes	No
Containment Safety (S_1)	minus	Mandatory Containment (S_a)	≥	0	S_1 [ ] – S_a [ ] = C [ ]		
Extinguishment Safety (S_2)	minus	Mandatory Extinguishment (S_b)	≥	0	S_2 [ ] – S_b [ ] = E [ ]		
People Movement Safety (S_3)	minus	Mandatory People Movement (S_c)	≥	0	S_3 [ ] – S_c [ ] = P [ ]		
General Safety (S_4)	minus	Occupancy Risk (R)	≥	0	S_4 [ ] – R [ ] = G [ ]		

WORKSHEET 4.7.10 FACILITY FIRE SAFETY REQUIREMENTS WORKSHEET

Complete one copy of this worksheet for each facility.
For each consideration, select and mark the appropriate column.

		Met	Not Met	Not Applic.
A.	Building utilities conform to the requirements of Section 9.1.			X
B.	In new facilities only, life-support systems, alarms, emergency communication systems, and illumination of generator set locations are powered as prescribed by 18.5.1.2 and 18.5.1.3.			
C.	Heating and air conditioning systems conform with the air conditioning, heating, and ventilating systems requirements within Section 9.2, except for enclosure of vertical openings, which have been considered in Safety Parameter 7 of Worksheet 4.7.6.			X
D.	Fuel-burning space heaters and portable electrical space heaters are not used.			X
E.	There are no flue-fed incinerators.			
F.	An evacuation plan is provided and fire drills conducted in accordance with 18.7.1/18.7.2 and 19.7.1/19.7.2.			X
G.	Smoking regulations have been adopted and implemented in accordance with 18.7.4 and 19.7.4.			X
H.	Combustibility of draperies, upholstered furniture, mattresses, furnishings, and decorations is limited in accordance with 18.7.5 and 19.7.5.			
I.	Fire extinguishers are provided in accordance with the requirements of 18.3.5.12 and 19.3.5.12.			X
J.	Exit signs are provided in accordance with the requirements of 18.2.10.1 and 19.2.10.1.			
K.	Emergency lighting is provided in accordance with 18.2.9.1 or 19.2.9.1.			
L.	Standpipes are provided in all new high-rise buildings as required by 18.4.2.			

All references are to NFPA *101*, *Life Safety Code.*

WORKSHEET 4.7.11 CONCLUSIONS

1. ☐ All of the checks in Worksheet 4.7.9 are in the “Yes” column and all applicable considerations in Worksheet 4.7.10 are identified as “Met”. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for health care occupancies.

2. ☐ All of the checks in Worksheet 4.7.9 are in the “Yes” column and all considerations identified in Worksheet 4.7.10 as “Not Met” have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for health care occupancies.

3. ☐ One or more of the checks in Worksheet 4.7.9 are in the “No” column or any consideration identified in Worksheet 4.7.10 as “Not Met” has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for health care occupancies.

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FIGURE 4.7 ***Continued***

4.7.1 Step 1 — Complete the Cover Sheet Using Worksheet 4.7.1. See Figure 4.7.

4.7.2 Step 2 — Determine Occupancy Risk Parameter Factors Using Worksheet 4.7.2. For each risk parameter in Worksheet 4.7.2, select and circle the appropriate risk factor value. Choose only one value for each of the five risk parameters.

4.7.3 Step 3 — Compute Occupancy Risk Factor *F* Using Worksheet 4.7.3. The following steps should be taken:

(1) Transfer the circled risk factor values from Worksheet 4.7.2 to the corresponding blocks in Worksheet 4.7.3.
(2) Compute occupancy risk factor *F* by multiplying the risk factor values as indicated in Worksheet 4.7.3.

4.7.4 Step 4 — Compute Adjusted Occupancy Risk Factor *R* Using Worksheet 4.7.4 or Worksheet 4.7.5. The following steps should be taken:

(1) If building is classified as "new," use Worksheet 4.7.4. If building is classified as "existing," use Worksheet 4.7.5.
(2) Transfer the value of *F* from Worksheet 4.7.3 to Worksheet 4.7.4 or Worksheet 4.7.5, as appropriate. Calculate *R*.
(3) Transfer *R* to the block labeled *R* in Worksheet 4.7.9.

4.7.5 Step 5 — Determine Safety Parameter Values Using Worksheet 4.7.6. Select and circle the safety value for each safety parameter in Worksheet 4.7.6 that best describes the conditions in the zone. Choose only one value for each of the 13 parameters. If two or more values appear to apply, choose the one with the lowest point value.

4.7.6 Step 6 — Compute Individual Safety Evaluations Using Worksheet 4.7.7. The following steps should be taken:

(1) Transfer each of the 13 circled safety parameter values from Worksheet 4.7.6 to every available block in the line with the corresponding safety parameter in Worksheet 4.7.7. For Safety Parameter 13, the value entered in the "People Movement Safety" column is recorded in Worksheet 4.7.7 as one-half the corresponding value circled in Worksheet 4.7.6.
(2) Add each of the four columns, keeping in mind that any negative numbers need to be deducted.
(3) Transfer the resulting total values for S_1, S_2, S_3, and S_4 to the corresponding blocks in Worksheet 4.7.9.

4.7.7 Step 7 — Determine Mandatory Safety Requirements Values Using Worksheet 4.7.8A, 4.7.8B, or 4.7.8C as Appropriate. The following steps should be taken:

(1) Using the classification of the building (i.e., new or existing) and the story where the zone is located, circle the appropriate value in each of the three columns in Worksheet 4.7.8A, 4.7.8B, or 4.7.8C.
(2) Transfer the three circled values from Worksheet 4.7.8A, 4.7.8B, or 4.7.8C to the blocks marked S_a, S_b, and S_c in Worksheet 4.7.9.
(3) The mandatory safety requirements values for basements are based on the distance of the basement level from the closest level of discharge. *(See also 4.6.1.2 and 4.6.1.3.)*

4.7.8 Step 8 — Determine Zone Fire Safety Equivalency Using Worksheet 4.7.9. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 4.7.9. Enter the differences in the appropriate answer blocks.
(2) For each row, check "yes" if the value in the answer block is zero (0) or greater. Check "no" if the value in the answer block is a negative number.

4.7.9 Step 9 — Evaluate Other Considerations Not Previously Addressed Using Worksheet 4.7.10. The equivalency covered by Worksheets 4.7.2 through 4.7.9 includes the majority of the considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 4.7.10, Facility Fire Safety Requirements Worksheet. Complete one copy of this separate worksheet for each facility.

4.7.10 Step 10 — Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that prescribed by the *Life Safety Code* using Worksheet 4.7.11, Conclusions. Worksheet 4.7.11 combines the zone fire safety equivalency evaluation of Worksheet 4.7.9 and the additional considerations of Worksheet 4.7.10.

Chapter 5 Fire Safety Evaluation System for Detention and Correctional Occupancies

5.1 General.

5.1.1 This chapter is part of an NFPA guide and, therefore, is not mandatory. The term *shall* in this chapter is used to indicate that if the provisions of the chapter are applied, the procedures mandated are to be followed to ensure the effectiveness of the evaluation system.

5.1.2 The fire safety evaluation system is a measuring system. It compares the level of safety provided by an arrangement of safeguards that differ from those specified in NFPA *101* to the level of safety provided in a building that conforms exactly with the details of the *Code*.

5.2 Procedure for Determining Equivalency. Evaluate the entire facility using Figure 5.5, Worksheets for Evaluating Fire Safety in Detention and Correctional Occupancies (Worksheets 5.5.1 through 5.5.8), as defined in Sections 22.1 and 23.1 (NFPA *101*), on a single worksheet. Where different use conditions or fire protection features are involved, portions of the facility separated from each other by 2-hour or greater fire resistance–rated construction (including any members that bear the load of detention use, egress, or refuge space and with 1½-hour fire protection–rated doors in any communication opening) shall be permitted to be evaluated separately.

5.3 Maintenance. Any protection system, requirement, arrangement, or procedure that is not maintained in a dependable operating condition, is used in such a manner that the intended fire safety function or hazard constraint is impaired, or is not in a sufficient state of readiness should be considered defective and should receive no credit in the evaluation.

5.4 Safety Parameters (Worksheet 5.5.3). The safety parameters are a measure of those building factors that bear upon or contribute to the safety of those persons who might be in the building at the time of a fire. *(See Worksheet 5.5.3.)* Each of the safety parameters is to be analyzed, and the safety value for each parameter that best describes the condition in the building is to be identified. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value governs.

5.4.1 Construction. Construction types are defined by the fire resistance and combustibility of load-bearing framing members, floor construction, and roof construction in accordance with NFPA 220, which extracts material from *NFPA 5000*. *(See Table 5.4.1.)*

5.4.1.1 Where the facility includes additions or connected structures of different construction, the rating and classification of the structure shall be based on one of the following:

(1) Separate buildings where a 2-hour or greater fire resistance–rated separation exists between the portions of the building
(2) The lower safety parameter point score involved, where such a separation does not exist

5.4.1.2 The story used to determine the parameter value is the highest story used for confinement purposes. Story height is based on stories starting with the level of exit discharge. Where there are stories below the level of exit discharge, the maximum value assigned to the construction parameter shall be based on a two-story building or the actual story height, whichever is the lower value.

5.4.1.3 A multitiered open cell block in an existing building shall be permitted to be considered a single story, provided that one or more of the following conditions exist:

(1) A smoke control system is provided (*see recommended design criteria in A.23.3.1.3 of* NFPA *101*) to maintain the level of smoke filling from potential cell fires at least 5 ft (1525 mm) above the floor level of any occupied tier.
(2) A smoke control system as described in 5.4.1.3(1) is provided to maintain the level of smoke filling at least 5 ft (1525 mm) above the exit level where either of the following situations exist:
    (a) The cell block is Use Condition II.

Table 5.4.1 Fire Resistance Ratings for Type I Through Type V Construction (hours)

	Type I		Type II			Type III		Type IV	Type V	
	442	**332**	**222**	**111**	**000**	**211**	**200**	**2HH**	**111**	**000**
Exterior Bearing Walls[a]										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting one floor only	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting a roof only	4	3	1	1	0[b]	2	2	2	1	0[b]
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses, and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor/Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof/Ceiling Assemblies	2	1½	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls[c]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]

H: Heavy timber members *(see NFPA 5000 for requirements)*.
[a]See 7.3.2.1 of *NFPA 5000*.
[b]See Section 7.3 of *NFPA 5000*.
[c]See 7.2.3.2.12, 7.2.4.2.3, and 7.2.5.6.8 of *NFPA 5000*.
[**5000:** Table 7.2.1.1]

(b) The cell block is Use Condition III, and all persons housed in the cell block can pass through a free access smoke barrier or freely pass below the calculated smoke level with not more than 50 ft (15 m) of travel from their cell.

(3) Complete automatic sprinkler protection is provided.

5.4.2 Hazardous Areas.

5.4.2.1 The assignment of charges for hazardous areas is a four-step process.

5.4.2.1.1 Step 1 — Identify Hazardous Areas. Hazardous areas are defined in 22.3.2 and 23.3.2 (NFPA *101*).

5.4.2.1.2 Step 2 — Determine the Level of Hazard. A hazardous area is classed as severe if it is an area requiring both automatic sprinkler protection and fire-rated enclosure per 22.3.2.1 (and 22.3.5.2) or 23.3.2.1 (NFPA *101*).

5.4.2.1.3 Step 3 — Determine the Fire Protection Provided. The parameter value for hazardous areas is based on the presence or absence of the fire protection necessary to control or confine the hazard. Two levels of fire protection are considered. The first consists of automatic sprinklers or other appropriate extinguishing system covering the entire hazard. The second is based on fire resistance–rated enclosures, including any bearing members in the space, partitions separating the hazardous area from all other spaces, and doors to the space sufficient to exceed the potential of the fire load involved. Any hazardous space that has either protection system is classified as having single protection. Any hazardous space that is both fully enclosed in a capable fire resistance–rated enclosure and sprinklered is classified as having double-level protection. On this basis, any fuel load that has the potential to overwhelm the available structural capability of both its own enclosure and the basic structure could, as a maximum, have single protection.

5.4.2.1.4 Step 4 — Determine the Degree of Deficiency and Assign Parameter Values. The parameter value ultimately is determined by the degree of the deficiencies of the hazardous area based on the level of protection needed.

5.4.2.2 Table 5.4.2.2 provides a matrix to be used to determine the degree of deficiency for this parameter. In some situations, more than one hazardous area with the same or differing levels of deficiency can exist. In this case, the choice is based on the single most serious deficiency for the hazardous area.

5.4.3 Fire Alarm. Fire alarms are defined in 5.4.3.1 through 5.4.3.3.

5.4.3.1 No Alarm. There is no fire alarm system, or the system is incomplete and does not meet the requirements for a higher-scored category.

5.4.3.2 Without Fire Department Notification (W/O F.D. Notification). There is a manual fire alarm system or smoke detection system conforming with the appropriate requirements of 22.3.4 or 23.3.4 (NFPA *101*), except that the requirements of 22.3.4.3.2 or 23.3.4.3.2 covering automatic transmission of the alarm to the fire department are not met.

5.4.3.3 With Fire Department Notification (W/ F.D. Notification). There is a manual fire alarm or smoke detection system conforming with the appropriate requirements of 22.3.4 or 23.3.4 (NFPA *101*).

5.4.3.3.1 Without Manual Alarm. There is no manual alarm system, but a smoke detection alarm system or sprinkler system recognized under Safety Parameter 4 or Safety Parameter 5 of this system is provided and is arranged to transmit an alarm automatically to the fire department under either of the following conditions:

(1) Fire resistance and structural strength exceed maximum potential of hazard.
(2) Fire resistance or structural strength is not sufficient to withstand potential of hazard.

5.4.3.3.2 With Manual Alarm. There is a manual alarm system, and it is arranged to transmit an alarm automatically to the fire department.

5.4.4 Smoke Detection.

5.4.4.1 General. A detection system as used herein is one based on the use of smoke detectors meeting the installation requirements of 22.3.4.4 and 23.3.4.4 (NFPA *101*) and *NFPA 72* with the extent of coverage as defined in 5.4.4.2. No credit is given for thermal detectors in habitable spaces.

5.4.4.2 The detection system categories are described in 5.4.4.2.1 through 5.4.4.2.5.

5.4.4.2.1 None. There are no smoke detectors, or, if present, they do not meet the requirements for a higher-scored category.

5.4.4.2.2 Corridors, Common Spaces, and Sleeping Rooms for More Than Four Persons. Smoke detection requirements of such spaces located within the residential housing area are covered by smoke detector installations in accordance with *NFPA 72*. In Use Condition II dormitory rooms in sprinklered buildings where staff is present whenever the dormitory room is occupied, detectors may be omitted from the dormitory room but not from the corridors and common spaces.

5.4.4.2.3 All Sleeping Rooms. Smoke detectors shall be considered as meeting the requirement when there is at least one smoke detector in each sleeping room occupied or used by prisoners. In rooms having a dimension in excess of 30 ft

Table 5.4.2.2 Hazardous Areas — Degree of Deficiency

	No protection	Sprinkler protection	Fire resistance–rated enclosure	Sprinklered and fire resistance–rated enclosure
Hazardous area	Single deficiency	No deficiency		
Severely hazardous area	Double deficiency	Single deficiency	Single deficiency* Double deficiency†	No deficiency* Single deficiency†

*If fire resistance and structural strength exceed maximum potential of hazard.
†If fire resistance and structural strength are not sufficient to withstand potential of hazard.

(9.1 m), additional detectors are provided so that detector spacing does not exceed approximately 30 ft (9.1 m). Detectors are not required in restrooms or closets.

5.4.4.2.4 Full Coverage. The requirements of 5.4.4.2.2 and 5.4.4.2.3 are met.

5.4.4.2.5 Total Building. Total building detector credit requires conformance with the requirements of *NFPA 72* for total coverage.

5.4.5 Automatic Sprinklers.

5.4.5.1 General. In evaluating sprinkler protection, the protection or lack of protection of hazardous areas is considered separately and covered under 5.4.2, except that total building protection shall include hazardous areas. In addition, the existence or lack of fire department notification is considered separately under 5.4.3. In all other situations, any sprinkler installations shall conform to 22.3.5 and 23.3.5 (NFPA *101*) and be graded based on the categories specified in 5.4.5.1.1 through 5.4.5.1.3.

5.4.5.1.1 None. No credit is given if there are no sprinklers or if sprinklers, though present, are not sufficient to qualify for one of the other categories specified.

5.4.5.1.2 Residential Housing Areas. The credit for sprinkler protection of residential housing areas is given for arrangements whereby sprinklers are located throughout the areas, such that all space within such areas (including cells or sleeping rooms) is covered by the protection spray pattern of sprinkler heads.

5.4.5.1.3 Entire Building. The building is totally sprinkler protected in accordance with NFPA 13 for light hazard occupancy (or higher hazard occupancy for any spaces classified as higher hazard by NFPA 13).

5.4.6 Interior Finish.

5.4.6.1 Classification of interior wall and ceiling finish materials is in accordance with Section 10.2 (NFPA *101*).

5.4.6.2 No consideration is included in the safety parameter value for any finish with a flame-spread index greater than 200 as tested by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials.* Some materials, including foamed plastics, high density polyethylene, and polypropylene, are not permitted to be tested in accordance with ASTM E84 and must be tested in accordance with NFPA 286 and must meet the acceptance criteria shown in 10.2 (NFPA *101*). Some materials, including asphalt-impregnated paper, are capable of inducing extreme rates of fire growth and rapid flashover. In any case involving these materials, the resultant risk is considered to classify any such finish area as a hazardous area to be evaluated under 5.4.2. Note that plywood of ¼ in. (6 mm) or greater thickness should be considered as having a flame-spread index of 200 or less. Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286 as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

5.4.7 Reserved.

5.4.8 Cell/Sleeping Room Enclosure.

5.4.8.1 The parameter value categories for cell or sleeping room enclosures are divided between those for cells or sleeping rooms that face directly onto a corridor and those for which there is an intervening common space (i.e., day room, group activity space, or other space between the sleeping room and the corridor access).

5.4.8.2 Open. The cell or sleeping room enclosure includes an opening in excess of 0.85 ft^2 (0.08 m^2). In Use Condition V, the closure shall be considered "open" if there are any openings exceeding the minimum necessary for door swing and latch, unless either of the following conditions exists:

(1) The affected cells meet the requirements for mechanically assisted smoke control in 5.4.13.3.
(2) There is a closure for such openings operable from inside the cell.

5.4.8.3 Smoke Resistant <1 Hour. An enclosure qualifies in this category if the walls are complete from slab to slab or to a continuous smoke-resistant ceiling, and if doors are complete, but some wall aspect (wall, ceiling, etc.) is less than 1-hour fire resistance–rated, or the door is not capable of resisting fire for at least 20 minutes.

5.4.8.4 One-Hour Fire Resistance–Rated or Greater (≥1-Hour Fire Resistance). An enclosure qualifies in this category if it meets all of the requirements of 5.4.8.3, all wall aspects have at least a 1-hour fire resistance rating, and the door is capable of resisting fire for at least 20 minutes.

5.4.9 Separation of Residential Housing Areas from Other Areas. A residential housing area includes sleeping areas and any contiguous day room, group activity space, or other common space.

5.4.9.1 The parameter value categories for separation of residential housing areas are based on the quality of the common walls, separating partitions, and doors between residential housing areas and the rest of the building. The parameter value is based on the residential housing area that has the lowest quality separation. Where a building contains more than one residential housing area, the separation of residential housing areas from each other also is to be considered equivalent to the separation of a residential housing area from some other type of space. In buildings entirely composed of a single residential housing area, the separation is considered to be fire resistant if there is at least a 30 ft (9.1 m) separation from other structures and smoke resistant if there is a separation of less than 30 ft (9.1 m).

5.4.9.2 Classification of internal separations is based on the criteria in 5.4.9.2.1 through 5.4.9.2.3.

5.4.9.2.1 Incomplete. Any separation that does not meet the criteria for 5.4.9.2.2 or 5.4.9.2.3 is incomplete.

5.4.9.2.2 Smoke-Resistant Less Than 1 Hour. An enclosure qualifies in this category if the walls are complete from slab to slab or to a continuous smoke-resistant ceiling, and if doors are complete, but some wall aspect (wall, ceiling, etc.) is less than 1-hour fire resistance–rated or the door is not capable of resisting fire for at least 20 minutes.

5.4.9.2.3 One-Hour Fire Resistance or Greater (≥1-Hour Fire Resistance). An enclosure qualifies in this category if it meets all of the requirements of 5.4.9.2.2, all wall aspects have at least a 1-hour fire resistance rating, and the door is capable of resisting fire for at least 20 minutes.

5.4.10 Exit System.

5.4.10.1 General. Exit routes are the paths of travel from the residential housing area to outside of any of the types and arrangements described in Chapter 7 (NFPA *101*). The exit route starts at the corridor interface with the cell or common space as indicated by 5.4.8.

5.4.10.2 Multiple Routes. Multiple routes exist where the occupants of any residential housing area have, either from the residential housing area or through access in a corridor adjacent to the residential housing area, a choice of two separate exit routes in accordance with 22.2.4 or 23.2.4 (NFPA *101*) to the outside of the types specified in 22.2.2 and 23.2.2 (NFPA *101*).

5.4.10.3 Deficient. An exit route is deficient if it is usable with reasonable safety but fails to meet any of the applicable criteria in Chapter 7 (NFPA *101*).

5.4.10.4 Direct Room Exits. To be credited with direct room exits, each cell or other sleeping room must have a door that opens to the exterior at grade or to an unenclosed exterior balcony with direct access to an exterior exit or smokeproof enclosure. The locking of such a door must be no more restrictive than that required for the least restrictive exit or smoke barrier door for the use condition involved. In large rooms, the maximum travel distance from any occupiable location to a direct room exit must not exceed 50 ft (15 m). Where the separation of the individual sleeping rooms from other spaces and from each other is smoke resistant, the credit for direct room exits is applicable even if there are no other exit routes from the involved sleeping rooms.

5.4.10.5 No exit shall be considered in this parameter unless the locking arrangement conforms with the criteria for the use condition being applied to the facility.

5.4.11 Exit Access.

5.4.11.1 Exit access is the travel distance from any point in a room to an exit (or to a smoke barrier in an existing building). In addition, any exit arrangement that does not conform with 22.2.6.2 (NFPA *101*) for new buildings or with 23.2.6.2 (NFPA *101*) for existing buildings shall receive a parameter value no higher than the score for egress travel [i.e., >150 ft (>45 m) and ≤200 ft (≤61 m)].

5.4.11.2 The penalty for dead-end access shall be assessed where any corridor affords access in only one direction to a required exit from that corridor. The calculation of the distance to determine the parameter value is the measurement from the centerline of the doorway exiting to the corridor to the doorway of the exit from the corridor or building, whichever is shorter. Exit travel is the distance from the door to the corridor to the point where the building is exited or a stairwell is entered, whichever is shorter. Where the distance to the stairwell is the shorter distance, that distance shall be based on the distance to the door enclosing the stairwell if the stairwell is enclosed, or to the top tread if the stairwell is open.

5.4.12 Vertical Openings.

5.4.12.1 General. These values apply to vertical openings and penetrations, including exit stairways, ramps, and any other vertical exits, pipe shafts, ventilation shafts, duct penetrations, and laundry and incinerator chutes. The charge for vertical openings shall be based on the presence or lack of enclosure and the fire resistance rating of the enclosure, if provided.

5.4.12.2 Open or Incomplete. A vertical opening or penetration shall be classified as an open or incomplete enclosure if it has any of the following characteristics:

(1) It is unenclosed.
(2) It is enclosed but does not have doors.
(3) It is enclosed but has openings other than doorways.
(4) It is enclosed with cloth, paper, or similar materials without any sustained firestopping capabilities.

5.4.12.2.1 If a shaft other than a credited exit route (i.e., credited as one of the multiple routes required in 5.4.10 or in determining travel distance in 5.4.11) is enclosed on all stories but one, and this results in an unprotected opening between that shaft and one, and only one, story, the parameter value assigned to that shaft shall be 0. If a required egress route is contained in that shaft, the parameter value shall be −2.

5.4.12.2.2 If vertical firestopping is incomplete, the vertical opening shall be evaluated using the criteria of 5.4.12.2 and 5.4.12.2.1.

5.4.12.3 Communicating Stories. Communicating stories shall be permitted without enclosure protection between levels, provided they meet the requirements of 22.3.1 or 23.3.1 (NFPA *101*), as appropriate.

5.4.12.4 Open Tiered Cells. The *open or incomplete enclosures* category does not apply to open, multitiered cell blocks in existing buildings classified as single-story buildings in accordance with 5.4.1.

5.4.12.5 Smoke Resistant. A complete enclosure is provided and is capable of resisting the passage of smoke but does not meet the fire resistance requirements of 8.6.5 (NFPA *101*). Unprotected vertical openings in accordance with 22.3.1(2) and 23.3.1.1(2) (NFPA *101*) shall be considered to be smoke resistant.

5.4.12.6 Fire Resistant. A smoke-resistant enclosure is provided that also meets the fire resistance requirements of 8.6.5 (NFPA *101*). Atriums in accordance with 8.6.7 (NFPA *101*) shall be considered to be fire resistant.

5.4.13 Smoke Control. Smoke control definitions are provided in 5.4.13.1 through 5.4.13.4.

5.4.13.1 No Control. Smoke barriers (or horizontal exits) are nonexistent on the story or are not accessible to those confined.

5.4.13.2 Smoke Compartment — Passive. Credit for smoke barriers is given to any facility meeting the requirements of 22.3.7 or 23.3.7 (NFPA *101*), as appropriate.

5.4.13.3 Smoke Compartment — Mechanically Assisted. Mechanically assisted smoke control on a compartment basis must include a smoke barrier (or a horizontal exit) supported by a mechanism of automatic control fans, smoke vent shafts, or a combination thereof to provide a pressure differential that assists in confining smoke to the compartment of origin. Fans involved shall be permitted to be special smoke control fans or special adjustments of the normal building air movement fans.

5.4.13.4 Heat and Smoke Vent System. A heat and smoke vent system is a tested and accepted system that handles smoke in order to maintain the level of smoke above head height in the residential housing area. Methods of judging the acceptability of the system are contained in NFPA 92 and NFPA *101*, A. 23.3.1.3. Additional credit for this system shall be given if the operation of the exhaust system is initiated automatically by smoke detection available in the zone.

5.5 Worksheets for Evaluating Fire Safety. The worksheets for evaluating fire safety zones use an eight-step process found in Figure 5.5.

5.5.1 Step 1 — Complete the Cover Sheet Using Worksheet 5.5.1. See Figure 5.5.

5.5.2 Step 2 — Determine the Most Restrictive Use Condition in the Facility Using Worksheet 5.5.2. See Figure 5.5.

5.5.3 Step 3 — Determine Safety Parameter Values Using Worksheet 5.5.3. Select and circle the safety value for each safety parameter that best describes the conditions in the zone. Choose only one value for each of the 13 safety parameters. If two or more values appear to apply, choose the one with the lowest point value.

5.5.4 Step 4 — Compute Individual Safety Evaluations Using Worksheet 5.5.4. The following steps should be taken:

(1) Transfer each of the 13 circled safety parameter values from Worksheet 5.5.3 to every available block in the line with the corresponding parameter title in Worksheet 5.5.4. Where the block is marked "÷ 2 =," enter one-half the value from Worksheet 5.5.3.
(2) Add each of the four columns, keeping in mind that any negative numbers need to be deducted.
(3) Transfer the resulting values for S_1, S_2, S_3, and S_4 to the corresponding blocks in Worksheet 5.5.6.

5.5.5 Step 5 — Determine Mandatory Safety Requirements Using Worksheet 5.5.5A, 5.5.5B, or 5.5.5C as Appropriate. The following steps should be taken:

(1) Select the proper row in Worksheet 5.5.5A, Worksheet 5.5.5B, or Worksheet 5.5.5C. For high-rise buildings, use Worksheet 5.5.5B. Circle the appropriate values.
(2) Transfer the circled values from Worksheet 5.5.5A, Worksheet 5.5.5B, or Worksheet 5.5.5C to the blocks marked S_a, S_b, S_c, and S_d in Worksheet 5.5.6.

5.5.6 Step 6 — Compute the Fire Safety Equivalency Evaluation Using Worksheet 5.5.6. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 5.5.6. Enter the differences in the appropriate answer blocks.
(2) For each row, check "yes" if the value in the answer block is zero (0) or greater. Check "no" if the value in the answer block is a negative number.

5.5.7 Step 7 — Evaluate Other Considerations Not Previously Addressed Using Worksheet 5.5.7. The equivalency covered by Worksheets 5.5.3 through 5.5.6 includes the majority of the considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 5.5.7, the Facility Fire Safety Requirements Worksheet. Complete one copy of this separate worksheet for each facility.

5.5.8 Step 8 — Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that prescribed by the *Life Safety Code* using Worksheet 5.5.8, Conclusions. Worksheet 5.5.8 combines the zone fire safety equivalency evaluation of Worksheet 5.5.6 and the additional considerations of Worksheet 5.5.7.

Chapter 6 Evacuation Capability Determination for Board and Care Occupancies

6.1 General.

6.1.1 This chapter is part of an NFPA guide and, therefore, is not mandatory. The term *shall* in this chapter is used to indicate that if the provisions of the chapter are applied, the procedures mandated are to be followed to ensure the effectiveness of the system. For ease of reading, only the masculine pronoun is used; however, the contents of this chapter apply equally to females and males.

6.1.2 Chapter 33 (NFPA *101*) specifies three sets of requirements for an existing facility based on its evacuation capability. The three levels of evacuation capability defined are *prompt*, *slow*, and *impractical*.

6.1.3 The evacuation capability shall be determined for the residents of a given facility who are living as a group and are provided with staff assistance prior to application of the fire protection requirements. This chapter describes one method for determining evacuation capability.

6.1.4 The evacuation capability for specific facilities, with residents living as a group with staff assistance, is determined by a mathematical method that includes the following:

(1) Determining the evacuation assistance scores of the individual residents
(2) Computing a relative level of evacuation difficulty faced by the resident of a specific facility based on the response capabilities of the staff
(3) Adjusting for vertical egress travel
(4) Calculating an evacuation capability score

6.1.5 Chapter 33 (NFPA *101*) defines the three evacuation capability levels in terms of residents' performance in a timely response to an emergency evacuation with assistance from staff members or other residents. Utilization of this chapter provides a numerical score that can be translated into one of the three levels of evacuation capability.

6.1.6 The evacuation capability shall be permitted to be used with either Chapter 7 of this guide or Chapter 33 (NFPA *101*).

6.2 Procedure for Determining Evacuation Capability.

6.2.1 Methodology. Evacuation capability shall be determined via the worksheets included in Figure 6.8.

6.2.2 Evacuation Capability by Zones.

6.2.2.1 Small facilities (those with no more than 16 residents) shall have their evacuation capability scores based on all the residents and the available staff measured in accordance with the criteria for evaluating residents and staff in this chapter.

6.2.2.2 Large facilities (those with more than 16 residents) shall be permitted to have their evacuation capability score calculated on the basis of the entire building, as with small facilities, or on the basis of separate fire or smoke zones. The

WORKSHEET 5.5.1 COVER SHEET

Fire Safety Evaluation Worksheet for Detention and Correctional Occupancies

Building Identification ______________________________

Evaluator ______________________________ Date ______________________________

Complete one worksheet for each building evaluated.

WORKSHEET 5.5.2 USE CONDITION

_______ Use Condition II — Zoned Egress

_______ Use Condition III — Zoned Impeded Egress

_______ Use Condition IV — Impeded Egress

_______ Use Condition V — Contained

NOTE: If Use Condition III or Use Condition IV is involved, staff location, remote release locks, or fire detection, or any combination of these, must be sufficient to ensure the prompt release required by the use condition checked.

WORKSHEET 5.5.3 SAFETY PARAMETER VALUES

Safety Parameters / **Parameter Values**

1. Construction	V(000)	V(111)	IV(2HH)	III(200)	III(211)	II(000)	II(111)	II(222) or I (ANY)
1 story	−2	0	0	−2	0	0	2	2
2 story	−2	0	0	−2	0	−2	2	2
3 story	−8(−2)[a]	−2(0)[a]	−2(0)[a]	−8(−2)[a]	0	−5(−2)[a]	2	2
≥4 stories	−10(−2)[a]	−4(0)[a]	−4(0)[a]	−10(−2)[a]	−2(0)[a]	−8(−2)[a]	0	2

2. Hazardous Areas	Within Res. Housing Area		Outside Res. Housing Area		None or No Deficiencies
	Double Deficiency	Single Deficiency	Double Deficiency	Single Deficiency	
	−7	−4	−4(−7)[b]	0	0

3. Fire Alarm	No Alarm	W/O F.D. Notification	W/ F.D. Notification	
			W/O Man. Alarm	W/ Man. Alarm
	−1	0	1	2

4. Smoke Detection	None	Residential Housing Area			Total Bldg.
		Partial Coverage		Full Coverage	
		Corr. + Comm. Spa. + Lrg. Sleeping Rms.	All Sleeping Rms.		
	−4(−1)[a]	0	2	4	5

5. Automatic Sprinklers	None	Residential Housing Areas	Entire Building
	0	8	10

6. Interior Finish (Corrs. and Egress)	Class C	Class B	Class A
	−3	−1	0

7. Interior Finish (Other Areas)	Class C	Class B	Class A
	−2	−1	0

8. Cell/Sleeping Room Enclosure	Cells (Rooms) Face on Corridor (Each Cell is a Separate Residential Housing Area)	Intervening Common Space Within Resid. Housing Area		
		Open	Smoke Resistant <1 Hour	≥1-Hour Fire Resistance–Rated
	0	−3(−5)[c] (0)[d]	0(−2)[c]	2(0)[c]

(Worksheet 5.5.3 continues.)

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FIGURE 5.5 Worksheets for Evaluating Fire Safety in Detention and Correctional Occupancies.

Worksheet 5.5.3 ***Continued***

9. Separation of Resid. Housing Areas from Other Areas	Incomplete		Smoke Resistant <1 Hour	≥1-Hour Fire Resistance–Rated
	Parameter 5 Value <10	Parameter 5 Value = 10		
	−6	2	2(4)[h]	4(2)[b]

10. Exit System	<2 Routes	Multiple Routes		Direct Room Exits
		Deficient	No Deficiencies	
	−6	−2	0	3

11. Exit Access	Dead Ends		No Dead Ends >50 ft and Travel Is[i]		
	>100 ft	>50 ft[i]	>200 ft	≤200 ft >150 ft	≤150 ft
	−2(0)[g]	−1(0)[g]	−2(0)[g]	−1(0)[g]	0

12. Vertical Openings	Open or Incomplete Enclosures			Enclosed[e]	
	Thru ≥4 Stories	2–3 Stories	1 Story	Smoke Resistant	Fire Resistant
	−10(0)[f]	−7(0)[f]	−2(0)[f]	0	2

13. Smoke Control	No Control	Smoke Compartments		Heat + Smoke Vent System
		Passive	Mechanically Assisted	
	−2	2	3	8

[a] Use ( ) if Parameter 5 is 10.
[b] Use ( ) if Parameter 1 is based on II(000), III(200), or V(000) construction and Parameter 5 is 0.
[c] Use ( ) for Use Condition V, new construction, where Parameter 5 is 0.
[d] Use ( ):
– For Use Condition II.
– For Use Condition III if intervening space is ≤50 ft.
– For Use Condition IV if Parameter 5 is ≥8 and intervening space is <50 ft.
For existing buildings if either:
– Parameter 13 = 8, or
– Parameter 5 is ≥8 and Parameter 4 is ≥0.
[e] Use 0 in 1-story buildings.
[f] Use ( ) if Parameter 13 is 8.
[g] Use ( ) if Parameter 10 is –6.
[h] Use ( ) for Use Conditions II, III, and IV, new construction, if cells are facing access corridor.
[i] Use 20 ft for Use Condition V.

For SI units, 1 ft = 0.3048 m; 1 ft² = 0.092 m².

WORKSHEET 5.5.4 INDIVIDUAL SAFETY EVALUATIONS

Safety Parameters	Fire Control Provided (S_1)	Egress Provided (S_2)	Refuge Provided (S_3)	General Fire Safety Provided (S_4)
1. Construction				
2. Hazardous Areas		÷ 2 =		
3. Fire Alarm	÷ 2 =			
4. Smoke Detection	÷ 2 =			
5. Automatic Sprinklers		÷ 2 =	÷ 2 =	
6. Interior Finish (Corrs. and Egress)				
7. Interior Finish (Other Areas)	÷ 2 =			
8. Cell/Sleeping Room Enclosure				
9. Separation of Residential Housing Areas from Other Areas		÷ 2 =		
10. Exit System			÷ 2 =	
11. Exit Access				
12. Vertical Openings	÷ 2 =			
13. Smoke Control				
Total	S_1 =	S_2 =	S_3 =	S_4 =

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FIGURE 5.5 ***Continued***

WORKSHEET 5.5.5A MANDATORY SAFETY REQUIREMENTS FOR PARTIALLY SPRINKLERED OR NONSPRINKLERED EXISTING BUILDINGS OTHER THAN HIGH RISE

Use Condition	Stories in Height	Fire Control (S_a)	Egress (S_b)	Refuge (S_c)	General (S_d)
II + III	1 Story 2 Stories ≥3 Stories	0 3 5	4 6 6	2 6 8	1 5 7
IV	1 Story 2 Stories ≥3 Stories	2 5 7	8 10 10	2 6 8	5 9 11
V	1 Story 2 Stories ≥3 Stories	6 9 9	9 11 11	6 10 10	9 13 13

WORKSHEET TABLE 5.5.5B MANDATORY SAFETY REQUIREMENTS FOR NEW BUILDINGS, TOTALLY SPRINKLERED BUILDINGS, AND HIGH-RISE BUILDINGS

		Fire Control (S_a)		Egress (S_b)		Refuge (S_c)		General (S_d)	
Use Condition	Stories in Height	New	Exist.	New	Exist.	New	Exist.	New	Exist.
II, III, IV	1 and 2 Stories ≥3 Stories	2 7	2 2	4 6	2 2	–1 5	–1 –1	2 8	0 0
V	1 and 2 Stories ≥3 Stories	10 15	10 10	7 9	6 6	7 13	7 7	9 15	8 8

WORKSHEET 5.5.5C MANDATORY SAFETY REQUIREMENTS — MODERNIZATIONS OR RENOVATIONS IN NONSPRINKLERED EXISTING BUILDINGS OTHER THAN HIGH RISE

Use Condition	Stories in Height	Fire Control (S_a)	Egress (S_b)	Refuge (S_c)	General (S_d)
II + III	1 Story 2 Stories ≥3 Stories	4 5 7	6 8 8	6 8 10	6 8 10
IV	1 Story 2 Stories ≥3 Stories	6 7 9	10 12 12	6 8 10	10 12 14
V	1 Story 2 Stories ≥3 Stories	8 9 9	10 12 12	8 10 10	12 14 14

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 3 of 4)

FIGURE 5.5 *Continued*

WORKSHEET 5.5.6 FIRE SAFETY EQUIVALENCY EVALUATION

						Yes	No
Control Provided (S_1)	minus	Required Control (S_a)	≥	0	S_1 [ ] − S_a [ ] = C [ ]		
Egress Provided (S_2)	minus	Required Egress (S_b)	≥	0	S_2 [ ] − S_b [ ] = E [ ]		
Refuge Provided (S_3)	minus	Required Refuge (S_c)	≥	0	S_3 [ ] − S_c [ ] = R [ ]		
General Fire Safety (S_4)	minus	Required Gen. Fire Safety (S_d)	≥	0	S_4 [ ] − S_d [ ] = G [ ]		

WORKSHEET 5.5.7 FACILITY FIRE SAFETY REQUIREMENTS WORKSHEET

		Yes	No
1.	Utilities and building services conform to the requirements of Sections 22.5 and 23.5, except for enclosure of vertical openings, which have been considered in Safety Parameter 12 of Worksheet 5.5.3.		
2.	24-hour staffing is provided as required by 22.7.1 and 23.7.1.		
3.	Combustibility of furnishing, upholstered furniture, mattresses, and decorations is limited in accordance with 22.7.4 and 23.7.4.		
4.	Portable fire extinguishers are provided at least at staff locations.		
5.	Standpipes are provided in all buildings over two stories in height as required by 22.3.5.5, 22.4.3, or 23.3.5.5.		
6.	If Use Condition III or Use Condition IV is involved, the combination of staff location, remote release locks, and fire detection is sufficient to ensure the prompt release required by those use conditions.		

All references are to NFPA *101*, *Life Safety Code.*

WORKSHEET 5.5.8 CONCLUSIONS

1. ☐ All of the checks in Worksheet 5.5.6 are in the "Yes" column and all applicable considerations in Worksheet 5.5.7 are identified as "Met". The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for detention and correctional occupancies.

2. ☐ All of the checks in Worksheet 5.5.6 are in the "Yes" column and all considerations identified in Worksheet 5.5.7 as "Not Met" have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for detention and correctional occupancies.

3. ☐ One or more of the checks in Worksheet 5.5.6 are in the "No" column or any consideration identified in Worksheet 5.5.7 as "Not Met" has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for detention and correctional occupancies.

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FIGURE 5.5 ***Continued***

procedure providing the better (i.e., lower) evacuation capability score shall be permitted to be used. A fire or smoke zone is a portion of the building separated from all other portions of the building by one of the following:

(1) Construction having at least 1-hour fire resistance
(2) A smoke barrier conforming to the requirements of Section 8.5 (NFPA *101*), with the smoke barriers constructed with at least a ½-hour fire resistance rating
(3) In buildings protected throughout with an automatic sprinkler system, construction that is sound and smoke-resistant

6.2.3 If a building is zoned, each zone shall be evaluated separately. The evacuation capability score is based on the residents of that zone and the staff available to that zone in accordance with the staff rating criteria in this chapter.

6.2.4 Where using zones, a separate evacuation capability score shall be determined for zones that include common use spaces where the residents of more than one zone congregate for meals, recreation, or other purposes. In such cases, adjust the resident evacuation assistance scores as appropriate to reflect the different needs that residents might have under such conditions.

6.3 Rating Residents.

6.3.1 Worksheets 6.8.1 through 6.8.4 of Figure 6.8 are used for rating individual residents and also for recordkeeping purposes.

6.3.2 This method of determining evacuation capability has been designed to minimize speculation about how a resident might perform in an actual fire emergency by using ratings based on observed performance. Instead of speculating, raters who are not familiar enough with a resident to provide ratings confidently should consult with an individual who has observed the resident on a daily basis.

6.3.3 Due to the stress of an actual fire emergency, it is likely that some residents will not perform at full capacity. Therefore, ratings based on commonly observed examples of poor performance provide the best readily available indication of behavior that could be reduced by the unusually stressful conditions of an actual fire. All persons are less capable on some occasions, and the ratings should be based on examples of resident performance on a typical "bad" day. Ratings should not be based on rare instances of poor performance.

6.4 Rating Residents Using Worksheets 6.8.1 through 6.8.4.

6.4.1 Risk of Resistance (Line I of Worksheet 6.8.2).

6.4.1.1 General.

6.4.1.1.1 Line I rates the risk that the resident might resist leaving the facility during an emergency evacuation. Unless there is specific evidence that resistance might occur, the resident should be rated as "minimal risk." If more than one rating applies, use the rating with the highest numerical score.

6.4.1.1.2 Specific evidence of resistance means that staff have had to use some physical force in the past. However, an episode of resistance should not be counted if it was the result of a situation that was different enough from an actual fire emergency that it probably does not predict behavior in such an emergency. For example, an incident in which a resident refuses to visit with parents probably does not predict behavior in an actual fire emergency and should not be counted as specific evidence. Resistance can be active (the resident might have struck a staff member or attempted to run away) or passive (the resident might have "gone limp" or hidden from staff members). Simply complaining or arguing is not considered resistance.

6.4.1.2 Minimal Risk. This rating indicates that there is no specific evidence to suggest that the resident might resist an evacuation.

6.4.1.3 Risk of Mild Resistance. This rating indicates that there is specific evidence that the resident might resist leaving the facility. Examples of specific evidence are as follows:

(1) The resident has mildly resisted instructions from staff. Further, the resistance was brief or easily overcome by one staff member and occurred in a situation similar enough to a fire emergency to predict that the behavior could recur during an actual fire emergency.
(2) The resident has hidden from the staff in a situation similar enough to a fire emergency to predict that the behavior could recur during an actual fire emergency. However, once found, the resident offered no further resistance.

6.4.1.4 Risk of Strong Resistance. The resident might offer resistance that necessitates the full attention of one or more staff members. Examples of specific evidence of such risk include the following:

(1) The resident has struggled vigorously in a situation similar enough to a fire emergency to predict that the behavior could recur during an actual fire emergency.
(2) The resident has totally refused to cooperate in a situation that is similar enough to a fire emergency to predict that the behavior could recur during an actual fire emergency.
(3) The resident has hidden in a situation that is similar enough to a fire emergency to predict that the behavior could recur during an actual fire emergency. Moreover, once found, the resident continued to offer resistance.

6.4.2 Impaired Mobility (Line II of Worksheet 6.8.2).

6.4.2.1 General.

6.4.2.1.1 Line II rates the physical ability of the resident to leave the facility. This rating should reflect the current physical environment in the building where the resident lives and should be based on the resident's lying awake on his bed. The resident is rated according to how easily he can leave, given the presence of factors such as physical barriers that hinder movement (e.g., stairs), his ability to get out of bed, or the chairs normally used. The resident should be given credit for being able to use devices that aid movement (e.g., wheelchairs, walkers, crutches, and leg braces). However, the rater shall be permitted to give credit for such devices only if the devices are always available for an emergency evacuation.

6.4.2.1.2 The resident should be rated on his ability to use the most accessible route out of the facility. For example, a resident who is "self-starting" when using the back door but who "needs limited assistance" to get out the front door would be rated as "self-starting."

6.4.2.1.3 The resident should be rated for performance while under the influence of any routinely administered medication that slows movement.

6.4.2.1.4 Where the resident needs physical assistance to make a timely evacuation, the rating of assistance needed is based on the degree of strength used by the staff member to assist the resident. Guiding or directing the resident by giving gentle pushes or leading by the hand is not considered physical assistance. If more than one rating applies, use the rating with the highest numerical score.

6.4.2.2 Self-Starting. The resident is physically able to start and complete an evacuation without physical assistance.

6.4.2.3 Slow. The resident prepares to leave and travels to the exit (or an area of refuge) at a speed significantly slower than normal. Specifically, the resident is rated "slow" if not able to prepare to leave and then travel from his sleeping room to the exit (or area of refuge) within 90 seconds.

6.4.2.4 Needs Limited Assistance. The resident might need some initial or brief intermittent assistance but can accomplish most of the evacuation without assistance. An example of specific evidence of such mobility is that the resident is physically able to start and complete an evacuation, except that the resident needs help to accomplish the following:

(1) Get into a wheelchair
(2) Descend stairs
(3) Get out of bed
(4) Open a door

6.4.2.5 Needs Full Assistance or Very Slow. The resident "needs full assistance" or is "very slow" as defined in 6.4.2.5.1 and 6.4.2.5.2.

6.4.2.5.1 Needs Full Assistance. The resident either needs physical assistance from a staff member during most of the evacuation or must be assisted by staff in one of the following ways:

(1) Carried from the facility
(2) Helped into a wheelchair and wheeled out of the facility
(3) Helped into leg braces and to descend the stairs

6.4.2.5.2 Very Slow. The resident is very slow if the time necessary to prepare to leave and then travel from his sleeping room to the exit is so long that the staff usually assists the resident to evacuate. Specifically, the resident is rated very slow if unable to prepare to leave and then travel to the exit (or area of refuge) within 150 seconds.

6.4.3 Impaired Consciousness (Line III of Worksheet 6.8.2).

6.4.3.1 General.

6.4.3.1.1 Line III rates the risk that a resident could experience a partial or total loss of consciousness in a fire emergency. Unless there is specific evidence that loss of consciousness might occur during a fire emergency, the resident should be rated as "no significant risk."

6.4.3.1.2 Specific evidence is an indication that the resident has experienced some temporary impairment of consciousness of short duration (seconds or minutes) six or more times during the three months preceding the rating of the resident. Regardless of frequency, if there is specific evidence that loss of consciousness might be caused by the stress of a fire emergency, the resident should be rated as having impaired consciousness. An episode of partial loss of consciousness should be counted only if the impairment was severe enough to significantly interfere with the resident's ability to leave the facility. Do not count episodes where the loss of consciousness was the result of a temporary medical problem (e.g., a severe infection). If more than one rating applies, use the rating with the highest numerical score.

6.4.3.2 No Significant Risk. The resident is not subject to loss of consciousness, or the resident has had fewer than six episodes of losing consciousness (partial and total) during the three months preceding the rating.

6.4.3.3 Partially Impaired. The resident has had at least six episodes of losing consciousness in the preceding three months, of which the most severe episode was only a partial loss of consciousness; that is, the resident still is able to participate in an evacuation to some degree. Specific evidence that a resident should be rated in this category includes loss of consciousness resulting from mild (partial or petit mal) seizures, dizzy spells, intoxication, or any other partially incapacitating impairment of consciousness.

6.4.3.4 Totally Impaired. The resident has had at least six episodes of losing consciousness in the preceding three months, the most severe episode involving total or severely incapacitating loss of consciousness; that is, the resident needs the full assistance of at least one staff member to get out of the building. Specific evidence that a resident should be rated in this category includes losses of consciousness resulting from severe (generalized or grand mal) seizures, fainting spells, intoxication, or other total or severely incapacitating loss of consciousness.

6.4.4 Need for Extra Help (Line IV of Worksheet 6.8.2).

6.4.4.1 General.

6.4.4.1.1 Line IV rates the possibility that more than one staff member might be needed to evacuate the resident. Specific evidence is a previous need for two or more persons to assist the resident and an indication that the resident could need assistance from two persons in a fire emergency.

6.4.4.1.2 Where determining the need for additional assistance, the evaluator should disregard the physical strength or weakness of staff members. (For example, a large staff member who is exceptionally strong might be able to assist a resident alone, while a smaller staff member might be unable to assist the resident fully. However, there is no assurance that a staff member who is able to assist alone always will be able to respond to a resident requiring extra assistance.)

6.4.4.2 Needs at Most One Staff Member. There is no specific evidence that the resident might need help from two or more persons in a fire emergency.

6.4.4.3 Needs Limited Assistance from Two Staff Members. The resident might need some initial or brief intermittent assistance from two staff members, but otherwise needs help from no more than one. Specific evidence supporting this rating is that a resident needs assistance from no more than one person except to accomplish the following:

(1) Getting into a wheelchair
(2) Descending stairs

6.4.4.4 Needs Full Assistance from Two Staff Members. The resident might need assistance from two staff members during most of an evacuation. Specific evidence of the need for assistance from two staff members follows:

(1) Two persons are needed to carry the resident from the facility.

(2) Two persons are needed to get the resident into a wheelchair and to get the wheelchair down a flight of stairs.
(3) The resident might resist an evacuation vigorously, and two persons are needed to get the resident out of the facility.

6.4.5 Response to Instructions (Line V of Worksheet 6.8.2).

6.4.5.1 General. Line V rates the resident's ability to receive, comprehend, and follow through with simple instructions during a staff-directed evacuation. Residents often do not respond equally well to all staff members; therefore, a resident should be rated on his responses to staff members whose directions he is least likely to follow. If more than one rating applies, use the rating with the highest numerical score.

6.4.5.2 Follows Instructions. The resident usually can be depended on to receive, comprehend, remember, and follow simple instructions.

6.4.5.3 Requires Supervision. The resident generally is capable of following instruction but is not dependable. Therefore, the resident might need to be guided, reminded, reassured, or otherwise accompanied during evacuation but does not require the exclusive attention of a staff member (e.g., a staff member can lead two or more residents who fit this classification simultaneously).

6.4.5.3.1 This category includes elderly persons who sometimes show early signs of senile dementia or Alzheimer's disease (e.g., confusion, disorientation, frequent "misplacement" of possessions) and young children who cannot be depended on to follow through with instructions.

6.4.5.3.2 Residents in this category generally are capable of following instructions except in one of the following situations:

(1) The resident is deaf or hearing impaired and sometimes misinterprets communications from staff using sign language.
(2) The resident sometimes forgets instructions after a brief period of time.
(3) The resident is sometimes distracted or confused and fails to follow through with instructions.
(4) The resident is sometimes groggy and might fail to listen carefully or follow through with instructions.
(5) The resident is sometimes uncooperative without apparent good reason.
(6) The resident is elderly and sometimes becomes "lost" in a familiar place.
(7) The resident is a young child who might become frightened and not follow through with instructions.

6.4.5.4 Requires Considerable Attention or Might Not Respond.

6.4.5.4.1 The resident might fail to receive, understand, or follow through with instructions; that is, the resident might not respond to instructions or general guidance. Therefore, the resident might require most of the attention of a staff member during an evacuation.

6.4.5.4.2 This category includes elderly persons who have the symptoms of senile dementia or Alzheimer's disease (e.g., severe confusion, disorientation, very limited short-term memory).

6.4.5.4.3 Residents in this category might display one or more of the following characteristics:

(1) The resident sometimes does not understand simple instructions.
(2) The resident might not respond to instructions from a particular staff member.
(3) The resident is sometimes emotionally upset and is therefore unwilling to follow instructions.
(4) The resident is deaf or hearing impaired and the staff cannot communicate reliably with the resident.
(5) The resident is very forgetful, easily confused, or easily distracted.

6.4.6 Waking Response to Alarm (Line VI of Worksheet 6.8.2).

6.4.6.1 General.

6.4.6.1.1 Line VI rates the risk that the fire alarm might fail to awaken the resident.

6.4.6.1.2 Residents should be rated as "response probable" unless any of the following conditions exists:

(1) The building does not have an alarm system meeting the requirements of Chapter 33 (NFPA *101*), or the alarm is not sufficiently loud where the resident sleeps (doors should be closed and barriers kept in place where determining the audibility of the fire alarm).
(2) Medication taken by the resident before retiring differs in type or amount (i.e., medication is increased) from the medication taken during waking hours.
(3) The resident has a readily apparent hearing impairment, or the resident's hearing aid is removed before sleeping.
(4) There is specific evidence that the resident is an exceptionally sound sleeper. For example, the resident previously failed to be awakened by a particularly loud noise, and staff members have had to shake the resident vigorously to awaken him.

6.4.6.1.3 Where any of the conditions in 6.4.6.1.2 exist, the resident should be rated as "response not probable" unless the resident's ability to wake up has been demonstrated. The demonstration of the resident's ability to wake up in response to the fire alarm should be conducted after the first half hour of sleep and during the first three hours of sleep. In addition, the resident's ability to wake up in response to the alarm should be demonstrated on two different nights under normal conditions (e.g., without hearing aid, under usual medications). Also, the resident should be alert enough to follow simple instructions within 1 minute after waking. To avoid waking other residents during the demonstrations of the capability of a particular resident, a device that makes a sound that is similar to, but not louder than, the fire alarm shall be permitted to be used (e.g., an alarm clock or clock radio with a sound similar to the fire alarm). Listed and approved tactile alarms shall be permitted as alternative devices used to demonstrate a hearing-impaired resident's response probability.

6.4.6.2 Response Probable. Either none of the conditions in 6.4.6.1.2 affect the resident, or, if any of the conditions exist, the resident's ability to be awakened has been demonstrated.

6.4.6.3 Response Not Probable. One or more of the conditions in 6.4.6.1.2 affect the resident, and either the resident has not been tested for the ability to be awakened by the fire alarm or the resident has failed to demonstrate the ability to be awakened by the fire alarm.

6.4.7 Response to Fire Drills (Line VII of Worksheet 6.8.2).

6.4.7.1 General.

6.4.7.1.1 Line VII rates the resident's ability to leave the facility during fire drills, as demonstrated by the resident's performance, without guidance or advice from the staff. A resident must demonstrate three separate responses reliably and without instructions or supervision to be rated "yes" in each case. The resident is rated "yes" only where he has been specifically trained or instructed in the desired reaction and has demonstrated the desired response in at least three of the last four fire drills in which a response was demonstrated. If the resident has not been involved in four fire drills, the rating shall be permitted to be "yes" only if the resident has demonstrated the desired response during the last two opportunities to demonstrate the response. Ratings are based on demonstrated performance, and any resident who has not been trained to participate in fire drills must be rated "no."

6.4.7.1.2 This rating covers the ability of the resident to make decisions but does not relate to mobility, which is covered separately. For example, a resident might need assistance only in transferring from a bed to a wheelchair but otherwise can initiate and complete an evacuation promptly. Such a resident would be rated "yes" for "Initiates and Completes Evacuation Promptly" but would be rated "Needs Limited Assistance," in Line II, Impaired Mobility.

6.4.7.1.3 Residents should be rated assuming that an emergency could occur when they are least likely to respond well. For most residents, this is after being awakened. Determining the rating should not include difficulties in actually awakening the resident, since there are great differences in how easily the same individual awakens at various times.

6.4.7.2 Initiates and Completes Evacuation Promptly. The resident has demonstrated a proper response to an alarm or warning of a fire by starting and completing the evacuation without unnecessary delay. Specific evidence leading to a rating of "no" includes the following responses:

(1) The resident might not react to the alarm until alerted by a staff member.
(2) The resident spends an excessive amount of time preparing to leave (e.g., getting dressed, observing others).
(3) The resident has a hearing impairment and, therefore, needs to be alerted by a staff member.
(4) The resident is sometimes upset or confused and, therefore, might seek out a staff member before evacuating.
(5) The resident consistently begins an evacuation but is easily distracted and needs some supervision.

6.4.7.3 Chooses and Completes Backup Strategy. The resident has demonstrated the ability to select an alternative means of escape or has taken other appropriate action if the primary escape route is blocked. Specific evidence leading to a rating of "no" is where the resident is unlikely to select a good course of action if the primary escape route cannot be used; that is, the resident has not been trained to find alternative escape routes, find an area of refuge, or perform other appropriate action(s). Where the resident lacks the conceptual ability to understand fire hazards and blocked escape routes, and, therefore, requires supervision, the rating should be "no."

6.4.7.4 Remains at Designated Location. The resident must have demonstrated willingness to remain at a designated safe location during fire drills. (The whereabouts of already evacuated residents needs to be confirmed to avoid dangerous return trips to look for residents who might have returned to buildings.)

6.4.7.4.1 Specific evidence leading to a "yes" for this rating includes the following:

(1) The resident has been specifically trained to remain at a designated location in a safe area and has demonstrated this ability without the presence of staff members in three of the previous four fire drills.
(2) The resident is physically immobile and, therefore, cannot leave the designated location.
(3) The facility uses a motor vehicle (e.g., a van or bus) or a building that is detached and remote from the facility (i.e., another building or a remote garage) as the designated location, and the resident has demonstrated in three of the previous four fire drills the ability to remain there without the presence of a staff member.
(4) The resident might tend to wander, but a reliable resident has been assigned to keep the wandering resident at the designated location without using any force or coercion. Furthermore, this arrangement has been demonstrated as effective in at least three of the previous four fire drills.

6.4.7.4.2 Specific evidence leading to a "no" for this rating includes the following:

(1) The resident has not been trained to remain at a designated location without any staff supervision.
(2) The resident has been trained to remain without staff supervision at a designated location but has failed to demonstrate this capability in three of the previous four fire drills.

6.5 Rating the Staff Shift (Worksheets 6.8.5 through 6.8.11).

6.5.1 This rating is intended to predict the promptness of response of a staff member who is present in the facility, at a given time (shift), and who is capable of assisting residents in an evacuation.

6.5.2 Before rating the staff shift, there are five basic requirements relative to the staff response capability, protection plans, and fire drills that shall be met. The determination of whether or not these requirements are met is recorded on Worksheet 6.8.8, Staff Shift Scores. If the corresponding requirements of 6.5.2.1 through 6.5.2.5 have been met, a "yes" rating should be given.

6.5.2.1 A protection plan shall have been promulgated, and all staff members considered in this rating shall have been trained in its implementation. Regardless of the staff's everyday competencies, they cannot be relied upon to innovate effective life safety actions under the extreme stress and time limitation of an actual fire emergency. Notwithstanding the facility's fire protection features, the staff must have a valid and practiced plan of action that can be put into effect immediately in an emergency. The protection plan should include the following features:

(1) A description of all available evacuation, escape, and rescue routes and the procedures and techniques needed to evacuate all the residents using the various routes
(2) A fundamental knowledge of fire growth, containment, and extinguishment necessary to make reasonable judgments about action priorities and viable egress routes

6.5.2.2 Staff shall be provided in accordance with 6.5.2.2.1 or 6.5.2.2.2.

6.5.2.2.1 The total available staff at any given time is able to handle the individual evacuation needs of each resident who might be in the facility. In calculating evacuation capability, it might be possible to have a ratio of staff to residents that appears to be favorable but that still is unacceptable under this system. This would be the case when a resident needs assistance from two staff members but only one staff member is present. Thus, the situation should be such that all residents can be evacuated by the available staff.

6.5.2.2.2 The facility meets the criteria for an evacuation capability level of "impractical," the resident whose evacuation needs cannot be handled is in a sleeping room or other room that provides adequate refuge from fire outside the room, and there is at least one staff member present who can close the door to the room. For example, a very heavy resident is in a facility, meeting the criteria for impractical level of evacuation capability, with one available staff member who cannot transfer the resident from a bed to a wheelchair. Although the staff member is unable to meet all the resident's evacuation assistance needs, the sleeping room provides adequate refuge.

6.5.2.3 Every staff member considered in this rating shall be able to participate meaningfully in the evacuation of every resident. For example, a staff member who, due to his own disability, might be unable to assist one or more physically disabled residents shall not be included in the rating. However, if a staff member's disability does not limit his ability to assist the residents, then the staff member shall be permitted to be included in the rating.

6.5.2.4 All staff members considered in this rating shall be in the facility when on duty, except as otherwise permitted by 6.5.2.4.1 through 6.5.2.4.4. This rating is based on the assumption that there are staff present when residents are in the facility.

6.5.2.4.1 Unstaffed facilities, which are not covered by this system, shall be permitted to be assigned an evacuation capability level based on the demonstrated ability of the residents to meet the criteria of Chapter 33 (NFPA *101*) without staff assistance.

6.5.2.4.2 Residents who receive only the most favorable ratings on Worksheet 6.8.3 for rating residents shall be permitted to be present in the facility without the presence of staff members.

6.5.2.4.3 A staff member shall be permitted to be at a location outside of the facility where his ability to respond to a fire emergency from the location is roughly equivalent to his response ability from within the facility. In determining equivalency, the authority having jurisdiction should consider the following:

(1) Whether the fire alarm meets the minimum loudness criteria *(see 6.5.3.2.2)* at the locations outside the facility or whether another staff member who is required to remain in the facility can immediately report a fire emergency to the staff member who is outside
(2) Travel time to the facility
(3) Detection of fire cues (e.g., smoke, noises) from locations outside the facility
(4) Whether the staff member will be notified immediately about which area of the facility has the fire emergency, if the staff member who is outside is required to report fire emergencies in more than one facility or fire zone

6.5.2.4.4 The authority having jurisdiction shall be permitted to grant partial credit (which shall not exceed the promptness of the response score that the staff member receives where required to remain in the facility) for staff members who are permitted at locations outside the facility and who have the ability to respond promptly.

6.5.2.5 Fire drills shall be conducted monthly, and at least 12 fire drills shall have been conducted during the previous year. A facility in operation for less than one year shall be permitted to have conducted a fire drill for each month of its operation.

6.5.3 Staff Shift Scores (Worksheet 6.8.8).

6.5.3.1 The purpose of this rating is to determine which staff shift is likely to be the least able to respond promptly to assist residents in an evacuation. If it is not obvious which staff shift will be the least able to respond, complete separate forms for each staff shift and use the staff shift having the lowest score.

6.5.3.2 Promptness of Response Scores (Worksheet 6.8.7).

6.5.3.2.1 Staff Availability. This rating determines whether there are circumstances in which a staff member is less able to respond appropriately or might be delayed in his response to a fire emergency. A staff member shall be included in this rating only under the following conditions:

(1) He is required to remain within the facility while on duty.
(2) He sleeps less than 100 ft (30 m) from all locations in the portion of the facility being evaluated.
(3) His travel time to any location in the portion of the facility being evaluated does not exceed 60 seconds.

6.5.3.2.1.1 Standby or Asleep. This rating means that the staff member does not have specific duties that ensure an immediate response to the alarm but is otherwise available to assist in a timely manner. This includes live-in staff who might be asleep, showering, or otherwise unable to respond immediately.

6.5.3.2.1.2 Immediately Available. This rating means that the staff member is required to be on duty to provide immediate assistance but is not required to remain in proximity to the residents (e.g., the staff member is allowed to wash clothes or do bookkeeping).

6.5.3.2.1.3 Immediately Available and Close By. This rating means that the staff member, in addition to satisfying the requirement for "immediately available," also is required to remain in proximity to the residents except for brief periods of time.

6.5.3.2.1.4 If the facility is classed as "large" and has multiple fire or smoke zones, some staff members might have responsibilities for residents outside the fire or smoke zone being evaluated. If a staff member's duties include rescue of residents in the fire zone being evaluated, the staff member shall be permitted to be assigned partial or full promptness of response scores. The authority having jurisdiction shall assign the points based on the proximity of the staff member to the zones and the nature of his duties in a fire emergency. This credit shall be given only if there is a smoke detection system that alerts the staff member and a system or procedure for promptly informing the staff member of the general location of the fire.

6.5.3.2.1.5 Individual residents shall be permitted to be assigned responsibilities similar to those of staff members to assist other residents during fire emergencies. The authority having jurisdiction shall be permitted to assign these individual residents as many as eight points for promptness of response, based on their capabilities and responsibilities.

6.5.3.2.2 Alarm Effectiveness. This rating determines whether smoke detector–activated alarm devices are loud enough to alert the staff to a fire emergency dependably.

6.5.3.2.2.1 Assured. To be rated "assured," the alarm shall be "easily noticeable" in all locations where the staff member is permitted, regardless of his rating on the promptness of response factor. "Easily noticeable" means the alarm shall be a minimum of 55 dBA measured at ear level. The authority having jurisdiction shall be permitted to require the alarm to be louder than 55 dBA where background noises could interfere with alarm audibility. For example, the alarm might need to be more than 55 dBA to be heard over noise such as from a washing machine in the laundry or a television in the day room. If there are staff who are permitted to sleep, the alarm shall be a minimum of 70 dBA measured at "pillow" level in any area where the staff might be asleep. The alarm shall be activated by smoke detectors, an automatic sprinkler system, or both. If the facility has smoke detectors meeting the requirements of Chapter 33 (NFPA *101*), the smoke detectors shall activate the alarm. If the facility has an automatic sprinkler system whose fire protection properties are considered in the evaluation of the facility, activation of the sprinkler system shall activate the alarm.

6.5.3.2.2.2 Not Assured. The alarm does not satisfy the conditions specified under "assured." Doors that normally are closed during the staff shift being rated should be closed when determining the loudness of the fire alarm. Any other barriers that could reduce the loudness of the fire alarm also shall be in place.

6.6 Rating the Facility (Worksheet 6.8.9).

6.6.1 The vertical distance from sleeping rooms to a story with exits might affect the risk because of the time and difficulty in moving on the stairs.

6.6.2 Special Terminology.

6.6.2.1 Direct Exit. Direct exit shall mean that there is no more than one step between the inside of the facility and either (1) ground level outside or (2) a level area outside the facility that is at least 32 ft^2 (3 m^2). This level area might be a porch or a stairway landing. Where the vertical distance is greater than one step, a ramp shall be permitted to be used to comply with this definition.

6.6.2.2 Vertical Distance. Vertical distance shall refer to the greatest number of stories that separate any resident sleeping room from its nearest direct exit.

6.6.3 All Sleeping Rooms on Stories with Direct Exit. Every room where residents sleep is on a story with at least one direct exit. Examples of facilities that fall within this category include the following:

(1) A one-story building without sleeping rooms in the basement
(2) A two-story building without sleeping rooms on the second story
(3) A split-level building with direct exits at each level
(4) A two-story building with sleeping rooms on the second story that has an exterior stairway from the second story, with a landing at the second story that is greater than 32 ft^2 (3 m^2)

6.6.4 Any Sleeping Room One Story from Exit. There is at least one room where residents sleep in which the shortest vertical distance to a direct exit is one story. Examples of facilities that fall within this category include the following:

(1) A two-story building with sleeping rooms on the second story, in the basement, or both
(2) A one-story building where all the exits have stairs that lead to grade without a landing or porch of, at minimum, 32 ft^2 (3 m^2)

6.6.5 Any Sleeping Room Two or More Stories from Exit. There is at least one room where residents sleep in which the shortest vertical distance to a direct exit is two or more stories. Buildings that fall within this category include the following:

(1) A three-story building with sleeping rooms on the third story and no exterior fire escape
(2) A three-story building with sleeping rooms on the third story that has an exterior stairway from the third story, but where the landing at the third story is less than 32 ft^2 (3 m^2)

6.6.6 Facilities in an Apartment House. If the facility is located in an apartment house and the unit containing the facility requires ascending or descending stairs to move from any sleeping room to the door to the corridor, a score of 1.2 for "vertical distance from sleeping rooms to exit" should be assigned. In all other apartments, the score for vertical distance from sleeping rooms to exits is 1.0.

6.7 Determining Evacuation Capability (Worksheet 6.8.10).

6.7.1 When the scores for the residents, the staff, and the vertical travel distances have been determined, the scores are entered on Worksheet 6.8.10 and the calculation made to obtain a numerical result.

6.7.2 The numerical evacuation capability score then is translated into a level of evacuation capability of either "prompt," "slow," or "impractical" and recorded on Worksheet 6.8.11. This evacuation capability is a valid assessment that shall be permitted to be used in Chapter 7 of this guide or in Chapter 33 (NFPA *101*).

6.8 Worksheets for Rating Residents. The worksheets for rating residents use a seven-step process found in Figure 6.8.

6.8.1 Step 1 — Complete the Cover Sheet Using Worksheet 6.8.1. See Figure 6.8.

6.8.2 Step 2 — Read Section 6.3 and Section 6.4, then Fill out Worksheets 6.8.2 and 6.8.3. Complete both forms for each resident, basing the ratings on commonly observed examples of poor performance.

6.8.3 Step 3 — Compute the Total Resident Evacuation Assistance Score. The following steps should be taken:

(1) List each resident's name on Worksheet 6.8.4. Use a separate scoresheet for each zone being rated. Use additional scoresheets for a large number of residents.
(2) Enter the score for each resident from Worksheet 6.8.3 that was completed for him.
(3) Total the scores for all residents in the facility or zone being rated, as appropriate.

WORKSHEET 6.8.1 COVER SHEET

Worksheet for Rating Residents

Resident's name ______________________ Evaluator ______________________

Facility ______________ Zone ______________ Date ______________

Write any explanatory remarks here:

WORKSHEET 6.8.2 RATING THE RESIDENT ON THE RISK FACTORS

Rate the resident on each of the factors below by checking the one circle for each risk factor that best describes the resident. For the first six factors, write the scores for the circles checked in the appropriate score boxes in the far right column. For "Response to Fire Drills," write the three checked scores in the large circles. Write the sum of the three scores in the large box on the right.

					Score Boxes
I. Risk of Resistance (Check only one)	Minimal Risk ○ score=0	Risk of Mild Resistance ○ score=6	Risk of Strong Resistance ○ score=20		☐
II. Impaired Mobility (Check only one)	Self-Starting ○ score=0	Slow ○ score=3	Needs Limited Assistance ○ score=6	Needs Full Assistance or Very Slow ○ score=20	☐
III. Impaired Consciousness (Check only one)	No Significant Risk ○ score=0	Partially Impaired ○ score=6	Totally Impaired ○ score=20		☐
IV. Need for Extra Help (Check only one)	Needs at Most One Staff ○ score=0	Needs Limited Assistance from 2 Staff ○ score=30	Needs Full Assistance from 2 Staff ○ score=40		☐
V. Response to Instructions (Check only one)	Follows Instructions ○ score=1	Requires Supervision ○ score=3	Requires Considerable Attention/Might Not Respond ○ score=10		☐
VI. Waking Response to Alarm (Check only one)	Response Probable ○ score=0	Response Not Probable ○ score=6			☐

VII. Response to Fire Drills (Without guidance or advice from staff)	Initiates and Completes Evacuation Promptly	Yes ○ score=0	No ○ score=8	○
	Chooses and Completes Back-up Strategy	Yes ○ score=0	No ○ score=4	+ ○
	Remains at Designated Location	Yes ○ score=0	No ○ score=6	+ ○

Sum of These Three Scores ☐

WORKSHEET 6.8.3 DETERMINING THE RESIDENT'S OVERALL NEED FOR ASSISTANCE

Compare the numbers in the seven score boxes filled in on Worksheet 6.8.2. Take the highest score from the score boxes and write it in the box at the right.

Evacuation Assistance Score ☐

Notes:

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 1 of 4)

FIGURE 6.8 Worksheets for Rating Residents.

WORKSHEET 6.8.3 DETERMINING THE RESIDENT'S OVERALL NEED FOR ASSISTANCE

Compare the numbers in the seven score boxes filled in on Worksheet 6.8.2. Take the highest score from the score boxes and write it in the box at the right.

Evacuation Assistance Score

Notes:

WORKSHEET 6.8.4 RESIDENT SCORES

Resident Name	Evac. Assistance Score	Resident Name	Evac. Assistance Score
Evacuation Assistance Score Total		Evacuation Assistance Score Total	

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 2 of 4)

FIGURE 6.8 ***Continued***

WORKSHEET 6.8.5 COVER SHEET

Staff Shift Score

Facility ______________________ Zone ______________________

Evaluator ______________________ Date ______________________

Staff Shift: From ______________________ To ______________________

WORKSHEET 6.8.6 STAFF RESPONSE AND TRAINING

	Yes	No
A protection plan has been promulgated and all staff members considered in this rating have been trained in its implementation. *(See 6.5.2.1.)*		
The total available staff at any given time is able to handle the individual evacuation needs of each resident who is in the facility. *(See 6.5.2.2.)*		
Every staff member considered in this rating can meaningfully participate in the evacuation of every resident. *(See 6.5.2.3.)*		
All staff members considered in this rating are required to be in the facility when on duty, except as permitted. *(See 6.5.2.4.)*		
At least 12 fire drills were conducted during the previous year. *(See 6.5.2.5.)*		

All items must score "Yes" before proceeding.

WORKSHEET 6.8.7 PROMPTNESS OF RESPONSE SCORES

	Alarm Effectiveness	
Staff Availability	**Assured**	**Not Assured**
Standby or asleep	16	2
Immediately available	20	2
Immediately available and close by	20	10

WORKSHEET 6.8.8 STAFF SHIFT SCORES

Staff Name	Promptness of Response Score	Staff Name	Promptness of Response Score
Staff Shift Score **Total**		**Staff Shift Score** **Total**	

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 3 of 4)

FIGURE 6.8 *Continued*

WORKSHEET 6.8.9 RATING THE FACILITY

	Vertical Distance from Sleeping Rooms to Exits		
	All SR on Stories with Direct Exit	Any SR One Story from Exit	Any SR Two or More Stories from Exit
Small Facility[a]	◯ Score 0.8	◯ Score 1.0	◯ Score 1.2
Large Facility or Apartment[b]		◯ Score 1.0	

[a] Small facilities have 16 or fewer residents.
[b] See 6.6.6 for apartments.

WORKSHEET 6.8.10 CALCULATION OF EVACUATION CAPABILITY SCORE

$$\frac{\text{Total Resident Evacuation Assistance Score (Worksheet 6.8.4)} \; \boxed{} \times \text{Vertical Distance from Sleeping Room to Exit (Worksheet 6.8.9)} \; \boxed{}}{\boxed{} \; \text{Staff Shift Score (Worksheet 6.8.8)}} = \boxed{} \; \text{Evacuation Capability Score}$$

(go to Worksheet 6.8.11)

WORKSHEET 6.8.11 EVACUATION CAPABILITY SCORE

Evacuation Capability Score	Level of Evacuation Capability	Evacuation Capability for this Facility or Zone
≤1.5	Prompt	
>1.5 to ≤5.0	Slow	
>5.0	Impractical	

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 4 of 4)

FIGURE 6.8 ***Continued***

6.8.4 Step 4 — Consider Prequalifications Related to Computing. The following steps should be taken:

(1) Complete the cover sheet in Worksheet 6.8.5.
(2) Complete Worksheet 6.8.6 for the time of day, week, and so on when the combined ratings for staff and residents yield the highest score. This usually is late at night. Where it is not obvious which staff shift will score highest, complete separate forms for each staff shift and utilize the highest score. Read Section 6.5 before filling out this form.

6.8.5 Step 5 — Determine the Staff Shift Score. Note that in large facilities, staff members might be responsible for assisting residents in a fire or smoke zone but also might have responsibilities for residents in other zones. *(See Section 6.5.)* The following steps should be taken:

(1) On Worksheet 6.8.8, list the names of staff members who are required to be on duty in the facility during the shift being rated.
(2) Determine whether the effectiveness of the alarm is "assured" or "not assured." *(See 6.5.3.2.2.)*
(3) Using the values from Worksheet 6.8.7, determine each staff member's "promptness of response score" for the shift being rated. Enter each staff member's name and score in the appropriate spaces on Worksheet 6.8.8.
(4) Total the "promptness of response scores" for the shift rated.

6.8.6 Step 6 — Rate the Facility Using Worksheet 6.8.9. Rate the facility by checking the circle that indicates the vertical distance a resident must travel from a sleeping room (SR) to an exit.

6.8.7 Step 7 — Determine Evacuation Capability. Determine the facility's evacuation capability, using Worksheet 6.8.10. Calculate the score by multiplying the Total Resident Evacuation Assistance Score (Worksheet 6.8.4) by the Vertical Distance from Sleeping Room to Exit (Worksheet 6.8.9) and then dividing by the Staff Shift Score (Worksheet 6.8.8). The evacuation capability is determined and recorded in Worksheet 6.8.11.

Chapter 7 Fire Safety Evaluation System for Board and Care Occupancies

7.1 Introduction.

7.1.1 This chapter is part of an NFPA guide and, therefore, is not mandatory. The term *shall* in this chapter is used to indicate that if the provisions of the chapter are applied, the procedures mandated are to be followed to ensure the effectiveness of the evaluation system.

7.1.2 Chapter 33 (NFPA *101*) defines three levels of evacuation capability for residents (with staff assistance): *prompt*, *slow*, and *impractical*. Chapter 33 (NFPA *101*) also prescribes the fire safety protection requirements for each level of evacuation capability. This chapter describes a procedure for determining whether a combination of fire safety features in a board and care facility provides a level of safety equivalent to that provided by explicit conformance to Chapters 32 and 33 (NFPA *101*). The definition of evacuation capability is given in Section 3.3 (NFPA *101*), and one procedure for determining evacuation capability is presented in Chapter 6 of this document.

7.1.3 Subsystems are provided as follows:

(1) Section 7.2 — Evaluating the fire safety protection in a small facility
(2) Section 7.4 — Evaluating the fire safety protection in a large facility
(3) Section 7.6 — Evaluating the suitability of an apartment building to house a board and care occupancy

7.2 Glossary for Fire Safety Evaluation Worksheet for a Small Facility.

7.2.1 Introduction. This glossary is provided to assist in completing Figure 7.3, Worksheets for Evaluating Fire Safety for a Small Facility, to determine the suitability of a small facility to house a board and care occupancy. The instructions for the mechanisms of completing the worksheet are included in Section 7.3. They are not repeated in this glossary. This glossary provides expanded discussion and definitions for the various items in the worksheet to assist the user where questions of definition or interpretation arise. To the maximum extent possible, the glossary does not repeat the definitions already existing in NFPA *101* but rather references the appropriate paragraphs in NFPA *101*.

7.2.2 Areas of Application.

7.2.2.1 The evaluation shall be completed covering the entire home, including spaces that are not used by the residents of the board and care home. See Worksheet 7.3.2. Row houses, townhouses, or other forms of independent living units having all of their entrances and means of escape completely separate from any other unit shall be permitted to be calculated as small facilities where they are separated from any abutting living units. Such separation shall be by fire-resistive partitions or walls having at least a 1-hour fire resistance rating and extending to the roof if it is noncombustible, or through the roof if the roof or its covering is of combustible material.

7.2.2.2 For dwelling units (apartments) in general-use apartment houses, the worksheet shall be used to evaluate the dwelling unit being used as the board and care home. The remainder of the apartment building shall be evaluated using the worksheet to determine the suitability of apartment buildings to house a board and care occupancy.

7.2.3 Maintenance. All protection systems, requirements, arrangements, and procedures shall be maintained in a dependable operating condition and a sufficient state of readiness and shall be used in such a manner that the intended safety function or hazard constraint is not impaired. Otherwise, they shall receive no credit in the evaluation.

7.2.4 Safety Parameters (Worksheet 7.3.2). The safety parameters are a measure of those building factors that bear upon or contribute to the safety of those persons who might be in the building at the time of a fire. Each of the safety parameters is to be analyzed, and the safety value for each parameter that best describes the condition in the building is to be identified. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value shall be used.

7.2.4.1 Construction/Fire Resistance. Construction types are as defined in 7.2.4.1.1 and 7.2.4.1.2, except that sprinkler protection shall not be considered in determining construction classification in any case where credit is given for sprinkler protection as defined in 7.2.4.5.

7.2.4.1.1 Protected (15 minutes). Buildings meeting the requirements of 33.2.1.3.2 (NFPA *101*).

7.2.4.1.2 Protected (1 hour). Buildings meeting the requirements of Type I, Type II(222), Type II(111), Type III(211), Type IV, or Type V(111) construction.

7.2.4.2 Hazardous Areas. The assignment of parameter values for hazardous areas is a four-step process.

7.2.4.2.1 Step 1 — Identify Hazardous Areas. Hazardous areas are as defined in 32.2.3.2 and 33.2.3.2 (NFPA *101*).

7.2.4.2.2 Step 2 — Determine the Area Exposed.

7.2.4.2.2.1 Primary Means of Escape. Hazardous area is on the same story as and is in or abuts a primary means of escape, as defined in 32.2.3.2 and 33.2.3.2 (NFPA *101*).

7.2.4.2.2.2 Sleeping Area. Hazardous area is on the same story as and is in or abuts the sleeping area (room).

7.2.4.2.3 Step 3 — Determine the Fire Protection Provided.

7.2.4.2.3.1 Sprinkler Protection. The hazardous area is protected by sprinklers (or other appropriate automatic extinguishing system).

7.2.4.2.3.2 Smoke-Resisting Separation. The hazardous area is separated from exposed sleeping areas and the primary means of escape routes by a separation that resists the passage of smoke. Any doors in such separation are self-closing or automatic-closing upon detection of smoke.

7.2.4.2.3.3 Half-Hour Fire Resistance–Rated Enclosure. Enclosures meeting the requirements of 32.2.3.2.5(1) and 33.2.3.2.5(1) (NFPA *101*).

7.2.4.2.3.4 1-Hour Fire Resistance–Rated Enclosure. Enclosures meeting the requirements of 32.2.3.2.4(1) and 33.2.3.2.4(1) (NFPA *101*).

7.2.4.2.4 Step 4 — Determine Degree of Deficiency and Assign Parameter Values. The parameter value ultimately is determined on the basis of the area exposed and the level of protection provided. Table 7.2.4.2.4 provides a matrix for determining the degree of deficiency to be assessed. In some situations, more than one hazardous area with the same or differing levels of deficiency exists. The parameter value then is based on the single most serious deficiency for the hazardous area.

7.2.4.3 Manual Fire Alarm. Manual fire alarms are defined in 7.2.4.3.1 through 7.2.4.3.3.

7.2.4.3.1 None or Incomplete. There is no manual fire alarm system, or the system is incomplete and does not meet the requirements necessary for a higher-scored category.

7.2.4.3.2 Without Fire Department Notification (W/O F.D. Notification). The credit for this level of protection is to be given for any installation that meets the requirements for a manual fire alarm system in 32.2.3.4.1 and 33.2.3.4.1 (NFPA *101*).

7.2.4.3.3 With Fire Department Notification (W/ F.D. Notification). There is a manual fire alarm system meeting the requirements of Section 9.6 (NFPA *101*), including fire department notification as defined in 9.6.4 (NFPA *101*).

7.2.4.4 Smoke Detection and Alarm. A detection system as used herein is one based on the use of smoke detectors. No recognition is given for thermal detectors. The detection system categories are described in 7.2.4.4.1 through 7.2.4.4.5.

7.2.4.4.1 None or Incomplete. There are no smoke detectors in the building, or, if any are present, they do not meet the requirements for a higher-scored category.

7.2.4.4.2 Single-Level Detection, Limited Warning. There are one or more detectors in the building, but they do not meet the criteria for every level detection set forth in 7.2.4.4.3. Detectors credited in this category shall be permitted to be any approved smoke detector, including a single-station detector. At least one detector must be located in the corridor or similar common space (lobbies, lounges, or other spaces that cannot be closed off) in the immediate vicinity of each separate sleeping area. If there is more than one sleeping area, each such area must be protected to obtain this credit.

7.2.4.4.3 Every Level Detection. This credit applies where the detector system meets the requirements of 32.2.3.4.3 and 33.2.3.4.3 (NFPA *101*).

7.2.4.4.4 Every Level Plus Single-Station Detection in Each Bedroom. To receive this credit, the requirements of 7.2.4.4.3 must be met in full with the addition of at least one single-station detector in each bedroom or other sleeping area.

7.2.4.4.5 Total Coverage System. This system provides a minimum of one detector in each occupied room or other habitable space and throughout any basements, storage areas (other

Table 7.2.4.2.4 Hazardous Areas — Degree of Deficiency

	Nonsprinklered			Sprinklered	
	Fire resistance rating with automatic fire detection				
	½ hour	1 hour	Unenclosed	Smoke-resistive separation	Unenclosed
Does not expose sleeping area or means of escape routes	No deficiency	No deficiency	Single deficiency	No deficiency	No deficiency
Exposes sleeping area or means of escape routes	Single deficiency	No deficiency	Double deficiency	No deficiency	No deficiency

than normal clothing closets), or combustible loft spaces. To qualify as a total system, there must be a manual fire alarm system in the building, and the operation of any smoke detector must automatically activate the manual fire alarm system evacuation alarm for the entire building.

7.2.4.5 Automatic Sprinklers. Automatic sprinklers are defined in 7.2.4.5.1 and 7.2.4.5.2.

7.2.4.5.1 Nonsprinklered. No credit is given if there are no sprinklers or if sprinklers, though present, are not sufficient to qualify for the sprinklered category.

7.2.4.5.2 Sprinklered ("Standard Sprinklers" or "Quick-Response or Residential Sprinklers"). The building is sprinklered in accordance with 32.2.3.5.1 through 32.2.3.5.7 and 33.2.3.5.3 through 33.2.3.5.7 (NFPA *101*).

7.2.4.6 Interior Finish. Except as noted in 7.2.4.6.1, classification of interior finish on the walls and ceilings of the occupied space is in accordance with Section 10.2 (NFPA *101*). There are no requirements for interior floor finish. Choose the safety parameter value in Worksheet 7.3.2 based on the interior finish material provided. For example, if the interior wall finish material has a flame-spread index of between 25 and 75, do not take the parameter value associated with a flame-spread index of less than 25, regardless of the presence of automatic sprinkler protection. The mandatory values have been calibrated to take into consideration any sprinkler protection provided.

7.2.4.6.1 Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286 as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

7.2.4.6.2 No consideration is included in the safety parameter value for any finish with a flame-spread index greater than 200 as measured by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Some materials, including foam plastics, high density polyethylene, and polypropylene, are not permitted to be tested in accordance with ASTM E84 and must be tested in accordance with NFPA 286, and must meet the acceptance criteria shown in 10.2 (NFPA *101*). Some materials, including asphalt-impregnated paper, are capable of inducing extreme rates of fire growth and rapid flashover. In any case involving these materials, the resultant hazard is considered beyond the capacity of this evaluation system and requires an individual fire hazard assessment. The following should be noted:

(1) Plywood of ¼ in. (6 mm) or greater thickness should be considered as having a flame-spread index of ≤200.
(2) Exposed wood open-joist construction or other exposed wood construction areas shall be charged as Class C interior finish, in addition to any charges under 7.2.4.1.
(3) If a space is classified as hazardous under 7.2.4.2, no additional charge shall be made as the result of interior finish in such areas.

7.2.4.7 Separation of Sleeping Rooms (from Other Levels and from Corridors). Separation of sleeping rooms is described in 7.2.4.7.1 through 7.2.4.7.3.

7.2.4.7.1 Separation of Sleeping Rooms from Other Levels. The classification of separation of sleeping rooms is categorized under the groups headed "Unprotected Vertical Openings" and "Protected Vertical Openings" (Parameter 7 in Worksheet 7.3.2). Determine the extent of vertical openings and number of stories connected.

7.2.4.7.1.1 Use the category of "Protected Vertical Openings" if any of the following apply:

(1) A single-story building without a basement
(2) All vertical openings, other than a two-story open stair in a sprinklered building, protected by a ½-hour or greater fire resistance–rated smoke partition
(3) All vertical openings, other than a three-story open stair in a sprinklered building where the primary means of escape from each sleeping area does not require occupants to pass through a story on the lower level, protected by a ½-hour or greater fire resistance–rated smoke partition
(4) All vertical openings protected by a ½-hour or greater fire resistance–rated smoke partition

7.2.4.7.1.2 Where none of the conditions in 7.2.4.7.1.1 apply, use the category of "Unprotected Vertical Openings."

7.2.4.7.2 Separation of Sleeping Rooms from Corridors and Common Spaces. The charge for "None or Incomplete" (Parameter 7 in Worksheet 7.3.2) is assessed in any case where the separation of sleeping rooms from corridors and common spaces is insufficient to meet any of the other classifications in this parameter.

7.2.4.7.3 Criteria for the Other Classifications of Sleeping Room Separation.

7.2.4.7.3.1 Smoke Resisting. Sleeping rooms are separated from corridors or other common spaces in accordance with 32.2.3.6 and 33.2.3.6 (NFPA *101*) without the door closer.

7.2.4.7.3.2 Smoke Resisting with Door Closer. Sleeping rooms are separated in accordance with 32.2.3.6 and 33.2.3.6 (NFPA *101*) with door closer.

7.2.4.7.3.3 Half-Hour Fire Resistance. Meets the requirements of 32.2.3.6 and 33.2.3.6 (NFPA *101*) without the door closer.

7.2.4.7.3.4 Half-Hour Fire Resistance with Door Closer. Sleeping rooms are separated in accordance with 32.2.3.6 and 33.2.3.6 (NFPA *101*) with door closer.

7.2.4.7.3.5 Half-Hour Fire Resistance with Automatic-Closing Doors. Automatic-closing doors shall be permitted if the doors have an arrangement that holds them open in a manner such that they are released by a smoke detector–operated device (e.g., magnetic or pneumatic hold-open device) prior to the passage of significant smoke from the space of fire origin into the corridor or from the corridor into the protected room. Smoke detectors for operation of such doors are either integral with the door closers, mounted at each door, or operated from a total smoke detection system covering both the room and corridor.

7.2.4.8 Means of Escape. Means of escape is defined in 7.2.4.8.1 through 7.2.4.8.6.

7.2.4.8.1 Means of Escape on All Sleeping Levels. A building shall be considered as having means of escape on all sleeping levels, provided the following conditions exist:

(1) The entire building is on a single level.
(2) All guest rooms used for sleeping are on a level having an exit door.

7.2.4.8.2 Primary Route. A normal means of escape that might involve interior or exterior stairs, corridors, doors, or other common means of movement through and out of a dwelling unit.

7.2.4.8.2.1 Protected. A primary route is classed as "protected" if it provides a path of travel to the outside of the building without traversing any corridor or space exposed to an unprotected vertical opening. Also, where the sleeping room is above or below the level of exit discharge, the primary means is an enclosed interior stair in accordance with 32.2.2.4 or 33.2.2.4 (NFPA *101*), an exterior stair, or a horizontal exit.

7.2.4.8.2.2 Unprotected. A primary route is classed as "unprotected" if it does not meet the requirements for "protected."

7.2.4.8.3 Fewer Than Two Remote Routes. The egress capability is classed as "<2 remote routes" if each bedroom does not have access to two routes leading to two separate building exit doorways.

7.2.4.8.4 With Alternative Means. The credit for this level of protection applies to any facility that meets the requirements for a second means of escape in 32.2.2.3 and 33.2.2.3 (NFPA *101*).

7.2.4.8.5 Two Remote Routes. To meet the requirement for "two remote routes," each bedroom must have access to two routes leading to two separate building exit doorways.

7.2.4.8.5.1 Separated. To meet the requirement for "two remote routes separated," the facility must meet the requirements of 32.2.2.2 through 32.2.2.3 and 33.2.2.1 (NFPA *101*).

7.2.4.8.5.2 Unseparated. The two remote routes do not meet the requirements for the classification "separated."

7.2.4.8.6 Direct Exit from Each Bedroom.

7.2.4.8.6.1 To be credited, each bedroom must have a door that is operable by the room occupant(s) and such door opens directly to grade without more than one step, opens directly to a ramp to grade, or opens directly to an external porch or landing with external stairs or other suitable access to grade.

7.2.4.8.6.2 Some buildings have a nonsleeping occupants use area (e.g., staff lounge) on a story without any exit, and the building otherwise qualifies to receive credit for direct exits or for two remote exits. To receive credit for direct exits or for two remote exits, there must be either a protected egress route or two remote routes from the occupants use area.

7.3 Worksheets for Evaluating Fire Safety for a Small Facility. A small facility is normally one with a capacity for 16 or fewer residents. For each individual residence or apartment used as a small board and care facility, the seven-step process in Figure 7.3 should be followed when evaluating fire safety.

7.3.1 Step 1 — Complete Cover Sheet Using Worksheet 7.3.1. See Figure 7.3.

7.3.2 Step 2 — Determine Safety Parameter Values Using Worksheet 7.3.2. Select and circle the safety value for each safety parameter in Worksheet 7.3.2 that best describes the conditions in the facility. Choose only one value for each of the eight parameters. If two or more values appear to apply, choose the one with the lowest point value.

7.3.3 Step 3 — Complete Individual Safety Evaluation Using Worksheet 7.3.3. The following steps should be taken:

(1) Transfer each of the eight circled safety parameter values from Worksheet 7.3.2 to every available block in the line with the corresponding safety parameter in Worksheet 7.3.3. Where the block is marked "÷ 2 =," enter one-half the value from Worksheet 7.3.2.
(2) Add each of the four columns, keeping in mind that any negative numbers need to be deducted.
(3) Transfer the resulting values for S_1, S_2, S_3, and S_4 to the corresponding blocks in Worksheet 7.3.5.

7.3.4 Step 4 — Determine Mandatory Requirements Using Worksheet 7.3.4A or 7.3.4B as appropriate. The following steps should be taken:

(1) Select the level of requirements from Worksheet 7.3.4A or 7.3.4B as appropriate. Circle the appropriate values.
(2) Transfer the circled values from Worksheet 7.3.4A or 7.3.4B to the corresponding blocks for S_a, S_b, S_c, and S_d in Worksheet 7.3.5.

7.3.5 Step 5 — Determine the Equivalency Evaluation. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 7.3.5. Enter the differences in the appropriate answer blocks.
(2) For each row, check "yes" if the value in the answer block is zero (0) or greater. Check "no" if the value in the answer block is a negative number.

7.3.6 Step 6 — Evaluate Other Considerations Not Previously Addressed, Using Worksheet 7.3.6. The equivalency covered by Worksheets 7.3.2 through 7.3.5 includes the majority of the considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 7.3.6, Facility Fire Safety Requirements Worksheet. Complete one copy of this separate worksheet for each facility.

7.3.7 Step 7 — Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that prescribed by the *Life Safety Code*, using Worksheet 7.3.7, Conclusions. Worksheet 7.3.7 combines the zone fire safety equivalency evaluation of Worksheet 7.3.5 and the additional considerations of Worksheet 7.3.6.

7.4 Glossary for Fire Safety Evaluation Worksheet for a Large Facility.

7.4.1 Introduction. This glossary is provided to assist in completing the "Fire Safety Evaluation Worksheet for a Large Facility" to determine the suitability of a large facility to house a board and care occupancy. The instructions for the mechanisms of completing the worksheet are included in Section 7.5. They are not repeated in this glossary. This glossary provides expanded discussion and definitions for the various items in the worksheet to assist the user where questions of definition or interpretation arise. To the maximum extent possible, the glossary does not repeat the definitions already existing in NFPA *101* but rather references the appropriate paragraphs in NFPA *101*.

7.4.2 Areas of Application.

7.4.2.1 The entire residence is evaluated on one set of worksheets to the degree indicated by each item on the worksheets. See Worksheets 7.5.1 through 7.5.7. However, spaces that are not used for living units, not in direct utility or maintenance support of the living units, not provided for resident use, or not in any way involved in resident emergency egress shall be

WORKSHEET 7.3.1 COVER SHEET

Fire Safety Evaluation Worksheet for a Small Board and Care Facility

Facility Identification ______________________________

Evaluator ______________________ Date ______________________

WORKSHEET 7.3.2 SAFETY PARAMETER VALUES — SMALL FACILITY

Safety Parameters	Parameter Values		
1. Construction/ Fire Resistance	Exposed Structural Members	Protected 15 min	Protected 1 hr
	0	1	3
2. Hazardous Areas	Double Deficiency	Single Deficiency	None or No Deficiency
	−7	−4	0
3. Manual Fire Alarm	None or Incomplete	W/O F.D. Notification	W/ F.D. Notification
	0	1	2

Safety Parameters	Parameter Values				
4. Smoke Detection and Alarm	None or Incomplete	Single Lev. Det./ Limited Warning	Warning to All Bedrooms: Every Lev. Det.[e]	Warning to All Bedrooms: Every Lev. Plus Det. in Each Bdrm.	Total Coverage System
	−4	0	2	3(4)[f]	4

Safety Parameters	Parameter Values		
5. Automatic Sprinklers	Nonsprinklered	Standard Sprinklers	Quick-Response or Residential Sprinklers
	0	8	10
6. Interior Finish	Flame-Spread Ratings		
	>75 to ≤200	>25 to ≤75	≤25
	−3	−1	0

Safety Parameters	Unprotected Vertical Openings			Protected Vertical Openings[d]					
7. Separation of Sleeping Rooms (from other levels and from corridors)	None or Incomp.	Smoke Resisting W/O Closers	Smoke Resisting W/ Closers	None or Incomp.	Smoke Resisting	½ hr	½ hr Auto-Closing	Smoke Res. W/ Door Closer	½ hr W/ Door Closer
	−6	−4	0(0)[c]	−2	0	1(0)[a]	2(0)[a]	1	2(1)[a]

Safety Parameters		<2 Remote Routes: W/O Alt. Means	<2 Remote Routes: W/ Alt. Means	2 Remote Routes Unseparated	2 Remote Routes Separated	Direct Exit from Each Bdrm.
8. Means of Escape	Means of Escape on All Sleeping Levels	−1	0	1(0)[b]	2(0)[b]	3(0)[b]

Safety Parameters		Primary Route Not Protected: <2 Remote Routes, W/O Alt. Means	Primary Route Not Protected: <2 Remote Routes, W/ Alt. Means	Primary Route Not Protected: 2 Remote Routes	Primary Route Protected: <2 Remote Routes, W/O Alt. Means	Primary Route Protected: <2 Remote Routes, W/ Alt. Means	Primary Route Protected: 2 Remote Routes
8. Means of Escape	Means of Escape Not on All Sleeping Levels	−4	−3	0	−1	0	2(0)[b]

[a] Use ( ) if Parameter 1 is 0 and Parameter 5 is 0.
[b] Use (0) if Parameter 7 is based on a “none or incomplete” situation.
[c] Use (0) if door is 20-minute and has automatic closer.
[d] Consider a single-level building as having protected vertical openings.
[e] Every level detection is permitted to be omitted with quick-response automatic sprinklers throughout; however, detection in each bedroom is required.
[f] Use (4) in existing buildings if detection in each bedroom and quick-response automatic sprinklers throughout.

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FIGURE 7.3 Worksheets for Evaluating Fire Safety in a Small Facility.

WORKSHEET 7.3.3 INDIVIDUAL SAFETY EVALUATIONS — SMALL FACILITY

Parameters	Fire Control (S_1)	Egress (S_2)	Refuge (S_3)	General Fire Safety (S_4)
1. Construction				
2. Hazardous Areas		$\prod$ 2 =		
3. Manual Fire Alarm	$\prod$ 2 =	*(See note.)*		
4. Smoke Detection and Alarm	$\prod$ 2 =		$\prod$ 2 =	
5. Automatic Sprinklers		$\prod$ 2 =		
6. Interior Finish	$\prod$ 2 =			
7. Separation of Sleeping Rooms				
8. Means of Escape				
Total	S_1 =	S_2 =	S_3 =	S_4 =

NOTE: Maximum value of manual fire alarm for means of escape is 1.

WORKSHEET 7.3.4A MANDATORY SAFETY REQUIREMENTS — NEW SMALL FACILITY

Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
10.5	5	11.5	7

WORKSHEET 7.3.4B MANDATORY SAFETY REQUIREMENTS — EXISTING SMALL FACILITY

Level of Evacuation Difficulty	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
Prompt	0	4	2	1
Slow	2	7	4	7
Slow*	1	6	2	5
Impractical	8	9	9	10

*Use these mandatory safety requirements if evacuation time is 8 minutes or less or if the evacuation capability score is 3 or less as determined by Chapter 6.

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FIGURE 7.3 *Continued*

WORKSHEET 7.3.5 EQUIVALENCY EVALUATION

						Yes	No
Control Provided (S_1)	minus	Required Control (S_a)	≥	0	S_1 [ ] – S_a [ ] = [ ]		
Egress Provided (S_2)	minus	Required Egress (S_b)	≥	0	S_2 [ ] – S_b [ ] = [ ]		
Refuge Provided (S_3)	minus	Required Refuge (S_c)	≥	0	S_3 [ ] – S_c [ ] = [ ]		
General Fire Safety (S_4)	minus	Required Gen. Fire Safety (S_d)	≥	0	S_4 [ ] – S_d [ ] = [ ]		

WORKSHEET 7.3.6 FACILITY FIRE SAFETY REQUIREMENTS WORKSHEET

Considerations	Met	Not Met
Complies with the applicable requirements of Sections 32.7 and 33.7 (NFPA *101*).		

WORKSHEET 7.3.7 CONCLUSIONS

1. ☐ All of the checks in Worksheet 7.3.5 are in the “Yes” column and all applicable considerations in Worksheet 7.3.6 are identified as “Met”. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for small residential board and care occupancies.

2. ☐ All of the checks in Worksheet 7.3.5 are in the “Yes” column and all considerations identified in Worksheet 7.3.6 as “Not Met” have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for small residential board and care occupancies.

3. ☐ One or more of the checks in Worksheet 7.3.5 are in the “No” column or any consideration identified in Worksheet 7.3.6 as “Not Met” has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for small residential board and care occupancies.

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FIGURE 7.3 ***Continued***

permitted to be omitted from the calculation where such space is separated from all of the resident spaces and resident-support spaces by 2-hour fire resistance–rated construction (including any building members that support the resident areas and emergency egress routes). In such a case, however, any appropriate charges under Safety Parameter 2, "Hazardous Areas," in Worksheet 7.5.2 shall be charged. Also, the assignment of values for Safety Parameter 3, "Manual Fire Alarm"; Safety Parameter 7, "Exit System"; and Safety Parameter 8, "Exit Access," shall not consider conditions in unoccupied spaces that do not involve any egress paths.

7.4.2.2 Note that zoning of buildings shall be permitted, and individual zones shall be permitted to have different safety values (levels). Such zoning shall, however, be limited to considerations of differences in Safety Parameters 6, 7, and 8, which cover exits and separation of sleeping areas. Zoning shall be by separate fire/smoke zones. A fire/smoke zone is a portion of the building separated from all other portions of the building by building construction having at least a 1-hour fire resistance rating or smoke barriers, or both, conforming to the requirements of Section 8.5 of NFPA *101* using smoke barriers of at least a ½-hour fire resistance rating. Zoning of the facility also shall be permitted in non–fire-resistive sprinklered buildings, provided the construction separating one zone from another is sound- and smoke-resistant.

7.4.3 Maintenance. All protection systems, requirements, arrangements, and procedures shall be maintained in a dependable operating condition, and a sufficient state of readiness, and shall be used in such a manner that the intended safety function or hazard constraint is not impaired. Otherwise, they shall receive no credit in the evaluation.

7.4.4 Safety Parameters (Worksheet 7.5.2). The safety parameters are a measure of those building factors that bear on or contribute to the safety of those persons who might be in the building at the time of a fire. Each of the safety parameters is to be analyzed, and the safety value for each parameter that best describes the condition in the building is to be identified. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value shall be used.

7.4.4.1 Construction.

7.4.4.1.1 Number of stories in height is defined in 4.6.3 (NFPA *101*).

7.4.4.1.2 Where the facility includes additions or connected structures of different construction, the rating and classification of the structure shall be based on the following:

(1) Separate buildings where a 2-hour or greater fire resistance–rated separation exists between the portions of the building
(2) The lower safety parameter point score involved where such a separation does not exist

7.4.4.1.3 The safety parameter values for Type V(000), Type III(200), and Type II(000) receive a higher parameter credit if the building is fully sheathed. This credit is to be given if all portions of the bearing walls, bearing partitions, floor construction, and roofs [or a roof/loft system if the space above the highest ceiling is inaccessible and either is provided with draft stops or other barriers on 30 ft (9.1 m) spacing or is provided with heat- or smoke-actuated fire detectors that sound the building fire alarm], and all columns, beams, girders, trusses, or similar bearing members either have an inherent fire resistance or are sheathed, encased, or otherwise treated to provide approximately a ½-hour or greater fire resistance rating. Buildings fully sheathed with sound lath and plaster, gypsum board, or equivalent sheathing are considered as meeting these criteria.

7.4.4.2 Hazardous Areas. The assignment of parameter values for hazardous areas is a four-step process.

7.4.4.2.1 Step 1 — Identify Hazardous Areas. Hazardous areas are those having a degree of hazard greater than that normal to the general occupancy of the building, such as areas for storage of combustibles or flammables, for heat-producing appliances, or for maintenance purposes.

7.4.4.2.2 Step 2 — Determine the Level of Hazard.

7.4.4.2.2.1 There are two levels of hazard: structurally endangering and not structurally endangering.

(A) Structurally Endangering. A hazardous occupancy with sufficient fire or explosion potential to defeat the basic integrity of the building framing as defined in 7.4.4.1.

(B) Not Structurally Endangering. A hazardous occupancy with sufficient fire potential to build to full involvement and present a danger of propagating through openings or wall partitions but not possessing sufficient total potential to endanger the structural framing or floor decking as defined in 7.4.4.1.

7.4.4.2.2.2 Table 7.4.4.2.2.2 provides an analysis of typical types of hazardous areas relative to inherent potential structural danger to different classes of structural systems.

7.4.4.2.3 Step 3 — Determine the Fire Protection Provided.

7.4.4.2.3.1 The parameter value for hazardous areas is based on the presence or absence of the fire protection necessary to control or confine the hazard. Two different types of fire protection are considered. The first consists of automatic sprinklers or other appropriate extinguishing systems covering the entire hazard. The second is a complete fire resistance–rated enclosure, including the separation of the hazardous area from any bearing members, partitions separating the hazardous area from all other spaces, and doors to the space sufficient to exceed the potential of the fire load involved. Any hazardous space that has either of these protection systems is classed as having single protection. Any hazardous space that is both fully enclosed — as described above— and sprinklered is classed as having both (i.e., double-level protection). On this basis, any hazardous area with a fuel load that has the potential of overwhelming the available structural capability could, as a minimum, have a single deficiency as determined in 7.4.4.2.4.

7.4.4.2.3.2 Note that where the hazardous area is within a living unit or abuts an egress route (exit or exit access) addressed in 7.4.4.7 and 7.4.4.8, the credit for sprinklers shall not be permitted unless the hazardous area is separated from the rest of the living unit or the egress route by reasonably smoke-resisting barriers and doors.

7.4.4.2.4 Step 4 — Determine Degree of Deficiency and Assign Parameter Values. The parameter value ultimately is determined by the degree of the deficiency of the hazardous area based on the level of protection needed. Table 7.4.4.2.4 provides a matrix to be used for determining the degree of deficiency to be assessed. In some situations, more than one

Table 7.4.4.2.2.2 Hazardous Areas — Level of Hazard

Large Facility — Inherent Structural Danger from Typical Hazardous Areas			
Exposure (area, space, activity, condition)	Minimum Fire Resistance Rating of Bearing Walls, Bearing Partitions, Columns, Beams, Girders, Trusses, and Floor/Ceiling Assemblies Exposed to Hazardous Area		
	≥2 hours	≥1 hour to <2 hours	<1 hour
Occupational therapy space	N/SE	Varies*	SE
Craft shop	N/SE	Varies*	SE
General storage area	N/SE	Varies*	SE
Garage	N/SE	N/SE	SE
Boiler, heater, or incinerator rooms	N/SE	Varies*	SE
Fuel storage	N/SE	SE	SE
Trash chutes	N/SE	SE	SE
Trash rooms	N/SE	SE	SE
Small trash collection room	N/SE	N/SE	SE
Laundries (institutional type)	N/SE	N/SE	SE
Repair shops	N/SE	Varies*	SE

N/SE: not structurally endangering. SE: structurally endangering.
*Must be judged on the combustibles involved in the individual situation.

hazardous area with the same or differing levels of deficiency exists. The overall parameter value then is based on the single most serious deficiency for the hazardous area.

7.4.4.3 Manual Fire Alarm. Fire alarms are defined in 7.4.4.3.1 through 7.4.4.3.3.

7.4.4.3.1 None or Incomplete. There is no fire alarm system, or the system is incomplete and does not meet the requirements for a higher-scored category.

7.4.4.3.2 Without Fire Department Notification (W/O F.D. Notification). There is a fire alarm system that meets the requirements of 32.3.3.4 and 33.3.3.4 (NFPA *101*), as appropriate.

7.4.4.3.3 With Fire Department Notification (W/ F.D. Notification). There is a fire alarm system that complies with 7.4.4.3.2 and automatically transmits a signal to the fire department in accordance with 9.6.4 (NFPA *101*).

7.4.4.4 Smoke Detection and Alarm. All references to detectors herein refer to smoke detectors. No credit is given for thermal detectors in habitable spaces except as specifically noted. Heat detectors can be credited in uninhabitable spaces where ambient temperatures can be expected to exceed 120°F (50°C) or fall below 0°F (–18°C) (such as in unfinished attics or cocklofts), provided separation from inhabited spaces is at least ½-hour fire resistance–rated. The categories under this parameter are described in 7.4.4.4.1 through 7.4.4.4.4.

7.4.4.4.1 None or Incomplete. There are no detectors, or those that are present do not meet the requirements for a higher-scored category.

7.4.4.4.2 Single-Station Units in Each Bedroom. There is one single-station detector (sounds the alarm only at the responding detector) in each bedroom or sleeping room.

7.4.4.4.3 Interconnected System. Interconnected systems are those systems where the operation of any detector sounds alarm devices that alert all of the occupants. The alarm sounding device shall be permitted to be on other interconnected detectors or be other separate alarm devices. Where the systems are of the total building variety, the credit shall be permitted to be given only if the system includes manual fire alarm features or the building has a manual fire alarm system and the operation of the detection system sounds the manual fire alarm as though a fire alarm box on that story had been operated.

7.4.4.4.3.1 Corridors and Common Spaces Without Bedroom/Suite Detectors. The system meets the requirements of 32.3.3.4.8 and 33.3.3.4.8 (NFPA *101*).

7.4.4.4.3.2 Corridors and Common Spaces with Single-Station Bedroom/Suite Detectors. There is one single-station detector

Table 7.4.4.2.4 Hazardous Areas — Degree of Deficiency

	No protection	Sprinkler protection	Fire resistance–rated enclosure	Sprinklered and fire resistance–rated enclosure
Not structurally endangering	Single deficiency	No deficiency		
Structurally endangering	Double deficiency	Single deficiency	No deficiency* Double deficiency†	No deficiency* Single deficiency†

*If fire resistance and structural strength exceed maximum potential of hazard.
†If fire resistance and structural strength are not sufficient to withstand potential of hazard.

in each bedroom or sleeping room and interconnected detectors in corridors and common spaces that are spaced as described in 7.4.4.4.3.1.

7.4.4.4.3.3 Corridors and Common Spaces with Interconnected Bedroom/Suite Detectors. The system is as in 7.4.4.4.3.2, except bedroom/suite detectors are interconnected with corridor/common space detectors. In buildings in which construction as specified in 7.4.4.1 is based on all members having a fire resistance rating of at least ½ hour or more, a system as described in 7.4.4.4.3.2 that also has a thermal detector in each bedroom/suite connected to the building fire alarm system shall be permitted to be credited in this category.

7.4.4.4.4 Total Building System. This system includes detectors located in every bedroom throughout the building and also provides detector coverage throughout all corridors, common spaces, and hazardous areas, with the system meeting the requirements for an automatic fire alarm system in accordance with *NFPA 72*.

7.4.4.5 Automatic Sprinklers. Any sprinkler installation that meets the requirements of 32.3.3.5 and 33.3.3.5 (NFPA *101*).

7.4.4.5.1 None or Incomplete.

7.4.4.5.1.1 No credit is given if there are no sprinklers or if sprinklers, though present, are not sufficient to qualify for one of the other categories specified herein.

7.4.4.5.1.2 Note that any space that is credited as being protected by automatic sprinklers and abuts a hazardous area judged deficient in accordance with 7.4.4.2 shall not be permitted to be considered as sprinkler protected unless the hazardous area also is sprinkler protected.

7.4.4.5.2 Bedrooms/Suites Only. All bedrooms/suites have sprinkler protection.

7.4.4.5.3 Corridors and Common Spaces. Sprinkler protection covers all of the corridors and public spaces that separate, directly expose, or are in the egress path from the bedrooms/suites (except fire resistance–rated, enclosed, noncombustible stairwells). Sprinklers shall be installed along the corridor ceiling, and, in addition, one sprinkler shall be installed opposite the center of and inside of any bedroom door opening onto the corridor.

7.4.4.5.4 Bedrooms/Suites, Corridors, and Common Spaces. Sprinkler protection meets the combined requirements for 7.4.4.5.2 and 7.4.4.5.3 and is equipped with an automatic alarm initiating device that activates the building manual fire alarm system or an alternate evacuation alarm.

7.4.4.5.5 Total Building. The building is totally sprinkler protected and is equipped with an automatic alarm initiating device that activates the building manual fire alarm system or an alternate evacuation alarm.

7.4.4.6 Separation of Sleeping Rooms from Exit Access. Separation of sleeping rooms from exit access is based on the wall partitions that make up the separation and the protection of the openings in those partitions.

7.4.4.6.1 The charge for "None or Incomplete" (Safety Parameter 6 in Worksheet 7.5.2) is assessed in any case where the separation of sleeping rooms from exit access is insufficient to meet any of the other classifications in this parameter.

7.4.4.6.2 Criteria for "Expectation of Door Closing."

7.4.4.6.2.1 Expectation — Not High. This credit is given if the requirements for "expectation — high" are not met.

7.4.4.6.2.2 Expectation — High. High expectation of a door closing (or being closed at time of fire) shall be considered to be met if the requirements of 32.3.3.6.5 and 33.3.3.6.6 (NFPA *101*) are met.

7.4.4.6.3 Smoke Resisting. Sleeping rooms are separated from corridors or other common spaces by walls, partitions, or other constructions that resist the passage of smoke. There are no louvers, transfer grilles, operable transoms, or other air passages penetrating the wall except properly installed heating and utility installations. Doors, in walls or partitions that separate sleeping rooms from corridors or other common spaces, resist the passage of smoke and are provided with latches, door closers, or other mechanisms suitable for keeping the doors tightly closed. Vision panels shall be permitted to be installed in doors or partitions without respect to glass type or size.

7.4.4.6.4 Half-Hour. The credit is given if the requirements of 32.3.3.6.3 through 32.3.3.6.6 and 33.3.3.6.3 through 33.3.3.6.6 (NFPA *101*) are met.

7.4.4.6.5 1-Hour Walls, 20-Minute Doors. Sleeping rooms are separated from corridors or other common spaces by walls or partitions and doors meeting the requirements of 7.4.4.6.4, and the walls and partitions have at least a 1-hour fire resistance rating.

Exception: Where doors meet the requirements of 7.4.4.6.4 and automatic sprinklers are provided on both sides of the door.

7.4.4.7 Exit System. Exit systems are the paths of travel from the facility to the outside. For the purposes of this parameter, however, only those exit routes used in fire drills in accordance with Sections 32.7 and 33.7 (NFPA *101*) shall be credited.

7.4.4.7.1 Exposed Route. An exit route is exposed if a segment of that route is the only available route for one or more residents and that segment of the exit route is not safeguarded by one of the following means:

(1) Separation from all other rooms or areas by walls and doors of equivalent separation to that credited in 7.4.4.6
(2) Protection of the other rooms or spaces by an automatic sprinkler system
(3) Protection of the other rooms or spaces by a smoke detection and alarm system connected to activate the building evacuation alarm; and where furnishings, finishes, and furniture, in combination with all other combustibles within the space, are of such minimum quantity and are so arranged that a fully developed fire is unlikely to occur
(4) Cooking faclities permitted to be open to the corridor in accordance with 32.3.3.8 or 33.3.3.8 (NFPA *101*).

7.4.4.7.2 Multiple Routes. Multiple routes exist where the occupants of any sleeping room have, either from the sleeping room or through access in a corridor adjacent to the sleeping room, a choice of two separate exit routes to the outside.

7.4.4.7.3 Deficient. An exit route is deficient if it fails to meet any of the applicable criteria in 32.3.2 and 33.3.2 (NFPA *101*), except those related to travel distances and dead ends. These conditions are evaluated separately in 7.4.4.8.

7.4.4.7.4 Without Horizontal Exit (W/O Horiz. Exit). An egress system is based on this charge if there are multiple routes that are not deficient but the arrangement does not include a horizontal exit as defined in 7.4.4.7.5, or that have an acceptable direct exit from each sleeping room as defined in 7.4.4.7.7.

7.4.4.7.5 With Horizontal Exit (W/ Horiz. Exit). The presence of a single horizontal exit meeting the criteria in 7.2.4 (NFPA *101*) on each story containing sleeping rooms shall be considered as sufficient criteria to meet this requirement, provided that the space created is of sufficient size to provide at least 3 ft^2 (0.28 m^2) of accessible space for all of the potential occupants already present in or evacuating to such space.

7.4.4.7.6 Smokeproof Enclosure. Credit for a smokeproof enclosure shall be permitted to be given for a stairway designed and tested in accordance with the requirements of 7.2.3 (NFPA *101*) for a smokeproof enclosure. To receive credit for a smokeproof enclosure, all exit stairs credited in Safety Parameter 7, "Exit System," and Safety Parameter 8, "Exit Access," of Worksheet 7.5.2 shall meet the smokeproof enclosure requirements.

7.4.4.7.7 Direct Exit.

7.4.4.7.7.1 To be credited for direct exits, each sleeping room shall have within that unit a door that opens to the exterior at grade level or onto an unenclosed exterior balcony with direct access to an exterior exit or smokeproof enclosure. Where such openings are directly onto grade in a location where any person egressing can move directly away from the building without further exposure, the credit for direct exit shall be permitted, even if there are no other exit routes from the involved living unit.

7.4.4.7.7.2 Note that this parameter value does not cover the charges for the dead-end conditions, travel distance, interior finish in the egress routes (exits or exit access), or enclosure of stairways or other exit routes that pass from story to story. These elements are covered separately in 7.4.4.8, 7.4.4.9, and 7.4.4.10.

7.4.4.8 Exit Access. Exit access is a measurement of the travel distance from the sleeping rooms to the outside or to any other point of safety as defined in Section 3.3 (NFPA *101*), whichever is shorter.

7.4.4.9 Interior Finish.

7.4.4.9.1 Classification of interior finish on walls and ceilings of the occupied space shall be in accordance with Section 10.2 (NFPA *101*). Choose the safety parameter value in Worksheet 7.5.2 based on the interior finish material provided. For example, if the interior wall finish material has a flame-spread index of between 25 and 75, do not take the parameter value associated with a flame-spread index of less than 25 regardless of the presence of automatic sprinkler protection. The mandatory values have been calibrated to take into consideration any sprinkler protection provided. Exposed portions of structural members complying with the requirements of Type IV(2HH) construction shall be permitted.

7.4.4.9.2 Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286 as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

7.4.4.9.3 Only floor coverings in the exit and exit access system are considered. For purposes of assigning the parameter values in Worksheet 7.5.2, such floor coverings are considered as having a flame-spread index ≤25 if they meet the requirements for Class I or Class II and as otherwise having a flame-spread index >75. Previously installed floor coverings shall be permitted, subject to the approval of the authority having jurisdiction.

7.4.4.9.4 No consideration is included in the safety parameter value for any interior wall or ceiling finish material with a flame-spread index greater than 200 as measured by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Some materials, including foam plastics, high density polyethylene, and polypropylene, are not permitted to be tested in accordance with ASTM E84 and must be tested in accordance with NFPA 286 and must meet the acceptance criteria shown in 10.2 (NFPA *101*). Some materials, including asphalt-impregnated paper, are capable of inducing extreme rates of fire growth and rapid flashover. In any case involving these materials, the resultant hazard is considered beyond the capacity of this evaluation system and requires an individual fire hazard assessment. Note that plywood of $\frac{1}{4}$ in. (6 mm) or greater thickness should be considered as having a flame-spread index of ≤200.

7.4.4.10 Vertical Openings.

7.4.4.10.1 These values apply to vertical openings and penetrations, including exit stairways, ramps, and any other vertical exits, pipe shafts, ventilation shafts, duct penetrations, and laundry and incinerator chutes. The charge for vertical openings shall be based on the presence or lack of enclosure and the fire resistance rating of the enclosure, if provided.

7.4.4.10.2 A vertical opening or penetration shall be classified as open, provided any of the following conditions apply:

(1) It is unenclosed.
(2) It is enclosed but does not have doors.
(3) It is enclosed but has openings other than doorways.
(4) It is enclosed with cloth, paper, or similar materials without any sustained firestopping capabilities, except as permitted by 32.3.3.1 and 33.3.3.1 (NFPA *101*), as appropriate.

7.4.4.10.3 If a shaft other than a credited exit route (i.e., credited as one of the multiple routes required in 7.4.4.7.2 or in determining travel distance in 7.4.4.8) is enclosed on all stories but one and this results in an unprotected opening between that shaft and one, and only one, story, the parameter value assigned to that shaft shall be 0. If a required egress route is contained in that shaft, the parameter value shall be –2.

7.4.4.11 Smoke Control. Smoke control definitions are provided in 7.4.4.11.1 through 7.4.4.11.5.

7.4.4.11.1 None. There are no smoke barriers (or horizontal exits) on the story, the story is not served by a smokeproof enclosure, and there are no mechanically assisted smoke control systems serving the story.

7.4.4.11.2 Smoke Barrier. Smoke barriers consist of installations conforming to the requirements of 32.3.3.7 and 33.3.3.7 (NFPA *101*), as appropriate. The full value for the presence of smoke barriers is awarded where an existing separation is by smoke partitions complying with Section 8.4 (NFPA *101*) on stories used for sleeping by not more than 30 residents.

7.4.4.11.3 Mechanically Assisted Systems — by Story. Mechanically assisted smoke control on a corridor basis is a tested and accepted smoke control system initiated by a method of smoke detection that ensures operation of the smoke control system before significant smoke has entered into the corridor involved. One method of judging the acceptability of smoke control systems is contained in NFPA 92.

7.4.4.11.3.1 The mechanism must be capable of pressurizing the corridor sufficiently to prevent smoke from the room/suite or space of origin from entering the corridor during the entire course of the fire. Such a system must be able to hold back the smoke through the expected maximum severity of the fire. It also must be capable of exhausting smoke from the corridor based on the assumption that the emergency evacuation procedures and other activities involving the opening and closing of doors will cause occasional brief periods during which the smoke control system is overpowered.

7.4.4.11.3.2 This results in the movement of the smoke from the fire area into the corridor. (The exhausting of the smoke normally would be accomplished by having an exhaust fan of lower capacity than the fan supplying air for pressurization exhaust from the corridor. The net pressurization force would occur from the effect of the pressurizing fan minus the effect of the removal or purging fan.)

7.4.4.11.3.3 The corridor's pressurizing system could involve early warning smoke detection, automatic closing of all room/suite doors, sprinkler protection, or all three. Where these additional protection devices are provided to effect such a smoke control system, the individual credits for each of the involved protection devices are in addition to the credits for the smoke control system.

7.4.4.11.4 Mechanically Assisted Systems — by Zone. Mechanically assisted smoke control on a zone basis shall include a smoke barrier (or a horizontal exit) supported by a tested and accepted smoke control system to provide a pressure differential that assists in confining smoke to the compartment of origin. One method of judging the acceptability of smoke control systems is contained in NFPA 92. Special smoke control fans shall be permitted to be used, or special adjustments of the normal building air movement fans shall be permitted to be made.

7.4.4.11.5 Mechanically Assisted Systems — by Room/Suite. Mechanically assisted smoke control on a room/suite basis is a tested and accepted smoke control system so designed as to provide a mechanism of automatically controlled fans, smoke vent shafts, or a combination thereof to ensure a positive pressure differential that prevents intrusion of smoke into any room or suite not involved in fire. One method of judging the acceptability of smoke control systems is contained in NFPA 92. In this method, the rooms have a pressure differential higher than that of the corridor and of any room where fire has been detected. Such systems shall be so arranged that there is detection in each room or suite that prevents a room involved in fire from becoming positively pressurized.

7.5 Worksheets for Evaluating Fire Safety in a Large Facility. A large facility normally is one that has a capacity for more than 16 residents. For each such facility to be evaluated, the seven-step process in Figure 7.5 should be followed when evaluating fire safety.

7.5.1 Step 1 — Complete Cover Sheet Using Worksheet 7.5.1. See Figure 7.5.

7.5.2 Step 2 — Determine Safety Parameter Values, Using Worksheet 7.5.2. Select and circle the safety value for each safety parameter that best describes the conditions in the facility. Choose only one value for each of the 11 parameters. If two or more values appear to apply, choose the one with the lowest point value.

7.5.3 Step 3 — Complete Individual Safety Evaluations Using Worksheet 7.5.3. The following steps should be taken:

(1) Transfer each of the 11 circled safety parameter values from Worksheet 7.5.2 to every available block in the line with the corresponding safety parameter in Worksheet 7.5.3. Where the block is marked "÷ 2 =," enter one-half the value from Worksheet 7.5.2.
(2) Add each of the four columns, keeping in mind that any negative numbers need to be deducted.
(3) Transfer the resulting values for S_1, S_2, S_3, and S_4 to the corresponding blocks in Worksheet 7.5.5.

7.5.4 Step 4 — Determine Mandatory Requirements Using Worksheet 7.5.4A, 7.5.4B, or 7.5.4C. The following steps should be taken:

(1) Select the level of requirements from Worksheet 7.5.4A, 7.5.4B, or 7.5.4(C). Circle the appropriate values.
(2) Transfer the circled values from Worksheet 7.5.4A, 7.5.4B, or 7.5.4C to the corresponding blocks for S_a, S_b, S_c, and S_d in Worksheet 7.5.5.

7.5.5 Step 5 — Evaluate Equivalency. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 7.5.5. Enter the differences in the appropriate answer blocks.
(2) For each row, check "yes" if the value in the answer block is zero (0) or greater. Check "no" if the value in the answer block is a negative number.

7.5.6 Step 6 — Evaluate Other Considerations Not Previously Addressed, Using Worksheet 7.5.6. The equivalency covered by Worksheets 7.5.2 through 7.5.5 includes the majority of the considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 7.5.6, Facility Fire Safety Requirements Worksheet. Complete one copy of this separate worksheet for each facility.

7.5.7 Step 7 — Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that prescribed by the *Life Safety Code*, using Worksheet 7.5.7, Conclusions. Worksheet 7.5.7 combines the zone fire safety equivalency evaluation of Worksheet 7.5.5 and the additional considerations of Worksheet 7.5.6.

7.6 Glossary for Fire Safety Evaluation Worksheet for an Apartment Building with Board and Care Occupancies.

7.6.1 Introduction. This glossary is provided to assist in completing Figure 7.7, Worksheets for Evaluating Fire Safety in an Apartment Building with Board and Care Occupancies, to determine the suitability of an apartment building to house a board and care occupancy. This is a two-step procedure. The first step is to evaluate the portion of the building used as a board and care home; the second step evaluates the remainder of the building. The instructions for completing Figure 7.7 are included in Section 7.7. They are not repeated in this glossary. This glossary provides expanded discussion and definitions for the various items in the worksheets to assist the user where questions of definition or interpretation arise. To the maximum extent possible, the glossary does not repeat the defini-

WORKSHEET 7.5.1 COVER SHEET

Fire Safety Evaluation Worksheet for a Large Board and Care Facility

Facility Identification ______________________________ Zone(s) Evaluated ______________________________

Evaluator ______________________________ Date ______________________________

WORKSHEET 7.5.2 SAFETY PARAMETER VALUES — LARGE FACILITY

Safety Parameters	Parameter Values							
1. Construction	Combustible					Noncombustible		
Stories in Height	Type V(000)	Type V(111)	Type III(200)	Type III(211)	Type IV (2HH)	Type II(000)	Type II(111)	Type II(222) & Type I
1 Story	−2( )[a]	0	−2( )[a]	0	0	0	2	2
2 Stories	−6( )[a]	0	−6( )[a]	0	0	−5( )[a](0)[s]	2	2
3–4 Stories	−8( )[a]	−2(0)[q]	−8( )[a]	0	−2(0)[q]	−6( )[a]	2	2
5–6 Stories	−8	−2(0)[q]	−8( )[a]	0	−2(0)[q]	−6( )[a]	2	2
Over 6 Stories	−10	−4	−10	−2(0)[q]	−4(0)[q]	−8	0	2

2. Hazardous Areas	Within Bdrms./Suite or on Exit Routes		Elsewhere in Building		None, or No Deficiency
	Double Deficiency	Single Deficiency	Double Deficiency	Single Deficiency	
	NP	−4	−4(−7)[b]	0(−4)[b]	0(−1)[t]

3. Manual Fire Alarm	None or Incomplete	Manual Alarm	
		W/O F.D. Notification	W/ F.D. Notification
	0(2)[f]	2	3

4. Smoke Detection and Alarm	None or Incomplete	Single Station Units in Each Bedroom	Interconnected System[i]			Total Building
			W/O Bdrm./Suite Detectors	Single Station Bdrm./Suite Detectors	Interconnected Bdrm./Suite Detectors	
	−10(0)[j]	0(2)[j]	2(0)[e]	3(0)[e](6)[p]	5(6)[p]	6

5. Automatic Sprinklers	None or Incomplete	Bdrms./Suites Only	Corrs., Common Spaces	Bdrms./Suites, Corrs., Common Spaces	Total Building	
					AS	QRS
	0	2(0)[c]	4(0)[c]	6	8	10

6. Separation of Sleeping Rooms From Exit Access	None or Incomplete	Fire Resistance/Walls and Doors—Expectation of Door Closing				
		Expectation—Not High		Expectation—High		
		Smoke Resisting[g]	½-hr Walls 20-min Doors[g,r]	Smoke Resisting[g]	½-hr Walls 20-min Doors[g,r]	1-hr Walls 20-min Doors[g]
	−6	−1(0)[k]	0(1)[k]	1	2(3)[l]	3(4)[l]

7. Exit System	Single or Exposed Route	Multiple Routes				Direct Exit
		Deficient	W/O Horiz. Exit	W/ Horiz. Exit	Smokeproof Enclosure	
	−6(0)[m]	−2(0)[m]	0	2	2	4

8. Exit Access (from living unit)	Max. Dead End		No Dead End >30 ft and Travel Is:			
	>100 ft	>30 ft to ≤100 ft	>250 ft	>125 ft to ≤250 ft	>50 ft to ≤125 ft	≤50 ft
	−6(0)[d]	−4(0)[d]	−2	−1	0	2

9. Interior Finish	Flame-Spread Ratings					
Exit Routes	>75 to ≤200		>25 to ≤75		≤25	
Rooms/Suites	>75 to <200	≤75	>75 to ≤200	≤75	>25 to ≤200	≤25
	−3	−1	0	1	1	2

10. Vertical Openings	Open (or Incomplete Enclosure)			Enclosed[h]		
	Involving 5 or More Stories	3–4 Stories	2 Stories	<30 min	≥30 min <1 hr	≥1 hr
	−10	−7	−2	−1	0	1(0)[b]

(Worksheet 7.5.2 continues)

(For use with NFPA 101A-2016/NFPA *101*-2015, B & C Large) (p. 1 of 4)

FIGURE 7.5 Worksheets for Evaluating Fire Safety in a Large Facility.

Worksheet 7.5.2 ***Continued***

11. Smoke Control	None	Smoke Barriers	Mechanically Assisted Systems: By Story W/O Part.	By Story W/ Part.	By Zone	By Rm./Suite
	0(2)[n]	2(2)[u]	2	3	3	4

[a] In existing facilities and for conversions, use (–1 × stories in height) if building is fully sheathed with plaster, gypsum board, or similar materials, but not < –2 if Parameter 5 is ≥8.
[b] Use ( ) if Parameter 1 is based on Type V(000), Type III(200), or Type II(000), if Note A does not apply, and if Parameter 5 is ≤4.
[c] Use ( ) if Parameter 1 is based on Type V(000), Type III(200), or Type II(000).
[d] Use ( ) if Parameter 7 is –6.
[e] Use ( ) if Parameter 6 is based on "none or incomplete," or "walls or doors" are ½-hour walls/20-minute doors and Parameter 5 is ≤4.
[f] Use ( ) for existing levels "prompt" and "slow" if Parameter 7 is 4 and building height is ≤3 stories.
[g] Rate separation as:
- In existing facilities, ½ hour (or actual rating, if greater) if Parameter 5 is ≥6.
- Smoke resisting if Parameter 1 is based on Type V(000), Type III(200), or Type II(000), if building is not fully sheathed per Note A, and if Parameter 5 is ≥4.

[h] Use 0 in 1-story building.

For SI units, 1 ft = 0.3048 m; 1 ft² = 0.092 m².

[i] Interconnected system covers corridors and common spaces plus indicated bedroom or suite detectors.
[j] Use ( ) if Parameter 5 is ≥6.
[k] Use ( ) in facilities where each bedroom/suite has occupant controlled personal security access locks.
[l] Use ( ) if separations between bedrooms/suites also meet criteria.
[m] Use ( ) if requirements for 33.3.3.6.1.2 (NFPA *101*) are met.
[n] Use ( ) if floor travel does not exceed 200 ft.
[p] Use (6) if facility protected throughout by quick-response automatic sprinklers, corridor and common space detectors, and bedroom/suite smoke alarms.
[q] Use (0) if Parameter 5 is ≥8.
[r] In new facilities, rate separation as ½-hour walls/20-minute doors, where doors are smoke resisting and walls are ½-hour fire resistance–rated if Parameter 5 is 10.
[s] Use (0) if Parameter 5 is 10.
[t] Use (– 1) if evacuation capability is impractical and fire-rated hazardous area separation barriers are not also smoke partitions.
[u] Use (2) if an existing separation is by smoke partition on stories used for sleeping by not more than 30 residents.

NP: Not permitted—system not usable while this condition exists.

WORKSHEET 7.5.3 INDIVIDUAL SAFETY EVALUATIONS — LARGE FACILITY

Safety Parameters	Fire Control (S_1)	Egress Provided (S_2)	Refuge Provided (S_3)	General Fire Safety Provided (S_4)
1. Construction		X		
2. Hazardous Areas		÷ 2 =		
3. Manual Fire Alarm	÷ 2 =		X	
4. Smoke Detection and Alarm	÷ 2 =		÷ 2 =	
5. Automatic Sprinklers		÷ 2 =	÷ 2 = *(See note.)*	
6. Separation of Sleeping Rooms from Exit Access		÷ 2 =		
7. Exit System	X		÷ 2 =	
8. Exit Access (from living unit)	X		X	
9. Interior Finish	÷ 2 =		X	
10. Vertical Openings	÷ 2 =			
11. Smoke Control	X			
Total	**S_1 =**	**S_2 =**	**S_3 =**	**S_4 =**

NOTE: Use full value if Safety Parameter 1 is based on Type V(000), Type III(200), or Type II(000) construction. Divide by 2 (÷ 2) in all other cases.

(For use with NFPA 101A-2016/NFPA *101*-2015, B & C Large) (p. 2 of 4)

FIGURE 7.5 ***Continued***

WORKSHEET 7.5.4A MANDATORY SAFETY REQUIREMENTS — NEW LARGE FACILITY

Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
1 Story	15	17	15	21
2 Stories	17.5	18	13	24
≥3 Stories	19.5	18	15	26

WORKSHEET 7.5.4B MANDATORY SAFETY REQUIREMENTS — EXISTING LARGE FACILITY WITH PROMPT OR SLOW EVACUATION CAPABILITY

Evacuation Capability and Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
Prompt ≤30 residents and 1 Story	1.5	7.5	2	6
Prompt or slow				
1 Story	3.5	8	4	8
2 Stories	2.5	8	3	7
3–6 Stories	4.5	8	5	9
>6 Stories	6.5	8	7	11

WORKSHEET 7.5.4C MANDATORY SAFETY REQUIREMENTS — EXISTING, SPRINKLER PROTECTED, LARGE FACILITY WITH PROMPT OR SLOW EVACUATION CAPABILITY

Evacuation Capability and Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
Prompt ≤30 residents 1 Story	5.5	3.5	6	5
Prompt or slow				
1 Story	5.5	3.5	6	5
2 Stories	1.5	3.5	2	1
3–6 Stories	5.5	3.5	6	5
>6 Stories	7.5	3.5	4	7

WORKSHEET 7.5.4D MANDATORY SAFETY REQUIREMENTS — EXISTING LARGE FACILITY WITH IMPRACTICAL EVACUATION CAPABILITY

Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
1 Story	6	6.5	8.5	8
2 Stories	2	6.5	4.5	4
3–6 Stories	6	6.5	8.5	8
>6 Stories	8	6.5	6.5	10

(For use with NFPA 101A-2016/NFPA *101*-2015, B & C Large) (p. 3 of 4)

FIGURE 7.5 ***Continued***

WORKSHEET 7.5.5 EQUIVALENCY EVALUATION

						Yes	No
Control Provided (S_1)	minus	Required Control (S_a)	≥	0	S_1 [ ] – S_a [ ] = [ ]		
Egress Provided (S_2)	minus	Required Egress (S_b)	≥	0	S_2 [ ] – S_b [ ] = [ ]		
Refuge Provided (S_3)	minus	Required Refuge (S_c)	≥	0	S_3 [ ] – S_c [ ] = [ ]		
General Fire Safety (S_4)	minus	Required Gen. Fire Safety (S_d)	≥	0	S_4 [ ] – S_d [ ] = [ ]		

WORKSHEET 7.5.6 FACILITY FIRE SAFETY REQUIREMENTS WORKSHEET

	Considerations	Met	Not Met	Not Applic.
A.	Utilities comply with the provisions of 32.3.6.1 and 33.3.6.1.			X
B.	Heating, ventilating, and air conditioning equipment comply with the provisions of 32.3.6.2 and 33.3.6.2, except for enclosure of vertical openings, which have been considered in Safety Parameter 10 of Worksheet 7.5.3.			X
C.	Elevators, dumbwaiters, and vertical conveyors comply with the provisions of 32.3.6.3 and 33.3.6.3.			
D.	Rubbish chutes, incinerators, and laundry chutes comply with the provisions of 32.3.6.4 and 33.3.6.4.			X
E.	Complies with the applicable requirements of Sections 32.7 and 33.7.			

All references are to NFPA *101*, *Life Safety Code.*

WORKSHEET 7.5.7 CONCLUSIONS

1. ☐ All of the checks in Worksheet 7.5.5 are in the "Yes" column and all applicable considerations in Worksheet 7.5.6 are identified as "Met". The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for large residential board and care occupancies.

2. ☐ All of the checks in Worksheet 7.5.5 are in the "Yes" column and all considerations identified in Worksheet 7.5.6 as "Not Met" have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for large residential board and care occupancies.

3. ☐ One or more of the checks in Worksheet 7.5.5 are in the "No" column or any consideration identified in Worksheet 7.5.6 as "Not Met" has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for large residential board and care occupancies.

Notes:

(For use with NFPA 101A-2016/NFPA *101*-2015, B & C Large) (p. 4 of 4)

FIGURE 7.5 ***Continued***

tions already existing in NFPA *101* but rather references the appropriate paragraphs in NFPA *101*.

7.6.2 Areas of Application.

7.6.2.1 The entire apartment building is evaluated on a form to the degree indicated by each item on the worksheet. See Worksheet 7.7.1. However, spaces that are not used for living units, are not in direct utility or maintenance support of the living units, are not provided for tenant use, or are not in any way involved in resident emergency egress shall be permitted to be omitted from the calculation where such space is separated from all of the tenant and tenant-support spaces by 2-hour fire resistance–rated construction (including any members that bear the load of tenant-use space and with 1½-hour fire doors in any communicating opening). In such cases, however, any appropriate charges under 7.6.4.2 in Safety Parameter 2, "Hazardous Areas," in Worksheet 7.7.2 shall be charged.

7.6.2.2 The suitability of the apartment unit actually used as the board and care home is evaluated separately and shall be permitted to be evaluated before or after evaluating the suitability of the apartment building.

7.6.2.3 Where evaluating an apartment unit, consider the common corridor as equivalent to the outside where evaluating egress routes. Also, where evaluating egress routes, credit a window only if it can be used in an emergency evacuation.

7.6.3 Maintenance. All protection systems, requirements, arrangements, and procedures shall be maintained in a dependable operating condition and a sufficient state of readiness and shall be used in such a manner that the intended safety function or hazard constraint is not impaired. Otherwise, they shall receive no credit in the evaluation.

7.6.4 Safety Parameters (Worksheet 7.7.2). The safety parameters are a measure of those building factors that bear on or contribute to the safety of those persons who might be in the building at the time of a fire. Each of the safety parameters is to be analyzed, and the safety value for each parameter that best describes the condition in the building is to be identified. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value shall be used.

7.6.4.1 Construction. The construction parameter values are applied to the entire building as defined in 7.6.4.1.1 through 7.6.4.1.3.

7.6.4.1.1 In evaluating the construction values, the height of the building is the story height of the board and care dwelling unit relative to the level of exit discharge, regardless of the total height of the building, which is defined as *stories in height* in Section 3.3 (NFPA *101*) and 4.6.3 (NFPA *101*).

7.6.4.1.2 Where the facility includes additions or connected structures of different construction, the rating and classification of the structure shall be based on the following:

(1) Separate buildings where a 2-hour or greater fire resistance–rated separation exists between the portions of the building
(2) The lower safety parameter point score involved where such a separation does not exist

7.6.4.1.3 The safety parameter values for Type V(000), Type III(200), and Type II(000) receive a higher parameter credit if the building is fully sheathed. This credit is to be given if all portions of the bearing walls, bearing partitions, floor construction, roofs [or a floor/loft system if the space above the highest ceiling is inaccessible and either is provided with draft stops or other barriers on 30 ft (9.1 m) spacing or is provided with heat- or smoke-actuated fire detectors that sound the building fire alarm], and all columns, beams, girders, trusses, or similar bearing members either have an inherent fire resistance or are sheathed, encased, or otherwise treated to provide approximately a ½-hour or greater fire resistance rating. Buildings fully sheathed with sound lath and plaster, gypsum board, or equivalent sheathing are considered to meet this criterion.

7.6.4.2 Hazardous Areas. The hazardous area parameter applies to the entire building except the apartment(s) actually used for the residential board and care facility. The assignment of charges for hazardous areas is a four-step process.

7.6.4.2.1 Step 1 — Identify Hazardous Areas. Hazardous areas are those having a degree of hazard greater than that normal to the general occupancy of the building, such as areas for storage of combustibles or flammables, for heat-producing appliances, or for maintenance purposes.

7.6.4.2.2 Step 2 — Determine the Level of Hazard. There are two levels of hazard: structurally endangering and not structurally endangering.

7.6.4.2.2.1 Structurally Endangering. A hazardous occupancy with sufficient fire or explosion potential to defeat the basic integrity of the building framing as defined in 7.6.4.1.

7.6.4.2.2.2 Not Structurally Endangering. A hazardous occupancy with sufficient fire potential to build to full involvement and present a danger of propagating through openings or wall partitions but not possessing sufficient total potential to endanger the structural framing or floor decking as defined in 7.6.4.1.

7.6.4.2.3 Step 3 — Determine the Fire Protection Provided. The parameter value for hazardous areas is based on the presence or absence of the fire protection necessary to control or find the hazard. Two different types of fire protection are considered. The first consists of automatic sprinklers or other appropriate extinguishing systems covering the entire hazard. The second is a complete fire resistance–rated enclosure, including the separation of the hazardous area from any bearing members, partitions separating the hazardous area from all other spaces, and doors to the space sufficient to exceed the potential of the fire load involved. Any hazardous space that has either of these protection systems is classed as having single protection. Any hazardous space that is both fully enclosed — as described above — and sprinklered is classed as having double-level protection. On this basis, any hazardous area with a fuel load that has the potential of overwhelming the available structural capability could as a minimum have a single deficiency as determined in 7.6.4.2.4. Note that, where the hazardous area abuts an egress route (exit or exit access) addressed in 7.6.4.7 and 7.6.4.8, the credit for sprinklers shall not be permitted unless the hazardous area is separated from the rest of the living unit or the egress route by reasonably smoke-resisting barriers and doors.

7.6.4.2.4 Step 4 — Determine Degree of Deficiency and Assign Parameter Values. The parameter value ultimately is determined by the degree of the deficiency of the hazardous area based on the level of protection needed. Table 7.6.4.2.4 provides a matrix for determining the degree of deficiency to be assessed. In some situations, more than one hazardous area with the same or differing levels of deficiency exists. The overall charge is based on the single most serious deficiency for the hazardous area.

7.6.4.3 Manual Fire Alarm. Manual fire alarms are defined in 7.6.4.3.1 through 7.6.4.3.3.

7.6.4.3.1 None or Incomplete. There is no manual fire alarm system, or the system is incomplete and does not meet the requirements for a higher-scored category.

7.6.4.3.2 Without Fire Department Notification (W/O F.D. Notification). There is a manual fire alarm system, regardless of the number of stories or units, meeting the appropriate requirements of 30.3.4.1 through 30.3.4.3 (NFPA *101*) and those requirements applicable to existing Option 1 apartment buildings in 31.3.4.1 through 31.3.4.3 (NFPA *101*).

7.6.4.3.3 With Fire Department Notification (W/ F.D. Notification). There is a manual fire alarm system that complies with the requirements of 7.6.4.3.2 and, in addition, automatically transmits a signal to the fire department in accordance with 9.6.4 (NFPA *101*).

7.6.4.4 Smoke Detection and Alarm. These parameter values apply only to apartments other than the group residence and to the areas used for apartment corridors and other common spaces. A detection system as used herein is one based on the use of smoke detectors. No credit is given for thermal detectors.

7.6.4.4.1 None or Incomplete. There are no detectors, or, if any are present, they do not meet the requirements for a higher-scored category.

7.6.4.4.2 Interconnected Systems. Interconnected systems are those systems where the operation of any detector sounds alarm devices on other detectors, or other separate alarm systems, that are spread out sufficiently to alert all of the building occupants. Where the systems are of the total building variety, the credit shall be permitted to be given only if the building has a manual fire alarm system and the operation of the detection system sounds the manual fire alarm as though a fire alarm box on that story had been operated. Interconnected systems must provide sounding devices that are sufficient in location and loudness to ensure the awakening of persons who sleep normally.

7.6.4.4.2.1 Corridors and Common Spaces. This parameter applies to those situations where there is at least one detector spaced every 30 ft (9.1 m) in corridors and an additional detector in all common use spaces for each 900 ft^2 (83.6 m^2) or less of floor space on that story. Detectors shall be permitted to be omitted from common use spaces that comply with one of the following:

(1) They are both sprinklered and protected from any egress routes or area of refuge or staging that serves the board and care home by the use of automatic-closing doors operated by smoke detection or activation of the sprinkler system.
(2) They are separated from the egress route or area of refuge or staging in 7.6.4.4.2.1(1) by fire resistance–rated construction and by automatic-closing doors of sufficient fire resistance rating to withstand the maximum fire potential in the common space.

7.6.4.4.2.2 Corridors and Common Spaces plus Each Level of Living Units. To be credited in this category, detectors must be provided in both of the following locations:

(1) Each living unit such that there is one detector or more in each single-level living unit or one detector or more on each level of any multilevel living unit
(2) Corridors and common spaces in accordance with the requirements of 7.6.4.4.2.1

7.6.4.4.3 Total Building System. A dwelling has a total building system if it meets the requirements of 31.3.4.4 for Option 2 (NFPA *101*).

7.6.4.5 Automatic Sprinklers. The parameter values for automatic sprinklers are based on the protection of spaces outside the apartment used for group residences.

7.6.4.5.1 None or Incomplete. No credit is given if there are no sprinklers or if sprinklers, though present, are not sufficient to qualify for one of the other categories specified herein. Note that any space that is credited as being protected by automatic sprinklers and abuts a hazardous area judged deficient in accordance with 7.6.4.2 shall not be permitted to be considered as sprinkler protected unless that hazardous area also is sprinkler protected.

7.6.4.5.2 Corridors, Public Spaces. Sprinkler protection covers all of the corridors and public spaces that separate, directly expose, or are in the egress path from the living units (except fire resistance–rated, enclosed, noncombustible stairwells). Sprinklers shall be installed along the corridor ceiling, and, in addition, one sprinkler shall be installed opposite the center of and inside of any living unit door opening onto the corridor.

7.6.4.5.3 Living Units Only. All living units have sprinkler protection complying with the requirements for light hazard protection in NFPA 13,NFPA 13D, or NFPA 13R, as appropriate.

Table 7.6.4.2.4 Hazardous Areas — Degree of Deficiency

	No protection	Sprinkler protection	Fire resistance–rated enclosure	Sprinklered and fire resistance–rated enclosure
Not structurally endangering	Single deficiency	No deficiency		
Structurally endangering	Double deficiency	Single deficiency	No deficiency* Double deficiency†	No deficiency* Single deficiency†

*If fire resistance and structural strength exceed maximum potential of hazard.

†If fire resistance and structural strength are not sufficient to withstand potential of hazard.

7.6.4.5.4 Corridor and Habitable Space. Such space meets the combined requirements for 7.6.4.5.2 and 7.6.4.5.3.

7.6.4.5.5 Total Building. The building is totally sprinkler protected in accordance with Section 9.7 (NFPA *101*) and is equipped with an automatic alarm initiating device that activates the building manual fire alarm system. Credit for total sprinkler protection shall not be given unless the living unit used for board and care purposes also is provided with total sprinkler protection.

7.6.4.6 Separation of Board and Care Home Unit and Its Exit Route from Other Spaces.

7.6.4.6.1 This parameter applies to all living units abutting corridors that might be used or involved in the exit system or to any areas of refuge or staging servicing the board and care unit. The separation requirements also apply to any common wall partitions between the board and care unit and any other living unit in the building.

7.6.4.6.2 Separation of living units from each other and from common spaces shall be based on the wall partition that makes up the separation and the protection of the openings in those partitions.

7.6.4.6.3 Duct penetrations where the duct is open on only one side of the partition and is of sheet steel construction shall be considered as equivalent to doors having a fire protection rating of at least 20 minutes. Where there are duct openings on both sides of the partition, the opening shall be considered unprotected unless there is a fire damper in the duct opening or the duct otherwise meets the requirements for omission of fire dampers as specified in NFPA 90A.

7.6.4.6.4 The partition shall be considered as "none or incomplete" if it has unprotected openings (louvers, gaps, transfer grilles, plain glass windows, or plain glass transoms) between the floor and the ceiling. If openings exist above the ceiling level (or even if the partition stops at the ceiling level), the walls shall be considered as complete if the ceiling itself is a complete membrane (such as plasterboard or lath and plaster). In this case, the fire resistance rating shall be based on that of the wall or ceiling system, whichever is less.

7.6.4.6.5 Walls shall be considered to have less than a ½-hour fire resistance rating if they are not equivalent to ½ in. (13 mm) gypsum wallboard, on both sides of studs, that is well nailed or fastened to the studs with appropriate taping and finishing of joints and fasteners. Walls shall be considered to be equivalent to or greater than a 1-hour fire resistance rating if they are part of any of the established systems recognized as having 1-hour or more fire resistance in accordance with recognized tests or approved listings.

7.6.4.6.6 Doors shall be considered as "none or incomplete" if any living unit does not have a door, or if the living unit has a door but there is some mechanism or obstruction that prevents closing of the door or otherwise leaves a significant opening between the door and the corridor, or the door has open louvers, or the door has ordinary glass lights or transoms. Doors that have been blocked open by doorstops, chocks, tiebacks, or other devices that need manual unlatching or releasing action to close the door shall be classified as "none or incomplete." Doors that are not provided with a latch or other device suitable for keeping the door tightly closed also shall be classified as "none or incomplete." Note that ordinary glass lights shall not be considered as requiring the "none or incomplete" classification in locations where both sides of the glass light are protected by automatic sprinklers.

7.6.4.6.7 Doors shall be considered as having 20-minute or greater fire protection rating if they are of 1¾ in. (44 mm) thick solid bonded wood core construction or an arrangement of equivalent or greater stability in fire integrity. The thermal insulation capability of the door is not considered. Hollow steel or sheet steel doors, therefore, meet the 20-minute requirement.

7.6.4.6.8 Doors shall be considered automatic-closing if they are provided with either traditional self-closing mechanisms or release mechanisms actuated by smoke detectors. In the case of doors separating living units from each other or from common spaces, self-closing doors shall be permitted whether or not they are equipped with devices that can be used to hold them in the open position, provided the normal routine of the living unit is to keep the door closed, particularly after the occupants have retired for the night. Note that this parameter category does not cover the charges for dead-end conditions, travel distance, interior finish in the egress routes (exit or exit access), or enclosure of stairways or other egress routes that pass from story to story. These elements are covered separately in 7.6.4.8, 7.6.4.9, and 7.6.4.10.

7.6.4.6.9 A separation is considered standard (i.e., rated as equivalent to walls greater than 1 hour, doors greater than 20 minutes) if the fire resistance of the doors and walls is equivalent to that specified by Chapters 30 and 31 (NFPA *101*) for the protection level involved.

7.6.4.7 Exit System. This parameter applies to the entirety of the exit routes serving the group residence. Exit routes are the paths of travel from the living unit to the outside, using any of the types and arrangements described in Chapter 7 (NFPA *101*).

7.6.4.7.1 Multiple Routes. Multiple routes exist where the occupants of any living unit have a choice of two separate exit routes to the outside, using those types permitted by Section 30.2 or 31.2, as appropriate (NFPA *101*). Occupants have a choice of routes either from the living unit or through access in a corridor adjacent to the living unit. Single exit routes complying with 30.2.4.6, 31.2.4.5, or 31.2.4.6 (NFPA *101*) qualify as multiple routes. *[See 7.6.4.7.6 for facilities complying with the single exit route provisions of 30.2.4.4 or 31.2.4.4 (NFPA 101).]*

7.6.4.7.2 Deficient. An exit route is deficient if it fails to meet any of the applicable criteria covered by Chapter 7 (NFPA *101*). The exit system also is classed as deficient if a smoke barrier, as required by 30.3.7 or 31.3.7 (NFPA *101*), is not provided.

7.6.4.7.3 Without Horizontal Exit (W/O Horiz. Exit). An egress system is based on this charge if there are multiple routes that are not deficient but the arrangement does not include a horizontal exit as defined in 7.6.4.7.4 or have an acceptable direct exit from each living unit as defined in 7.6.4.7.6.

7.6.4.7.4 With Horizontal Exit (W/ Horiz. Exit). A single horizontal exit on each story containing living units shall be considered a horizontal exit if the space created is of sufficient size to provide at least 3 ft^2 (0.28 m^2) of accessible space for all of the potential occupants, including those already present in and those evacuating to such space. The details of horizontal exits also shall meet the requirements of 7.2.4 (NFPA *101*). A horizontal exit acts as a smoke barrier, and, where provided, is credited as both a smoke barrier in 7.6.4.11 and a horizontal exit in 7.6.4.7.

7.6.4.7.5 Smokeproof Enclosure. Credit for a smokeproof enclosure shall be permitted to be given if either the stairway so designated meets the requirements for a smokeproof enclosure specified in 7.2.3 (NFPA *101*) or the stairway has an acceptably designed smoke pressurization system maintaining a positive pressure in the stairwell sufficient to prevent intolerable contamination of the stairwell by smoke or other fire effects. To receive the credit for smokeproof enclosures, all exit stairs credited in 7.6.4.7 and 7.6.4.8 must meet the smokeproof enclosure requirement.

7.6.4.7.6 Direct Exit.

7.6.4.7.6.1 To be credited for direct exits, each living unit shall have within that unit a door that opens to the exterior at grade or onto an unenclosed exterior balcony with direct access to an unenclosed exterior exit or smokeproof enclosure. The credit for direct exit is applicable even if there are no other exit routes from the involved living unit and if the following apply:

(1) The opening is directly onto a grade.
(2) The exit is located so that any person egressing can move directly away from the building without further exposure.

7.6.4.7.6.2 Single exit routes complying with 30.2.4.4 or 31.2.4.4 (NFPA *101*) qualify as direct exits. *[See 7.6.4.7.1 for facilities complying with the single exit route provisions of 30.2.4.6, 31.2.4.5, or 31.2.4.6 (*NFPA *101).]* Existing buildings more than six stories in height with exterior exit access in accordance with 31.3.5.11.2 (NFPA *101*) qualify as having a direct exit.

7.6.4.8 Exit Access. This parameter applies only to the exit access route from the board and care home.

7.6.4.8.1 Exit access is a measurement of travel distance from the living unit to the outside or to an enclosed interior stairway or other exit (e.g., horizontal exit) or to a smoke barrier meeting the requirements in 7.6.4.11, whichever is shorter.

7.6.4.8.2 The charge for dead ends shall be made where any corridor affords access in only one direction to a required exit from the corridor. The calculation of the distance to determine the level of charge is the measurement from the centerline of the doorway exiting the living unit to the nearest point where a person has a choice of two directions or routes of egress.

7.6.4.9 Interior Finish (Egress Routes).

7.6.4.9.1 The interior finish within the living units is evaluated separately from the interior finish in the corridor and egress routes and other public space. Classification of interior wall and ceiling finish materials is based on the flame-spread index and smoke developed index measured in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. The requirements apply to interior wall and ceiling finish materials as described in Section 10.2 (NFPA *101*). Choose the safety parameter value in Worksheet 7.7.2 based on the interior finish material provided. For example, if the interior wall finish material has a flame-spread index of between 25 and 75, do not take the parameter value associated with a flame-spread index of less than 25 regardless of the presence of automatic sprinkler protection. The mandatory values have been calibrated to take into consideration any sprinkler protection provided. Exposed portions of structural members complying with the requirements of Type IV(2HH) construction shall be permitted.

7.6.4.9.2 Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286 as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

7.6.4.9.3 Only floor coverings in the exit and exit access system are considered. For purposes of assigning the parameter values in Worksheet 7.7.2, such floor coverings are considered as having a flame-spread index ≤25 if they meet the requirements for Class I or II and as otherwise having a flame-spread index >75. Previously installed floor coverings shall be permitted, subject to the approval of the authority having jurisdiction.

7.6.4.9.4 No consideration is included in the safety parameter value for any finish with a flame-spread index greater than 200 as measured by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Some materials, including foam plastics, high density polyethylene, and polypropylene, are not permitted to be tested in accordance with ASTM E84 and must be tested in accordance with NFPA 286 and must meet the acceptance criteria shown in 10.2 (NFPA *101*). Some materials, including asphalt-impregnated paper, arecapable of inducing extreme rates of fire growth and rapid flashover. In any case involving these materials, the resultant hazard is considered beyond the capacity of this evaluation system and requires an individual fire hazard assessment. Note that plywood of ¼ in. (6 mm) or greater thickness should be considered as having a flame-spread index of ≤200.

7.6.4.10 Vertical Openings. This parameter applies to those portions of vertical openings exposing the story containing the group residence or the exit routes from an apartment.

7.6.4.10.1 These values apply to vertical openings and penetrations including exit stairways, ramps, and any other vertical exits, pipe shafts, ventilation shafts, duct penetrations, and laundry and incinerator chutes. The charge for vertical openings shall be based on the presence or lack of enclosure and the fire resistance rating of the enclosure, if provided.

7.6.4.10.2 A vertical opening or penetration shall be classified as open or incomplete provided any of the following conditions apply:

(1) It is unenclosed.
(2) It is enclosed but does not have doors.
(3) It is enclosed but has openings other than doorways.
(4) It is enclosed with cloth, paper, or similar materials without any sustained firestopping capabilities.

7.6.4.10.3 If a shaft other than a credited exit route (i.e., credited as one of the multiple routes required in 7.6.4.7.1 or in determining travel distance in 7.6.4.8.1) is enclosed on all stories but one, and this results in an unprotected opening between that shaft and one, and only one, story, the parameter value assigned to that shaft shall be 0. If a required egress route is contained in that shaft, the parameter value shall be –2.

7.6.4.11 Smoke Control. This parameter applies to the story containing the board and care home. Smoke control definitions are provided in 7.6.4.11.1 through 7.6.4.11.5.

7.6.4.11.1 None. There are no smoke barriers (or horizontal exits) on the story, the story is not served by a smokeproof enclosure, and there are no mechanically assisted smoke control systems serving the story.

7.6.4.11.2 Smoke Barriers. Smoke barriers are partitions extending across the entire width of the building or so arranged as to combine a partition in the corridor with existing building elements and subdividing partitions and walls to partition the building into two completely separate units. The smoke barrier must be equipped with doors in the corridor that are self-closing, closed upon detection by smoke detectors located at the door arches, or closed by smoke detector systems that have been credited with a six-point parameter value in 7.6.4.4. Smoke barriers also shall conform to the requirements of Section 8.5 (NFPA *101*). A horizontal exit acts as a smoke barrier and is credited as both a smoke barrier in 7.6.4.11 and a horizontal exit in 7.6.4.7.

7.6.4.11.3 Mechanically Assisted Automatic Systems — by Zone. Mechanically assisted smoke control systems protected on a zone basis shall include a smoke barrier (or a horizontal exit) supported by a mechanism of automatic control fans, smoke vent shafts, or a combination thereof to provide a pressure differential that assists in confining smoke to the compartment of origin. Fans shall be permitted to be special smoke control fans, or special adjustments of the normal building air movement fans shall be permitted to be made.

7.6.4.11.4 Mechanically Assisted Automatic Systems — by Unit. Mechanically assisted smoke control systems protected on a living unit basis are systems so designed as to provide a mechanism of automatically controlled fans, smoke vent shafts, or a combination thereof to ensure a positive pressure differential that prevents intrusion of smoke into any living unit not involved in fire. Therefore, the living unit has a pressure differential higher than that of the corridor and higher than that of any living unit where fire has been detected. Such systems shall be so arranged that the detection mechanism in each living unit prevents a fire-involved living unit from becoming positively pressurized.

7.6.4.11.5 Mechanically Assisted Automatic Systems — by Corridor. A mechanically assisted smoke control system protected on a corridor basis is a system initiated by a method of smoke detection that ensures operation of the smoke control system before significant smoke has entered into the corridor involved.

7.6.4.11.5.1 The mechanism must be capable of pressurizing the corridor sufficiently to prevent smoke from the living unit or space of origin from entering the corridor during the entire course of the fire. Such a system must be able to hold back the smoke through the expected maximum severity of the fire. It also must be capable of exhausting smoke from the corridor based on the assumption that the emergency evacuation procedures and other activities involving the opening and closing of doors will cause occasional brief periods during which the smoke control system is overpowered.

7.6.4.11.5.2 This results in the movement of the smoke from the fire area into the corridor. (The exhausting of the smoke normally would be accomplished by having an exhaust fan of lower capacity than that of the fan supplying air for pressurization exhaust from the corridor. The net pressurization force would occur from the effect of the pressurizing fan minus the effect of the removal or purging fan.)

7.6.4.11.5.3 The corridor's pressurizing system could involve early warning smoke detection, automatic closing of all living unit doors, sprinkler protection, or all three. Where these additional protection devices are provided to effect such a smoke control system, the individual credits for each of the involved protection devices are in addition to the credits for the smoke control system.

7.7 Worksheets for Evaluating Fire Safety in an Apartment Building with Board and Care Occupancies. For each apartment house containing one or more apartment units with a board and care occupancy, the seven-step process in Figure 7.7 should be followed when evaluating fire safety in an apartment building with board and care occupancies.

7.7.1 Step 1 — Complete Cover Sheet Using Worksheet 7.7.1. See Figure 7.7.

7.7.2 Step 2 — Determine Safety Parameter Values Using Worksheet 7.7.2. First, select and circle the safety value for each safety parameter in Worksheet 7.7.2 that best describes the conditions in the facility. Then, choose only one value for each of the parameters. If two or more values appear to apply, choose the one with the lowest point value.

7.7.3 Step 3 — Complete Individual Safety Evaluations Using Worksheet 7.7.3. The following steps should be taken:

(1) Transfer each of the 11 circled safety parameter values from Worksheet 7.7.2 to every available block in the line with the corresponding safety parameter in Worksheet 7.7.3. Where the block is marked "÷ 2 =," enter one-half the value shown in Worksheet 7.7.2.
(2) Add each of the four columns, keeping in mind that any negative numbers need to be deducted.
(3) Transfer the resulting values for S_1, S_2, S_3, and S_4 to the corresponding blocks in Worksheet 7.7.5.

7.7.4 Step 4 — Determine Mandatory Requirements Using Worksheets 7.7.4A through 7.7.4D. The following steps should be taken:

(1) Using the classifications of the building (i.e., "new" or "existing"), the building height, and the level of requirements established for small dwelling units, circle the appropriate value in each of the four columns in Worksheet 7.7.4A, 7.7.4B, 7.7.4C, or 7.7.4D as appropriate.
(2) Transfer the circled values from Worksheet 7.7.4A, 7.7.4B, 7.7.4C, or 7.7.4D to the corresponding blocks for S_a, S_b, S_c, and S_d in Worksheet 7.7.5.

7.7.5 Step 5 — Evaluate Fire Safety Equivalency. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 7.7.5. Enter the differences in the appropriate answer blocks.
(2) For each row, check "yes" if the value in the answer block is zero (0) or greater. Check "no" if the value in the answer block is a negative number.

7.7.6 Step 6 — Evaluate Other Considerations Not Previously Addressed Using Worksheet 7.7.6. The equivalency covered by Worksheets 7.7.2 through 7.7.5 includes the majority of the considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 7.7.6, Facility Fire Safety Requirements Worksheet. Complete one copy of this separate worksheet for each facility.

WORKSHEET 7.7.1 COVER SHEET

Fire Safety Evaluation Worksheet for an Apartment Building with Board and Care Occupancies

Building Identification ______________________________

Evaluator ______________________ Date ______________________

WORKSHEET 7.7.2 SAFETY PARAMETER VALUES — APARTMENT BUILDING

Safety Parameters	Parameter Values							
1. Construction	Combustible					Noncombustible		
Stories in Height	Type V (000)	Type V (111)	Type III (200)	Type III (211)	Type IV (2HH)	Type II (000)	Type II (111)	Type II(222) & Type I
1 Story	−2( )[a]	0	−2( )[a]	0	0	0	2	2
2 Stories	−6( )[a]	0	−6( )[a]	0	0	−5( )[a]	2	2
3–4 Stories	−8( )[a]	−2(0)[k]	−8( )[a]	0	−2(0)[k]	−6( )[a]	2	2
5–6 Stories	−8	−2(0)[k]	−8( )[a]	0	−2(0)[k]	−6( )[a]	2	2
Over 6 Stories	−10	−4	−10	−2(0)[k]	−4(0)[k]	−8	0	2

Safety Parameters	Double Deficiency	Single Deficiency	None or No Deficiency
2. Hazardous Areas (outside board & care home units)	−4(−7)[b,g]	0(−4)[g]	0

Safety Parameters	None or Incomplete	Manual Alarm	
3. Manual Fire Alarm		W/O F.D. Notification	W/ F.D. Notification
	0(2)[i] (3)[m]	2	3

Safety Parameters	None or Incomplete	Interconnected System		Total Building
4. Smoke Detection and Alarm (outside board & care home units)		Corrs. & Common Spaces	Corrs., Common Spaces, & Each Level of Living Units	
	0	3(0)[e] (3)[j]	4	6

Safety Parameters	None or Incomplete	Corrs., Public Spaces	Living Units Only	Corrs., Hab., & Public Spaces	Total Building
5. Automatic Sprinklers (outside board & care home units)	0	2(0)[c]	4(0)[c]	6	8

Safety Parameters	None or Incomplete	Walls <30 min		Walls ≥30 min to <1 hr		Walls ≥1 hr	
6. Separation of Board & Care Home Unit and Its Exit Route from Other Spaces		Doors <20 min W/O Closer	Doors ≥20 min W/O Closer	Doors <20 min W/Closer	Doors ≥20 min W/Closer	Doors <20 min W/Closer	Doors ≥20 min W/Closer
	−6	−2	0(−2)[b]	1(−2)[b]	2(−2)[b]	1(−2)[b]	4(−2)[b]

Safety Parameters	<2 Standard Routes	Multiple Routes				Direct Exit
7. Exit System (serving board & care home units)		Deficient	W/O Horiz. Exit	W/ Horiz. Exit	Smokeproof Enclosure	
	−6	−2	0	2	2	4

Safety Parameters	Max. Dead End Is		No Dead End > 50 ft and Travel Is				
8. Exit Access (serving board & care home units)	>100 ft	>50 ft or corridor common path >35 ft	>200 ft	>150 ft to ≤200 ft	>100 ft to ≤150 ft	>50 ft to ≤100 ft	≤50 ft
	−6(0)[d]	−4(0)[d]	−2	−1	0	1	2

Safety Parameters	Flame-Spread Ratings		
9. Interior Finish (egress routes serving board & care home units)	>75 to ≤200	>25 to ≤75	≤25
	−3	−1	0

(Worksheet 7.7.2 continues)

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FIGURE 7.7 Worksheets for Evaluating Fire Safety in an Apartment Building with Board and Care Occupancies.

Worksheet 7.7.2 *Continued*

10. Vertical Openings	Open or Incomplete Enclosure			Enclosed [h]	
	Thru 5 or More Stories	3–4 Stories	2 Stories	<1 hour [f]	≥1 hour [f]
	−10	−7	−2	0	1(0)[b]

11. Smoke Control (serving stories having board & care home units)	None	Smoke Barriers	Mechanically Assisted Systems		
			By Zone	By Unit	By Corridor
	0(2)[l]	2	3	3	4

[a] Use (−1 × stories in height) if building is fully sheathed with plaster, gypsum board, or similar materials but not <−2 if Parameter 5 is 8.

[b] Use ( ) if Parameter 1 is based on Type V(000), Type III(200), or Type II(000), if Note [a] does not apply, and if Parameter 5 is × 4.

[c] Use ( ) if Parameter 1 is based on Type V(000), Type III(200), or Type II(000).

[d] Use ( ) if Parameter 7 is −6.

[e] Use ( ) if Parameter 6 is based on “None or Incomplete,” or “Walls or Doors” are ½-hr walls/20-min doors and Parameter 5 is × 4.

[f] ≥30 min in existing building.

[g] Use ( ) if hazardous area is on exit route or in refuge area serving group home unit.

[h] Use 0 in 1-story building.

[i] Use (2) in 1–3 story buildings with <12 living units.

[j] Use (3) if corridors and common spaces are protected by quick response sprinklers.

[k] Use (0) if Parameter 5 is 8.

[l] Use ( ) where exemptions of 31.3.7.1 through 31.3.7.5 (NFPA *101*) apply.

[m] Use (3) if in compliance with 30.3.4.2.2 and 30.3.4.3.5 (NFPA *101*).

For SI units, 1 ft = 0.3048 m; 1 ft² = 0.092 m².

WORKSHEET 7.7.3 INDIVIDUAL SAFETY EVALUATIONS — APARTMENT BUILDINGS

Safety Parameters	Fire Control (S_1)	Egress Provided (S_2)	Refuge Provided (S_3)	General Fire Safety Provided (S_4)
1. Construction				
2. Hazardous Areas		÷ 2 =		
3. Manual Fire Alarm	÷ 2 =			
4. Smoke Detection and Alarm	÷ 2 =			
5. Automatic Sprinklers		÷ 2 =	÷ 2 = *(See note.)*	
6. Separation of Living Units		÷ 2 =		
7. Exit System			÷ 2 =	
8. Exit Access				
9. Interior Finish				
10. Vertical Openings	÷ 2 =			
11. Smoke Control				
Total	**S_1 =**	**S_2 =**	**S_3 =**	**S_4 =**

NOTE: Use full value if Safety Parameter 1 is based on Type V(000), Type III(200), or Type II(000) construction. Divide by 2 (÷ 2) in all other cases.

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FIGURE 7.7 *Continued*

WORKSHEET 7.7.4A MANDATORY SAFETY REQUIREMENTS — EXISTING APARTMENT BUILDINGS HOUSING EXISTING BOARD AND CARE FACILITIES

Stories in Height	Evacuation Capability	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
1 Story	Prompt/Slow	2	5	3	5
	Impractical	5	5	6	8
2–6 Stories	Prompt/Slow	3	6	5	7
	Impractical	5	6	7	9
>6 Stories	Prompt/Slow	10.5	3.5	6	8
	Impractical	13.5	5.5	8	12

WORKSHEET 7.7.4B MANDATORY SAFETY REQUIREMENTS — NEW APARTMENT BUILDINGS

Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
1 Story	9	3	4	6
2 Stories	11.5	4	7	9
≥3 Stories	13.5	4	9	11

WORKSHEET 7.7.4C MANDATORY SAFETY REQUIREMENTS — NONSPRINKLERED APARTMENT BUILDINGS MEETING 30.3.5.2 (NFPA *101*)

Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
1 Story	3	10	4	10
2 Stories	5.5	11	7	13
≥3 Stories	7.5	11	9	15

WORKSHEET 7.7.4D MANDATORY SAFETY REQUIREMENTS — NEW BOARD AND CARE FACILITIES LOCATED IN EXISTING APARTMENT BUILDINGS

Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	Refuge Requirement (S_c)	General Fire Safety Requirement (S_d)
1 Story	9	7.5	6	11
2 Stories	10.5	7.5	7	12
≥3 Stories	12.5	7.5	9	14

(For use with NFPA 101A-2016/NFPA *101*-2015, B & C Apts.) (p. 3 of 4)

FIGURE 7.7 ***Continued***

WORKSHEET 7.7.5 EQUIVALENCY EVALUATION

						Yes	No
Control Provided (S_1)	minus	Required Control (S_a)	≥	0	S_1 ☐ – S_a ☐ = ☐		
Egress Provided (S_2)	minus	Required Egress (S_b)	≥	0	S_2 ☐ – S_b ☐ = ☐		
Refuge Provided (S_3)	minus	Required Refuge (S_c)	≥	0	S_3 ☐ – S_c ☐ = ☐		
General Fire Safety (S_4)	minus	Required Gen. Fire Safety (S_d)	≥	0	S_4 ☐ – S_d ☐ = ☐		

WORKSHEET 7.7.6 FACILITY FIRE SAFETY REQUIREMENTS WORKSHEET

	Considerations	Met	Not Met	Not Applic.
A.	Utilities comply with the provisions of 32.3.6.1 and 33.3.6.1.			X
B.	Heating, ventilating, and air conditioning equipment comply with the provisions of 32.3.6.2 and 33.3.6.2, except for enclosure of vertical openings, which have been considered in Safety Parameter 10 of Worksheet 7.7.2.			X
C.	Elevators, dumbwaiters, and vertical conveyors comply with the provisions of 32.3.6.3 and 33.3.6.3.			
D.	Rubbish chutes, incinerators, and laundry chutes comply with the provisions of 32.3.6.4 and 33.3.6.4.			X
E.	Complies with the applicable requirements of Sections 32.7 and 33.7.			

All references are to NFPA *101*, *Life Safety Code*.

WORKSHEET 7.7.7 CONCLUSIONS

1. ☐ All of the checks in Worksheet 7.7.5 are in the "Yes" column and all applicable considerations in Worksheet 7.7.6 are identified as "Met". The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for an apartment building to house residential board and care occupancies.

2. ☐ All of the checks in Worksheet 7.7.5 are in the "Yes" column and all considerations identified in Worksheet 7.7.6 as "Not Met" have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for an apartment building to house residential board and care occupancies.

3. ☐ One or more of the checks in Worksheet 7.7.5 are in the "No" column or any consideration identified in Worksheet 7.7.6 as "Not Met" has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for an apartment building to house residential board and care occupancies.

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FIGURE 7.7 ***Continued***

7.7.7 Step 7 — Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that prescribed by the *Life Safety Code,* using Worksheet 7.7.7, Conclusions. Worksheet 7.7.7 combines the zone fire safety equivalency evaluation of Worksheet 7.7.5 and the additional considerations of Worksheet 7.7.6.

Chapter 8 Fire Safety Evaluation System for Business Occupancies

8.1 Introduction.

8.1.1 This chapter is part of an NFPA guide and, therefore, is not mandatory. The term *shall* in this chapter is used to indicate that if the provisions of the chapter are applied, the procedures mandated are to be followed to ensure the effectiveness of the evaluation system.

8.1.2 The Fire Safety Evaluation System (FSES) is a measuring system. It compares the level of safety provided by an arrangement of safeguards that differ from those specified in NFPA *101* to the level of safety provided in a building that conforms exactly with the details of the *Code*.

8.1.3 This chapter is provided to assist in completion of Figure 8.6, Worksheets for Evaluating Fire Safety in Business Occupancies. The step-by-step instructions for completion appear in the text of Section 8.6. This chapter provides expanded discussion and definition of the various items in the worksheet to assist the user when questions of definitions or interpretation arise. The chapter is organized to follow the format of the worksheet progressively.

8.2 Procedure for Determining Equivalency.

8.2.1 Evaluate the factors affecting either every fire zone or the building as a whole using Figure 8.6, Worksheets for Evaluating Fire Safety in Business Occupancies.

8.2.1.1 Zoning must divide the building into units that consist of one or more complete fire/smoke zones. A fire/smoke zone is a portion of a building that is separated from all other portions of the building by vertical or horizontal fire barriers having at least a 1-hour fire resistance rating or vertical smoke barriers conforming to the requirements of Section 8.5 (NFPA *101*), or a combination of both. Any vertical openings (shafts, stairs) involved also must provide 1-hour separation. In facilities completely protected by automatic sprinkler protection, these fire resistance requirements do not apply. The elements separating one zone from another, however, must be of sound- and smoke-resisting construction. Doors in zone separations must be either self-closing or equipped with automatic closers operated by smoke detectors.

8.2.1.2 Zones shall be permitted to be either adjacent to each other (e.g., separate wings or building sections) or above each other (e.g., stories or groups of stories).

8.2.1.3 Each zone containing spaces used for business occupancy can be evaluated using this system.

8.2.1.4 Each of the safety parameters is to be analyzed, and the safety value for each parameter that best describes the condition in the building is to be identified.

8.2.2 Using the Facility Fire Safety Requirements Worksheet (Worksheet 8.6.6), determine the acceptability of the general building systems (utilities, HVAC, elevator installations, standpipes and fire extinguishers, and rubbish chutes, incinerators, and laundry chute installations).

8.2.3 Equivalency is achieved if the building or fire/smoke zone evaluations show equivalency or better in each and every zone and the requirements of the Facility Fire Safety Requirements Worksheet (Worksheet 8.6.6) are met.

8.3 Glossary for Fire Safety Evaluation Worksheet for Business Occupancies.

8.3.1 Introduction. This glossary is provided to assist in completing the Worksheets for Evaluating Fire Safety in Business Occupancies. This glossary provides expanded discussion and definitions for the various items in the worksheets to assist the user where questions of definition or interpretation arise. To the maximum extent possible, the glossary does not repeat the definitions already existing in NFPA *101* but rather references the appropriate paragraphs in NFPA *101*.

8.3.2 Areas of Application.

8.3.2.1 The entire building can be evaluated on a single set of worksheets. The building might, however, be zoned by considering each zone separately or by using any convenient grouping of zones.

8.3.2.1.1 Charges for Safety Parameter 2, "Segregation of Hazards," in Worksheet 8.6.2, apply to any hazardous area in the zone being evaluated and to any hazardous area in zones adjacent to or below the zone being evaluated.

8.3.2.1.2 Where zones are located above each other, the value assigned to Parameter 1, "Construction," in Worksheet 8.6.2, in each zone is based on the highest story used for regular human occupancy in that "stack of zones" and the type of construction for that stack of zones.

8.3.2.1.3 The assignment of values for Safety Parameter 5, "Fire Alarm"; Parameter 9, "Exit Access"; and Parameter 10, "Egress Route," in Worksheet 8.6.2, does not consider conditions in unoccupied spaces in other zones where such are not involved in any egress paths.

8.3.2.1.4 The evaluation of Safety Parameter 10, "Egress Route," in Worksheet 8.6.2, includes those portions of any egress route that serve the zone being evaluated. Any exposures or deficiencies pertaining to any part of the egress route must be taken into account in the evaluation of the zone.

8.3.2.2 Zones that do not involve regular human occupancy are evaluated the same as those with regular human occupancy, with the following variations:

(1) Any such zone shall be permitted to be omitted from the numerical evaluation if both of the following conditions are met:
    (a) The zone is not involved in the egress route from any space with regular human occupancy.
    (b) The zone conforms to NFPA *101* requirements applicable to its use.
(2) Alternatively, such zones shall be permitted to be evaluated using this system, on the condition that any additional egress capabilities and arrangements appropriate to the specific use of the space are provided.

8.4 Maintenance. All protection systems, requirements, arrangements, and procedures shall be maintained in a dependable operating condition and a sufficient state of readiness and shall be used in such a manner that the intended safety function or hazard constraint is not impaired. Otherwise, they shall receive no credit in the evaluation.

8.5 Safety Parameters (Worksheet 8.6.2). The safety parameters are a measure of those building factors that bear on or contribute to the safety of those persons who might be in the building at the time of a fire. The safety parameters in Worksheet 8.6.2 are described in the following subsections.

8.5.1 Construction. Construction types are classified in accordance with the definitions of NFPA 220. Where the facility includes additions or connected structures of different construction, the rating and classification of the structure is based on one of the following:

(1) Separate buildings where the separation between the portions of the building is a fire barrier having at least a 1-hour fire resistance rating and any opening protectives have at least a 45-minute fire protection rating
(2) The lower safety parameter point score involved where such a separation does not exist

8.5.2 Segregation of Hazards. The assignment of charges for unsegregated hazardous areas is a four-step process.

8.5.2.1 Step 1 — Identify Hazardous Areas. A hazardous area is any space or compartment in which a storage or other activity exists that is not a part of normal office space arrangements and that possesses the potential for producing a fully involved fire.

8.5.2.2 Step 2 — Determine the Level of Hazard.

8.5.2.2.1 There are two levels of hazard: structurally endangering and not structurally endangering.

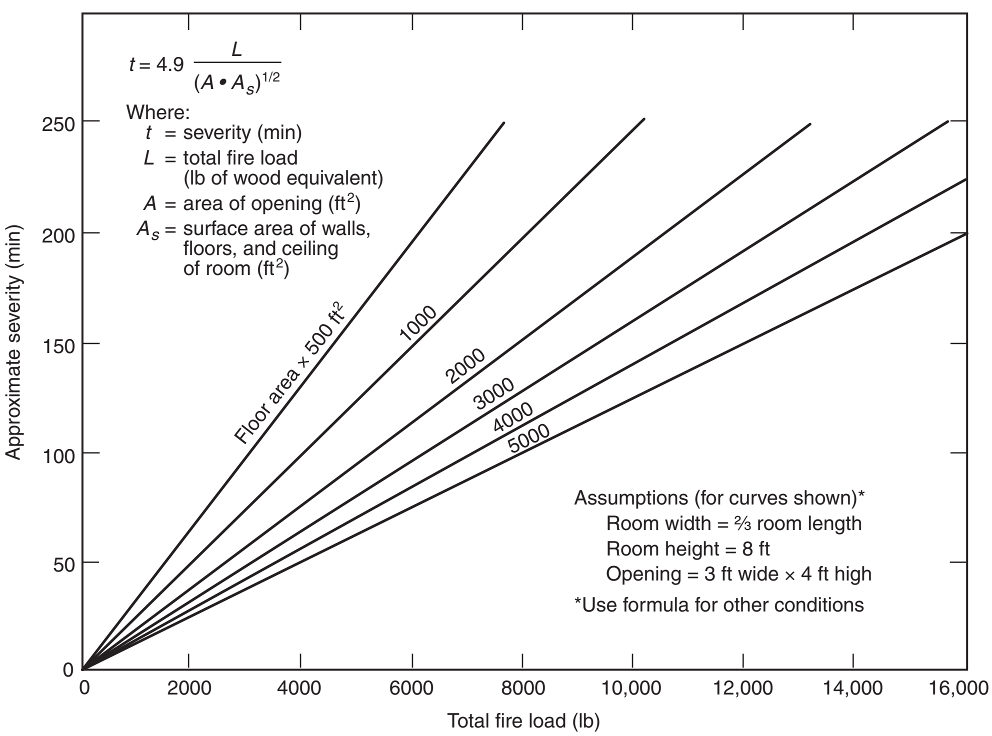
8.5.2.2.1.1 Structurally Endangering. A hazardous area with a potential fire severity that might exceed the tested resistance of the enclosure and defeat the basic structural integrity of the building framing as defined in Safety Parameter 1, "Construction," of Worksheet 8.6.2. *[See Figure 8.5.2.2.1.1 for determining approximate potential fire severity.]*

8.5.2.2.1.2 Not Structurally Endangering. A hazardous area with sufficient fire potential to build to full involvement (flashover) and present a danger of propagating through openings or wall partitions but not possessing sufficient total potential to endanger the structural framing or floor decking as defined in Safety Parameter 1 of Worksheet 8.6.2. *[See Figure 8.5.2.2.1.2 for assistance in estimating the fire size needed to flash over the area containing various combustible contents.]*

8.5.2.2.2 Example of Structurally Endangering. For a room 20 ft × 30 ft × 8 ft high (6.1 m × 9.1 m × 2.4 m high) with a (window) opening 3 ft wide × 4 ft high (0.9 m wide × 1.4 m high), 3000 lb (1361 kg) of ordinary fuel can produce a fire severity of approximately 95 minutes. If the fire resistance of the hazardous area enclosure is less than 95 minutes and the fire is likely to continue to its estimated duration, the hazardous area shall be permitted to be classed as structurally endangering.

8.5.2.3 Step 3 — Determine the Fire Protection Provided.

8.5.2.3.1 The parameter value for hazardous areas is based on the presence or absence of the fire protection necessary to control or confine the hazard. Two different types of fire protection are considered. The first consists of automatic sprinklers or other appropriate extinguishing systems covering the entire hazard. The credit for sprinklers shall not be given



For SI units, 1 lb = 0.4536 kg; 1 ft = 0.3048 m; 1 ft^2 = 0.0929 m^2.

FIGURE 8.5.2.2.1.1 Approximate Fire Severity.

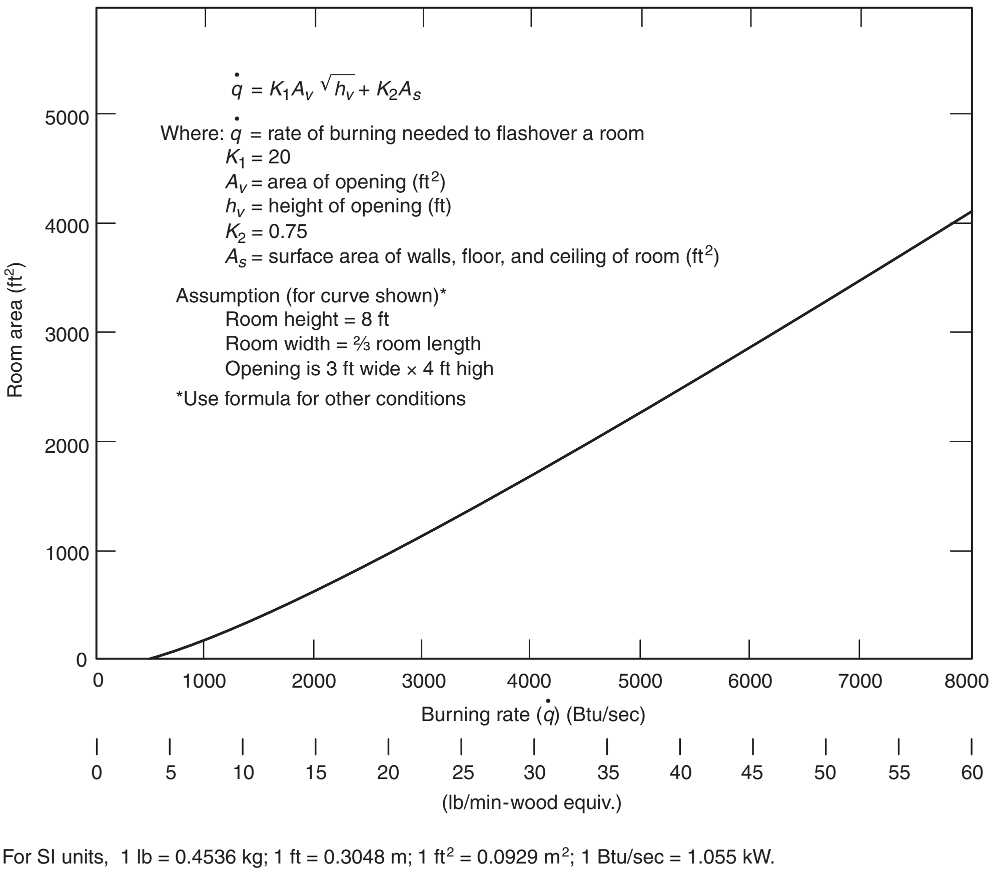


FIGURE 8.5.2.2.1.2 Approximate Flashover Energy.

unless the hazardous area is separated from the rest of human occupancy or the egress route by reasonably smoke-resistant partitions and doors. The second is a complete fire enclosure having a sufficient fire resistance rating to contain the potential fire severity of the hazardous area. This includes the following:

(1) The separation of the hazardous area from any structural framing members
(2) Partitions separating the hazardous area from all other spaces
(3) Fire protection–rated doors sufficient to exceed the potential of the fire load involved

8.5.2.3.2 Any hazardous space that has any of these protection systems is classified as having single protection.

8.5.2.4 Step 4 — Determine Degree of Deficiency and Assign Parameter Values.

8.5.2.4.1 The parameter value ultimately is determined by the degree of the deficiency of the hazardous area based on the level of protection needed. Table 8.5.2.4.1 provides a matrix to be used for determining the degree of deficiency to be assessed.

8.5.2.4.2 In some situations, more than one hazardous area with the same or differing levels of deficiency exists. The overall charge is based on the single most serious deficiency for the hazardous area.

Table 8.5.2.4.1 Segregation of Hazards — Degree of Deficiency

	No protection	Sprinkler protection	Fire resistance–rated enclosure*	Sprinklered and fire resistance–rated enclosure*
Not structurally endangering	Single deficiency	No deficiency		
Structurally endangering	Double deficiency	Single deficiency	No deficiency	

*Complete enclosure having sufficient fire resistance to contain the potential of the hazardous contents area.

8.5.2.4.3 Open-Plan Office Space.

8.5.2.4.3.1 A sprinkler-protected open-plan office space is not considered a hazardous space.

8.5.2.4.3.2 An unsprinklered open-plan office space is not considered a hazardous space unless it involves such a collection of fuel that flashover is likely to occur. This can be estimated in the following manner:

(1) Appraise the largest fuel concentrations. A fuel concentration is a collection of combustible materials (desks, files, or other material or items) that is separated from other fuel concentrations by a clear space that is 24 in. (610 mm) wide or one-half the height of the collection, whichever is greater. Floor covering is not considered in this estimate.
(2) The burning rate is based on the best available data. If test data are available, use those data; otherwise use Table 8.5.2.4.3.2. If data are not available and Table 8.5.2.4.3.2 is not sufficient, the burning rate is based on 125 Btu/sec · ft^2 of actual fuel-covered floor space for typical wooden desk modules. Ignore space occupied by metal desks or metal file cabinets. For open-shelf storage or similar piled or stacked concentrations of combustible materials, estimate 100 Btu/sec · ft^2 of covered floor space for each foot of height of combustible material. Double these figures for the portion of the fuel assembly that is foamed plastic.
(3) Based on the estimated burning rate, appraise the flashover potential. Use Figure 8.5.2.2.1.1.
(4) If flashover is shown as a potential, use Figure 8.5.2.2.1.2 to appraise severity, classify the space as a hazardous area, and assign charges, as appropriate.

8.5.3 Vertical Openings. These values apply to vertical openings and penetrations including exit stairways, ramps, and any other vertical exits, pipe shafts, ventilation shafts, duct penetrations, and laundry and incinerator chutes. The charge for vertical openings is based on the fire resistance of the enclosure, if provided. Where the protection of vertical openings (other than exits) meets the requirements of 38.3.1 and 39.3.1 (NFPA *101*), the parameter is assessed on the basis of "Enclosed, >1 hr" for new buildings >75 ft in height, and "Enclosed, 30 min to 1 hr" for all other buildings.

8.5.3.1 A vertical opening or penetration is classified as open if it has any of the following characteristics:

(1) Unenclosed
(2) Enclosed but has doorways (or similar portals) that are without doors
(3) Enclosed but has unprotected openings other than doorways
(4) Enclosed with cloth, paper, or similar materials without any sustained firestopping capabilities

8.5.3.2 The credit for vertical opening protection varies depending on the number of stories connected by the vertical opening and the degree of enclosure.

8.5.4 Sprinklers.

8.5.4.1 Where an automatic sprinkler is installed for either total or partial building coverage, the system shall be in accordance with the requirements of NFPA 13.

8.5.4.2 To receive credit for protection, the sprinkler system must be equipped with an automatic alarm initiating device that activates the building manual fire alarm system or otherwise sounds an alarm sufficiently audible to be heard in all occupied areas.

8.5.4.3 To receive credit for "total building" sprinkler protection, the entire building must be provided with sprinkler coverage and that coverage must cover all zones of the building.

8.5.5 Fire Alarm. Fire alarms are defined in 8.5.5.1 through 8.5.5.4.

8.5.5.1 None. There is no fire alarm system, or the system is incomplete and does not meet the requirements for a higher-scored category.

8.5.5.2 Without Fire Department Notification (W/O F.D. Notification). There is a fire alarm system that meets the requirements of Section 9.6 (NFPA *101*).

8.5.5.3 With Fire Department Notification (W/ F.D. Notification). There is a fire alarm system that complies with the requirements of 8.5.5.2 and, in addition, automatically transmits a signal to the fire department that is committed to serve the area in which the building is located through a direct connection, an approved central station, or other acceptable means.

8.5.5.4 With Voice Communication. There is a fire alarm system with voice alarm in accordance with 11.8.4 (NFPA *101*).

8.5.6 Smoke Detection.

8.5.6.1 All references to detectors herein refer to smoke detectors. No credit is given for heat detectors in habitable space except as specifically noted in 8.5.6.2 through 8.5.6.5. Heat detectors can be credited in uninhabitable spaces where ambient temperatures can be expected to reach 120°F (50°C) or fall below 0°F (–18°C), provided separation from inhabited spaces is at least ½-hour fire resistance–rated.

8.5.6.2 To meet the requirements for smoke detector coverage, the spaces must be provided with smoke detectors installed in accordance with *NFPA 72*.

8.5.6.3 Only those detectors whose activation will sound the alarm throughout the zone of origin are to be credited in this parameter.

8.5.6.4 If the building is evaluated by zones as defined in 8.3.2, the evaluation is based solely on detection within the zone.

8.5.6.5 To receive credit for smoke detection in corridors only, all corridors in the building or zone must have smoke detectors.

8.5.7 Interior Finish.

8.5.7.1 Classification of interior finish is based on the flame-spread index and smoke developed index of the interior wall and ceiling finish materials as tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. The requirements apply to wall and ceiling finish materials as described in Section 10.2 (NFPA *101*).

8.5.7.2 No consideration is included in the safety parameter value for any finish with a flame-spread rating of more than 200 as measured by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Thus, this FSES should not be used where such conditions

Table 8.5.2.4.3.2 Some Typical Peak Rates of Heat Release

Btu/sec · ft^2	Growth Rate[a]	Potential Fuel
1.5	S	Fire retardant–treated mattress (including normal bedding)
15[b]	M	Lightweight Type C upholstered furniture[c]
35[b]	S	Moderate weight Type C upholstered furniture[c]
35	F	Mail bags (full) stored 5 ft high
50[b]	M	Cotton/polyester innerspring mattress (including bedding)
60[b]	M	Lightweight Type B upholstered furniture[c]
60[b]	S	Medium weight Type C upholstered furniture[c]
65[b]	VF	Methyl alcohol pool fire
70[b]	S	Heavy weight Type C upholstered furniture[c]
80[b]	F	Polyurethane innerspring mattress (including bedding)
90[b]	M	Moderate weight Type B upholstered furniture[c]
125	M	Wooden pallets 1½ ft high
145[b]	M	Medium weight Type B upholstered furniture[c]
150[b]	F	Lightweight Type A upholstered furniture[c]
150	F	Empty cartons 15 ft high
175[b]	M	Heavy weight Type B upholstered furniture[c]
175	F	Diesel oil pool fire (> about 3 ft diameter)
175	VF	Cartons containing polyethylene bottles 15 ft high
220[b]	F	Moderate weight Type A upholstered furniture[c]
225[b]	F	Particleboard wardrobe/chest of drawers
290	VF	Gasoline pool fire (> about 3 ft diameter)
340[b]	VF	Thin plywood wardrobe with fire-retardant paint on all surfaces (50 in. × 24 in. × 72 in. high)
350	F	Wooden pallets 5 ft high
360[b]	F	Medium weight Type A upholstered furniture[c]
450[b]	F	Heavy weight Type A upholstered furniture[c]
600[b]	VF	Thin plywood wardrobe (50 in. × 24 in. × 72 in. high)

For SI units, (Btu/sec)/ft^2 = 11.35 kW/m^2; 1 in. = 25.4 mm; 1 Btu/sec = 1.055 kW; 1 ft = 0.3048 m; 1 lb = 0.4536 kg; 1 ft^2 = 0.0929 m^2.

[a]Growth Rates:

S — Slow: Burning rate in the range of a *t*-squared fire that reaches 1000 Btu/sec in 600 seconds.

M — Moderate: Burning rate in the range of a *t*-squared fire that reaches 1000 Btu/sec in 300 seconds.

F — Fast: Burning rate in the range of a *t*-squared fire that reaches 1000 Btu/sec in 150 seconds.

VF — Very Fast: Burning rate in the range of a *t*-squared fire that reaches 1000 Btu/sec in 75 seconds.

[b]Peak rates of heat release were of short duration. These fuels typically showed a rapid rise to the peak and a corresponding rapid decline. In each case, the fuel package tested consisted of a single item.

[c]The classification system used to describe upholstered furniture is as follows:

Lightweight — Less than about 5 lb/ft^2 of floor area. A typical 6 ft long couch weighs under 75 lb.

Moderate weight — About 5 lb/ft^2 to 10 lb/ft^2 of floor area. A typical 6 ft long couch weighs between 75 lb and 150 lb.

Medium weight — About 10 lb/ft^2 to 15 lb/ft^2 of floor area. A typical 6 ft long couch weighs between 150 lb and 300 lb.

Heavy weight — More than about 15 lb/ft^2 of floor area. A typical 6 ft long couch weighs over 300 lb.

Type A — Furniture with untreated or lightly treated foam plastic padding and nylon or other melting fabric.

Type B — Furniture with untreated or lightly treated foam plastic padding or with nylon or other melting fabric, but not both.

Type C — Furniture with cotton or heavily treated foam plastic padding and having cotton or other fabric that resists melting.

The estimated heat release rates are based on furniture having simple lines. For ornate or convoluted shapes, increase the indicated rates by up to 50 percent based on elaborateness.

Additional potential fuel heat release information can be found in *NFPA 72*, NFPA 204, the *SFPE Handbook of Fire Protection Engineering*, and other references.

exist. Some materials, including foam plastics, high density polyethylene, and polypropylene, are not permitted to be tested in accordance with ASTM E84 and must be tested in accordance with NFPA 286 and must meet the acceptance criteria shown in 10.2 (NFPA *101*). Some materials, including asphalt-impregnated paper, are capable of inducing extreme rates of fire growth and rapid flashover. In any case involving these materials, the resultant hazard is considered beyond the capacity of this evaluation system and requires an individual fire hazard assessment.

8.5.7.3 Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286 as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

8.5.7.4 Any interior finish having a flame-spread index of 75 or less that is protected by automatic sprinklers is evaluated as having a flame-spread index not exceeding 25. Any interior finish having a flame-spread index of more than 75 but not more than 200 that is protected by automatic sprinklers is evaluated as having a flame-spread index not exceeding 75.

8.5.8 Smoke Control. Smoke control definitions are provided in 8.5.8.1 through 8.5.8.2.2.

8.5.8.1 No Control. There are no smoke barriers or horizontal exits to a separated fire/smoke zone on the story and no mechanically assisted smoke control systems serve the story.

8.5.8.2 Smoke Barriers. Smoke barriers consist of installations conforming to the requirements of Section 8.5 (NFPA *101*).

8.5.8.2.1 Passive. The smoke control system is passive if it consists of continuous vertical membranes designed to restrict the movement of smoke. Passive smoke barriers might or might not have a fire resistance rating and might have protected openings.

8.5.8.2.2 Active. The smoke control system is active if it has a tested and accepted smoke control system that obstructs the leakage of smoke between compartments or zones. One method of judging acceptance of smoke control systems is contained in NFPA 92.

8.5.9 Exit Access.

8.5.9.1 The charge for dead-end access is made where any corridor affords access in only one direction to a required exit.

8.5.9.2 If dead-end distances exceed 100 ft (30 m), a separate analysis must be made to evaluate the potential of flashover of any spaces that could block egress from the dead end and to determine the potential rate of smoke-filling of the egress system involved. If the safe time is shorter than the expected egress time, the evaluation should be discontinued unless a corrective action is specified.

8.5.9.3 The 50 ft (15 m) dead-end limit is applicable to existing buildings or new fully sprinklered buildings. A value of 20 ft (6.1 m) should be used for other new buildings.

8.5.9.4 Any system with common path of travel in excess of that permitted by NFPA *101* should be considered deficient under Safety Parameter 10, "Egress Route."

8.5.10 Egress Route.

8.5.10.1 Egress routes are the paths of travel from any point within a room to the public way using any types and arrangements described in Sections 38.2 or 39.2 (NFPA *101*).

8.5.10.2 Egress routes are defined in 8.5.10.2.1 through 8.5.10.2.5.

8.5.10.2.1 Single Egress Route. A single egress route exists where the occupants on any story do not have either a direct exit to the public way or multiple egress routes as defined in 8.5.10.2.2.

8.5.10.2.2 Multiple Egress Routes. Multiple egress routes exist where the occupants on a story have a choice of at least two separate means of egress routes to the public way using the permitted types in Sections 38.2 or 39.2 (NFPA *101*).

8.5.10.2.3 Deficient — Multiple Routes. An egress route is deficient if it fails to meet any of the applicable criteria of NFPA *101* including capacity. Any system with a common path of travel in excess of that permitted by NFPA *101* should be considered deficient under Parameter 10, "Egress Route."

8.5.10.2.4 Smokeproof Enclosure. Credit for a smokeproof enclosure shall be permitted to be given for a stairway designed and tested in accordance with the requirements of 7.2.3 (NFPA *101*) for a smokeproof enclosure. To receive credit for a smokeproof enclosure, all exit stairs credited in Safety Parameter 10, "Egress Route," shall meet the smokeproof enclosure requirements.

8.5.10.2.5 Direct Exit. To be credited for direct exits, each room shall have within that unit a door that opens to the exterior at grade level or onto an exterior balcony with direct access to an exterior exit. Where such openings are directly onto grade in a location where any person egressing can move directly away from the building without further exposure, the credit for direct exit shall be given even if there are no other exit routes from the space.

8.5.11 Corridor/Room Separation. The values assigned in Safety Parameter 11, "Corridor/Room Separation," are based on the quality of separation between the room and the corridor. For purposes of this evaluation, corridor separation in new buildings is considered as complete (i.e., 1 hour with door closer) if it meets the requirements of 38.3.6 (NFPA *101*).

8.5.11.1 Corridor/room separation is defined in 8.5.11.1.1 through 8.5.11.1.3.

8.5.11.1.1 Incomplete.

8.5.11.1.1.1 The separation is judged as "incomplete" if the wall to the corridor has unprotected openings (no door, or there are louvers, gaps, or transfer grilles) between the floor and ceiling. If openings exist above the ceiling level, the separation is considered complete if the ceiling in the room is a completed membrane. In this case, the separation rating is based on the level of resistance involved in the wall/ceiling system.

8.5.11.1.1.2 The score for incomplete separation is based on the potential time that at least the lower 5 ft (1.5 m) of the corridor could be expected to remain free of smoke if a fully involved fire were to occur in an exposing room. This is dependent on the amount of leakage from the exposing room with the greatest leakage and the size of the corridor *(see Figure 8.5.11.1.1.2)*. The scores are shown in Table 8.5.11.1.1.2.

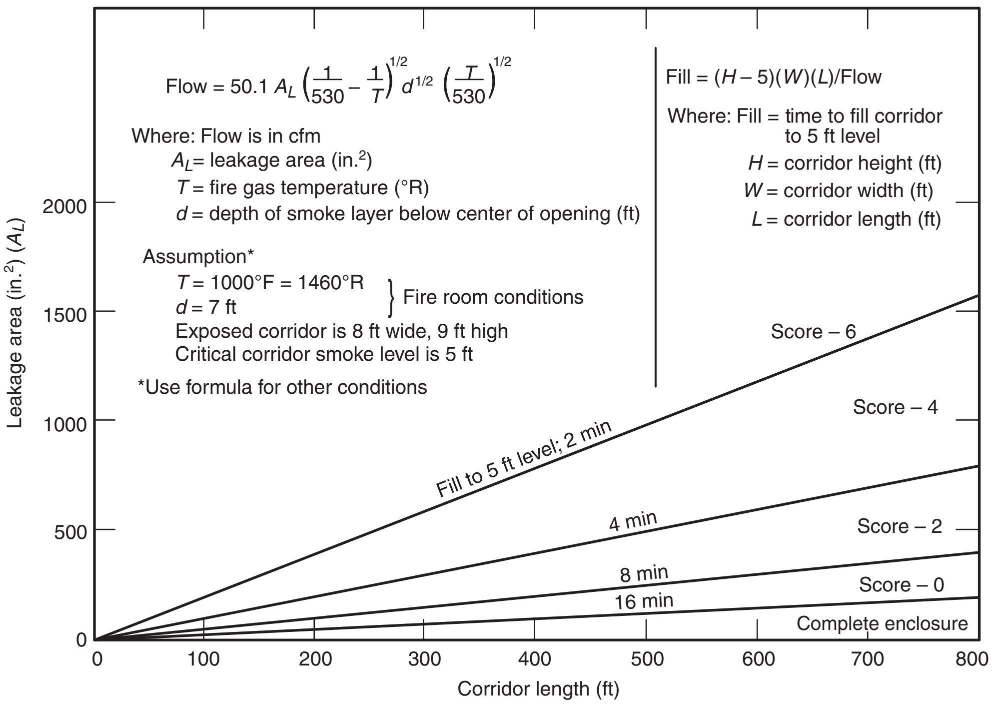
8.5.11.1.2 Complete Separation. The separation, if not judged to be "incomplete" based on the criteria in Table 8.5.11.1.1.2, is considered "complete."

8.5.11.1.3 No Separation. There is "no separation" if the story or the smoke zone is not subdivided (i.e., there is no corridor leading to an exit). *[See 38.3.6.1(1) through 38.3.6.1(3) (NFPA 101).]*

8.5.11.2 For information on credit for door closers, "smoke resistive" versus "≥½ hr" or "1 hr," see Note e to Worksheet 8.6.2.

Table 8.5.11.1.1.2 Incomplete Separation Scores

Safe Time (min)	Score
<2	−6
≥2 but <4	−4
≥4 but <8	−2
≥8 but <16	0
≥16	Complete separation



For SI units, 1 in.^{2} = 6.452 cm^2; 1 ft = 0.3048 m; 5⁄9 (°F – 32) = °C.

FIGURE 8.5.11.1.1.2 Approximate Time to Smoke Impact.

8.5.12 Occupant Emergency Program.

8.5.12.1 The value of this parameter is determined by the number of fire exit drills conducted in the building each year. If no fire exit drills are conducted, the parameter is assessed a value of –2. If drills are conducted once or twice a year, the value is zero (0). If drills are conducted more than twice a year, this parameter is given a value of 1. If the building occupant load is fewer than 500 persons with fewer than 100 persons above or below the street level, this parameter should be given, as a minimum, a value of 1.

8.5.12.2 To qualify for credit, a majority of the building or zone occupants must take part in scenario-oriented fire exit drills. The scenarios should be based on the hazardous conditions that could develop during a fire in the facility.

8.5.12.3 The fire exit drills should be conducted in accordance with the appropriate provisions of NFPA *101*.

8.6 Worksheets for Evaluating Fire Safety in Business Occupancies. The worksheets for evaluating fire safety use a five-step process found in Figure 8.6.

8.6.1 Step 1 — Complete the Cover Sheet Using Worksheet 8.6.1. See Figure 8.6.

8.6.2 Step 2 — Determine Individual Safety Evaluations Using Worksheet 8.6.2. The following steps should be taken:

(1) Select and circle the safety value for each parameter in Worksheet 8.6.2 that best describes the conditions in the facility. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value governs.
(2) Transfer each of the 12 circled safety parameter values from Worksheet 8.6.2 to the available blocks corresponding to each safety parameter in Worksheet 8.6.3. Where the blocks indicate "÷ 2 =," enter one-half the value from Worksheet 8.6.2.
(3) Add each of the three columns, keeping in mind that any negative numbers need to be deducted.
(4) Transfer the resulting values for S_1, S_2, and S_3 to Worksheet 8.6.5.

8.6.3 Step 3 — Determine Mandatory Requirements Using Worksheet 8.6.4. The following steps should be taken:

(1) Circle the mandatory values in Worksheet 8.6.4 for the building being evaluated.
(2) Transfer the circled values from Worksheet 8.6.4 to the boxes marked S_a, S_b, and S_c in Worksheet 8.6.5.

8.6.4 Step 4 — Evaluate Fire Safety Equivalency Using Worksheet 8.6.5. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 8.6.5. Enter the differences in the appropriate boxes.
(2) For each row, check "yes" if the value in the answer box is zero (0) or greater. Check "no" if the value in the answer box is negative.

8.6.5 Step 5 – Evaluate Other Considerations Not Previously Addressed, Using Worksheet 8.6.6. The equivalency covered by Worksheets 8.6.2 through 8.6.5 includes the majority of the considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 8.6.6, Facility Fire Safety Requirements Worksheet. Complete one copy of this separate worksheet for each facility.

8.6.6 Step 6— Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that

WORKSHEET 8.6.1 COVER SHEET

Fire Safety Evaluation Worksheet for Business Occupancies

Facility Identification ______________________________

Evaluator ______________________ Date ______________________

Notes:

WORKSHEET 8.6.2 SAFETY PARAMETERS

Safety Parameters	Parameter Values							
1. Construction	Noncombustible			Combustible				
NFPA 220 Bldg. Constr. Types/Stories in Height	Type I (442) or (332) Type II(222)	Type II (111)	Type II (000)	Type III (211)	Type III (200)	Type IV (2HH)	Type V (111)	Type V (000)
1–2 Stories	0	0	0	0	–1	0	0	–1
3 Stories	2	2	–6	0	–6	0	0	–12
4–5 Stories but ≤75 ft	2	2	–10	0	–12	0	–3	–12
>5 Stories but ≤75 ft	2	2	NV	0	NV	0	–6	NV
>75 ft but <150 ft	2	–1	NV	0	NV	0	NV	NV
≥150 ft	2	NV	NV	0	NV	0	NV	NV

Safety Parameters	Exposed Exit System		Segregation from Exit Routes		None or No Deficiencies
2. Segregation of Hazards	Double Def.	Single Def.	Double Def.	Single Def.	
	–7	–4	–4	0	0

Safety Parameters	Open (or incomplete enclosure)				Enclosed		
3. Vertical Openings[a]	Connects 5 or More Stories	4 Stories	3 Stories	2 Stories	<30 min	30 min to 1 hr	>1 hr[g]
	–10	–7	–4	–2	–1	0	1

Safety Parameters	None	Corridors Only	All but Corridors and Lobbies		Total Building	
4. Sprinklers			Standard	Fast Resp.	Standard	Fast Resp.
	0	0	4	6	10	12

Safety Parameters	None	W/O F. D. Notification		W/ F. D. Notification	
5. Fire Alarm		W/O Voice Commun.	W/ Voice Commun.	W/O Voice Commun.	W/ Voice Commun.
	0 (–2)[k]	1(0)[k] (–1)[p]	2(0)[p]	2(1)[k] (–1)[p]	4(2)[p]

(Worksheet 8.6.2 continues)

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 1 of 4)

FIGURE 8.6 Worksheets for Evaluating Fire Safety in Business Occupancies.

Worksheet 8.6.2 *Continued*

6. Smoke Detection	None	Corridor	Rooms	Total Bldg. (zone)
	0	1	2	4

7. Interior Finish	Flame-Spread Ratings[b]					
Exit Routes	>75 to ≤200		>25 to ≤75		≤25	
Rooms/Suites	>75 to ≤200	≤75	>75 to ≤200	≤75	>25 to ≤200	≤25
	−3	−1	0	1	1	2

8. Smoke Control	None	Passive	Active
	0	3	4(3)[j]

9. Exit Access	Max. Dead Ends		No Dead End >50 ft and Travel Is			
	>75 ft to ≤100 ft	>50 ft (20 ft)[h] to ≤75 ft	>200 ft[c] to <400 ft	>100 ft to 200 ft[c]	>50 ft to 100 ft	≤50 ft
	−2[d]	−1	−1	0	1	3

10. Egress Route	Single	Multiple Routes			Direct Exits
		Deficient	Not Deficient	Smokeproof Enclosures	
	−6(0)[i]	−2	0	3	5

11. Corridor/Room Separation (compartmentation)	Separation Exists and Level of Protection Is						No Separation, or Single Tenant, or Parameter 4 Value ≥10
		Smoke Resistive[e]		≥½ hr[e]		≥1 hr[e]	
	Incomplete	W/O Door Closer	W/Door Closer	W/O Door Closer	W/Door Closer	W/Door Closer	
	−6 to 0[l]	0	1(2)[f]	1	2(3)[f]	3(4)[f]	3

12. Occupant Emergency Program	Number of Fire Drills Conducted Per Year		
	0	1 to 2	>2
	−2(−3)[m]	0(1)[n]	1(2)[n]

NV – Where these conditions exist, this FSES does not evaluate overall safety. Other analysis techniques shall be permitted to be applied in accordance with the equivalency concept of Section 1.4 of NFPA *101*, *Life Safety Code*.

[a] Use 0 if building is one level.

[b] In any sprinkler-protected spaces, consider flame-spread rating to be 25 or 75 if the interior finish material flame spread does not exceed 75 or 200, respectively.

[c] Increase 200 to 300 if Parameter 4 is 10 or more.

[d] Use 0 if Parameter 11 is −6.

[e] Rate separation as ½ hr (or use actual separation, if greater) if Parameter 4 is 10 or more. Rate separation as "smoke resistive" if Parameter 1 is based on construction Type II(000), III(200), or V(000) and Parameter 4 value < 10.

[f] Use ( ) if separation between rooms also meets criteria.

[g] Use only if all vertical openings have more than 1-hr enclosure and meet the requirements of 7.1.3 and 38.3.1 or 39.3.1 (NFPA *101*).

For SI units, 1 ft = 0.3048 m; 1 ft² = 0.092 m².

[h] Use 50 ft for existing buildings and 20 ft for new construction.

[i] Use ( ) for single exit in accordance with 38.2.4 and 39.2.4 (NFPA *101*).

[j] Use (3) if Parameter 4 value <10.

[k] Use ( ) for building that has:

(a) ≥2 stories above level of exit discharge, or

(b) Occupant load ≥50 (≥100 in existing buildings) above or below level of exit discharge, or

(c) Total occupant load ≥300 (≥1,000 in existing buildings).

[l] See 8.5.11.1.1 for guidance.

[m] Use ( ) in buildings over 150 ft in height with no formal occupant emergency organization program.

[n] Use ( ) in any building, regardless of height, with a formal occupant emergency organization program.

[p] Use ( ) for new high-rise buildings.

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 2 of 4)

FIGURE 8.6 *Continued*

WORKSHEET 8.6.3 INDIVIDUAL SAFETY EVALUATION

Safety Parameters	Fire Control (S_1)	Egress Provided (S_2)	General Fire Safety Provided (S_3)
1. Construction		X	
2. Segregation of Hazards			
3. Vertical Openings	÷ 2 =		
4. Sprinklers		÷ 2 =	
5. Fire Alarm	÷ 2 =		
6. Smoke Detection	÷ 2 =		
7. Interior Finish	÷ 2 =	X	
8. Smoke Control	X	÷ 2 =	
9. Exit Access	X		
10. Exit Systems	X		
11. Corridor/Room Separation	÷ 2 =	÷ 2 =	
12. Occupant Emergency Program	X		
Total	S_1 =	S_2 =	S_3 =

WORKSHEET 8.6.4 MANDATORY SAFETY REQUIREMENTS

	Control Requirement (S_a)		Egress Requirement (S_b)		General Fire Safety Requirement (S_c)	
Stories in Height	**New**	**Existing**	**New**	**Existing**	**New**	**Existing**
1–2 Stories	0.5	–1.0	1.5	0	2	–1
3 Stories	2.0	0	2.5	0	4	0
>3 Stories and ≤75 ft	4.5	2.0	3.5	0	7	2
>75 ft but <150 ft	10.5	7.5	9.5	5	12	6
≥150 ft	13.5	10.5	9.5	5	15	9

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FIGURE 8.6 *Continued*

WORKSHEET 8.6.5 EQUIVALENCY EVALUATION

						Yes	No
Control Provided (S_1)	minus	Required Control (S_a)	≥	0	S_1 [ ] – S_a [ ] = [ ]		
Egress Provided (S_2)	minus	Required Egress (S_b)	≥	0	S_2 [ ] – S_b [ ] = [ ]		
General Fire Safety (S_3)	minus	Required Gen. Fire Safety (S_c)	≥	0	S_3 [ ] – S_c [ ] = [ ]		

WORKSHEET 8.6.6 FACILITY FIRE SAFETY REQUIREMENTS WORKSHEET

	Considerations	Met	Not Met	Not Applic.
A.	Building utilities conform to the requirements of Section 9.1.			X
B.	The air conditioning, heating, and ventilating systems conform to Section 9.2, except for enclosure of vertical openings, which have been considered in Safety Parameter 3 of Worksheet 8.6.2.			X
C.	Elevator installations are made in accordance with the requirements of Section 9.4.			
D.	Rubbish chutes, incinerators, and laundry chutes are installed in accordance with Section 9.5.			
E.	Portable fire extinguishers are installed and maintained in accordance with the requirements of 38.3.5/39.3.5 and Section 9.9.			X
F.	Standpipes are provided in all new high-rise buildings as required by 38.4.2.			

All references are to NFPA *101*, *Life Safety Code.*

WORKSHEET 8.6.7 CONCLUSIONS

1. ☐ All of the checks in Worksheet 8.6.5 are in the "Yes" column and all applicable considerations in Worksheet 8.6.6 are identified as "Met". The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for business occupancies.

2. ☐ All of the checks in Worksheet 8.6.5 are in the "Yes" column and all considerations identified in Worksheet 8.6.6 as "Not Met" have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for business occupancies.

3. ☐ One or more of the checks in Worksheet 8.6.5 are in the "No" column or any consideration identified in Worksheet 8.6.6 as "Not Met" has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for business occupancies.

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FIGURE 8.6 ***Continued***

prescribed by the *Life Safety Code*, using Worksheet 8.6.7, Conclusions. Worksheet 8.6.7 combines the fire safety equivalency evaluation of Worksheet 8.6.5 and the additional considerations of Worksheet 8.6.6.

Chapter 9 Fire Safety Evaluation System for Educational Occupancies

9.1 Introduction.

9.1.1 This chapter is part of an NFPA guide and, therefore, is not mandatory. The term *shall* in this chapter is used to indicate that if the provisions of the chapter are applied, the procedures mandated are to be followed to ensure the effectiveness of the evaluation system.

9.1.2 The Fire Safety Evaluation System (FSES) is a measuring system. It compares the level of safety provided by an arrangement of safeguards that differ from those specified in NFPA *101* to the level of safety provided in a building that conforms exactly with the details of the *Code*.

9.1.3 This Fire Safety Evaluation System is designed and intended to be used for evaluating educational occupancies (as defined in NFPA *101* as applying through the 12th grade). It is not designed or intended to be used for evaluating day care occupancies, assembly occupancies, or other non-educational occupancy uses of educational facilities. Neither is it designed or intended to be used for evaluating educational occupancies located in high-rise buildings.

9.2 Procedure for Determining Equivalency.

9.2.1 Evaluate the factors affecting either every fire zone or the building as a whole using Figure 9.6, Worksheets for Evaluating Fire Safety in Educational Occupancies.

9.2.1.1 Zoning must divide the building into units that consist of one or more complete fire/smoke zones. A fire/smoke zone is a portion of a building that is separated from all other portions of the building by building construction having at least a 1-hour fire resistance rating or smoke barriers having a 30-minute fire resistance rating and conforming to the requirements of Section 8.5 (NFPA *101*), or a combination of both. Any vertical openings (shafts, stairs) involved also must provide 1-hour separation. In facilities completely protected by automatic sprinkler protection, these fire resistance requirements do not apply. The elements separating one zone from another, however, must be of sound, smoke-resisting construction. Doors in zone separations must be either self-closing or equipped with automatic closers operated by smoke detectors.

9.2.1.2 Zones shall be permitted to be either adjacent to each other (e.g., separate wings or building sections) or above each other (e.g., stories or groups of stories).

9.2.1.3 Each zone containing spaces used for an educational occupancy can be evaluated using this system.

9.2.1.4 Each of the 14 safety parameters is to be analyzed, and the safety value for each parameter that best describes the condition in the building is to be identified. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value governs.

9.2.2 Using Worksheet 9.6.6, Facility Fire Safety Requirements, determine the acceptability of the general building systems (i.e., utilities, HVAC, elevator installations, and rubbish chutes, incinerators, and laundry chute installations).

9.2.3 Equivalency is achieved if the building or fire/smoke zone evaluations show equivalency or better in each and every zone and the requirements of Worksheet 9.6.6, Facility Fire Safety Requirements, are met. See Steps 1 through 6 in Section 9.6.

9.3 Glossary for Fire Safety Evaluation Worksheet for Educational Occupancies.

9.3.1 Introduction. This glossary is provided to assist in completing the Worksheet for Evaluating Fire Safety in Educational Occupancies. This glossary provides expanded discussion and definitions for the various items in the worksheets to assist the user where questions of definition or interpretation arise. To the maximum extent possible, the glossary does not repeat the definitions already existing in NFPA *101* but rather references the appropriate paragraphs in NFPA *101*.

9.3.2 Areas of Application.

9.3.2.1 The entire building can be evaluated on a single set of worksheets. The building might, however, be zoned by considering each zone separately or by using any convenient grouping of zones.

9.3.2.1.1 Charges for Safety Parameter 2, "Segregation of Hazards," in Worksheet 9.6.2, Safety Parameters, apply to any hazardous area as described in 9.5.2 in the zone being evaluated and to any hazardous area in zones adjacent to or below the zone being evaluated.

9.3.2.1.2 Where zones are located above each other, the value assigned to Parameter 1, "Construction," in Worksheet 9.6.2, Safety Parameters, in each zone is based on the highest story used for regular human occupancy in that "stack of zones" and the type of construction for that stack of zones.

9.3.2.1.3 The assignment of values for Safety Parameter 5, "Detection, Alarm, and Communication"; Parameter 10, "Exit Access Corridors"; and Parameter 11, "Egress Routes," in Worksheet 9.6.2, Safety Parameters, does not consider conditions in unoccupied spaces in other zones where such are not involved in any egress paths.

9.3.2.1.4 The evaluation of Safety Parameter 11, "Egress Routes," in Worksheet 9.6.2, Safety Parameters, includes those portions of any egress route that serve the zone being evaluated. Any exposures or deficiencies pertaining to any part of the egress route must be taken into account in the evaluation of the zone.

9.3.2.2 Zones that do not involve regular human occupancy are evaluated the same as those with regular human occupancy, with the following variations:

(1) Any such zone shall be permitted to be omitted from the numerical evaluation if both of the following conditions are met:
   (a) The zone is not involved in the egress route from any space with regular human occupancy.
   (b) The zone conforms to NFPA *101* requirements applicable to its use.
(2) Alternatively, such zones shall be permitted to be evaluated using this system, provided any additional egress capabilities and arrangements appropriate to the specific use of the space are provided.

9.4 Maintenance. All protection systems, requirements, arrangements, and procedures shall be maintained in a dependable operating condition and a sufficient state of readiness and shall be used in such a manner that the intended safety function or hazard constraint is not impaired. Otherwise, they shall receive no credit in the evaluation.

9.5 Safety Parameters (Worksheet 9.6.2). The safety parameters are a measure of those building factors that bear upon or contribute to the safety of those persons who might be in the building at the time of a fire. The safety parameters in Worksheet 9.6.2 are described in 9.5.1 through 9.5.14.

9.5.1 Construction. Construction types are classified in accordance with the definitions of NFPA 220. Where the facility includes additions or connected structures of different construction, the rating and classification of the structure is based on one of the following:

(1) Separate buildings where the separation between the portions of the building is a fire barrier having at least a 2-hour fire resistance rating and any opening protectives have at least a 1½-hour fire protection rating
(2) The lower safety parameter point score involved where such a separation does not exist

9.5.2 Segregation of Hazards. The assignment of charges for unsegregated hazardous contents areas is a four-step process.

9.5.2.1 Step 1 — Identify Hazardous Contents Areas. A hazardous area is any space or compartment in which a hazardous activity or storage of flammable or readily combustible products exists that possesses the potential for producing a fully involved fire. Examples of these types of areas in typical educational occupancies include the following:

(1) Laundries
(2) Chemistry storage rooms
(3) Maintenance (such as woodworking and painting areas)
(4) Janitor closets
(5) Boiler rooms and furnace rooms
(6) Rooms used for the storage or processing of combustible supplies
(7) Rooms used for the storage or processing of hazardous materials, flammable liquids, or combustible liquids

9.5.2.2 Step 2 — Determine the Level of Hazard. There are two levels of hazard: structurally endangering and not structurally endangering.

9.5.2.2.1 Structurally Endangering. A hazardous area with a potential fire severity that might exceed the tested resistance of the enclosure and defeat the basic structural integrity of the building framing as defined in Safety Parameter 1, "Construction," of Worksheet 9.6.2. In educational occupancies, shops and industrial technology areas involving the use of open flames, welding operations, and limited quantities of flammable liquids should be considered structurally endangering. Other areas not having these types of uses should be considered not structurally endangering.

9.5.2.2.2 Not Structurally Endangering. A hazardous area with sufficient fire potential to build to full involvement (flashover) and present a danger of propagating through openings or wall partitions but not possessing sufficient total potential to endanger the structural framing or floor decking as defined in Safety Parameter 1 of Worksheet 9.6.2.

9.5.2.3 Step 3 — Determine the Fire Protection Provided.

9.5.2.3.1 The parameter value for hazardous areas is based on the presence or absence of the fire protection necessary to control or confine the hazard. Two different types of fire protection are considered. The first consists of automatic sprinklers or other appropriate extinguishing systems covering the entire hazard. The credit for sprinklers shall not be given unless the hazardous area is separated from the rest of human occupancy or the egress route by reasonably smoke-resistant partitions and doors (other than sprinklered janitor closets with louvered doors in accordance with 14.3.2.1 or 15.3.2.1 of NFPA *101*). The second is a complete fire enclosure having a sufficient fire resistance rating to contain the potential fire severity of the hazardous area. This includes the following:

(1) The separation of the hazardous area from any structural framing members
(2) Partitions separating the hazardous area from all other spaces
(3) Fire protection–rated doors sufficient to exceed the potential of the fire load involved

9.5.2.3.2 Any hazardous space that has any of these protection systems is classified as having single protection.

9.5.2.4 Step 4 — Determine Degree of Deficiency and Assign Parameter Values.

9.5.2.4.1 The parameter value ultimately is determined by the degree of the deficiency of the hazardous contents area based on the level of protection needed. Table 9.5.2.4.1 provides a matrix to be used to determine the degree of deficiency to be assessed.

9.5.2.4.2 In some situations, more than one hazardous area with the same or differing levels of deficiency exists. The overall charge is based on the single most serious deficiency for the hazardous area.

9.5.3 Vertical Openings. These values apply to vertical openings and penetrations including exit stairways, ramps, and any

Table 9.5.2.4.1 Segregation of Hazards — Degree of Deficiency

	No protection	Sprinkler protection	Fire resistance–rated enclosure*	Sprinklered and fire resistance–rated enclosure*
Not structurally endangering	Single deficiency	No deficiency		
Structurally endangering	Double deficiency	Single deficiency	Single deficiency	No deficiency

*Complete enclosure having sufficient fire resistance to contain the potential of the hazardous contents area.

other vertical exits, pipe shafts, ventilation shafts, duct penetrations, and laundry and incinerator chutes. The charge for vertical openings is based on the fire resistance of the enclosure, if provided.

9.5.3.1 A vertical opening or penetration is classified as open if it has any of the following characteristics:

(1) Unenclosed
(2) Unenclosed but is the only vertical opening and is in accordance with the convenience opening provisions of 8.6.9.1 of NFPA *101*, in which case the parameter value of 9.5.3.1(2) is to be assigned
(3) Enclosed but has doorways (or similar portals) that are without doors
(4) Enclosed but has unprotected openings other than doorways
(5) Enclosed with cloth, paper, or similar materials without any sustained fire-stopping capabilities

9.5.3.2 The credit for vertical opening protection varies depending on the number of stories connected by the vertical opening and the degree of enclosure.

9.5.4 Sprinklers.

9.5.4.1 Where an automatic sprinkler is installed for either total or partial building coverage, the system shall be in accordance with Section 9.7 (NFPA *101*) for the sprinklered areas.

9.5.4.2 To receive credit for protection, the sprinkler system must be equipped with an automatic alarm-initiating device that activates the building's fire alarm system or otherwise sounds an alarm sufficiently audible to be heard in all occupied areas.

9.5.4.3 To receive credit for "complete building" sprinkler protection, the entire building must be provided with sprinkler coverage and must cover all zones of the building.

9.5.4.4 To receive credit for "partial – occupied areas" sprinkler protection, sprinklers must be provided throughout all areas subject to occupancy and all hazardous contents areas.

9.5.5 Detection, Alarm, and Communication. Fire alarm systems are defined in 9.5.5.1 through 9.5.5.4.

9.5.5.1 None. There is no fire alarm system, or the system is incomplete and does not meet the requirements for a higher-scored category.

9.5.5.2 Manual System Only. There is a manual fire alarm system that provides automatic occupant notification and meets the requirements of Section 9.6 (NFPA *101*). An alternative protection system in accordance with 14.3.4.2.3 or 15.3.4.2.3 (NFPA *101*) is to be considered an alarm system with manual initiation.

9.5.5.3 Manual with Fire Detection in Hazardous Areas. There is a manual fire alarm system that provides automatic occupant notification, where additional initiation occurs via automatic fire detection in hazardous areas such as boiler rooms, shops, laboratories, kitchens, laundry rooms, and storage rooms, and such system meets the requirements of Section 9.6 (NFPA *101*).

9.5.5.4 Manual with Smoke Detection. There is a manual fire alarm system that provides automatic occupant notification, where additional initiation occurs via automatic smoke detection throughout the building, and such system meets the requirements of Section 9.6 (NFPA *101*).

9.5.6 Emergency Forces Notification. Emergency forces notification means are defined in 9.5.6.1 through 9.5.6.3.

9.5.6.1 None. There is no emergency forces notification, or the system is incomplete and does not meet the requirements for a higher-scored category.

9.5.6.2 Administrative. Administrative emergency forces notification is a system in accordance with 15.3.4.3.2.1 (NFPA *101*).

9.5.6.3 Automatic. Automatic emergency forces notification is a system in accordance with 9.6.4 (NFPA *101*).

9.5.7 Interior Finish in Exits.

9.5.7.1 Classification of interior finish is based on the flame-spread index and smoke developed index of the interior wall and ceiling finish materials tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. The requirements apply to interior wall and ceiling finish materials as described in Section 10.2 (NFPA *101*).

9.5.7.2 No consideration is included in the safety parameter value for any finish with a flame-spread index of more than 200 as measured by ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. Thus, this FSES should not be used where such conditions exist. Some materials, including foam plastics, high-density polyethylene, and polypropylene, are not permitted to be tested in accordance with ASTM E84 and must be tested in accordance with NFPA 286 and must meet the acceptance criteria shown in 10.2 (NFPA *101*). Some materials, including asphalt-impregnated paper, are capable of inducing extreme rates of fire growth and rapid flashover. In any case involving these materials, the resultant hazard is considered beyond the capacity of this evaluation system and requires an individual fire hazard assessment.

9.5.7.3 Interior wall and ceiling finish materials tested in accordance with NFPA 265 or NFPA 286 as permitted by Section 10.2 (NFPA *101*), and meeting the criteria established in Section 10.2 (NFPA *101*) for those test standards, shall be scored as Class A interior finish materials (flame spread ≤25).

9.5.7.4 Any interior finish having a flame-spread index of 75 or less that is protected by automatic sprinklers is evaluated as having a flame-spread index not exceeding 25. Any interior finish having a flame-spread index of more than 75 but not more than 200 that is protected by automatic sprinklers is evaluated as having a flame-spread index not exceeding 75.

9.5.8 Interior Finish in Corridors and Lobbies. See 9.5.7.

9.5.9 Interior Finish in Rooms. See 9.5.7.

9.5.10 Exit Access Corridor.

9.5.10.1 The charge for dead-end access is made where any corridor affords access in only one direction to a required exit.

9.5.10.2 If a dead-end corridor distance exceeds 75 ft (23 m), a separate analysis must be made to evaluate the potential of flashover of any spaces that could block egress from the dead-end corridor and to determine the potential rate of smoke-filling of the egress system involved. If the safe time is shorter than the expected egress time, the evaluation should be discontinued unless a corrective action is specified.

9.5.10.3 Any system with common path of travel in excess of that permitted by NFPA *101* should be considered deficient under Safety Parameter 11, "Egress Routes."

9.5.11 Egress Routes.

9.5.11.1 Egress routes are the paths of travel from any point within a room to the public way using any types and arrangements described in Chapters 14 and 15 (NFPA *101*).

9.5.11.2 Egress routes are defined in 9.5.11.2.1 through 9.5.11.2.5.

9.5.11.2.1 Single Egress Route. A single route exists where occupants on any story do not have either a direct exit to a public way or multiple egress routes as defined in 9.5.11.2.2.

9.5.11.2.2 Multiple Egress Routes. Multiple routes exist where the occupants on a story have a choice of two separate means of egress routes to a public way using the permitted types in Chapters 14 and 15 (NFPA *101*).

9.5.11.2.3 Deficient — Multiple Egress Routes. An egress route is deficient if it fails to meet any of applicable criteria of NFPA *101* including capacity. Any system with common path of travel in excess of that permitted by Chapters 14 and 15 (NFPA *101*) should be considered deficient under Parameter 11, "Egress Routes." An egress route is deficient if a room or space larger than 1000 ft^2 (92.9 m^2) or with an occupant load of more than 50 persons does not have a minimum of two exit access doors providing access to separate exits.

9.5.11.2.4 Smokeproof Enclosure. Credit for a smokeproof enclosure shall be permitted to be given for a stairway designed and tested in accordance with the requirements of 7.2.3 (NFPA *101*) for a smokeproof enclosure. To receive credit for a smokeproof enclosure, all exit stairs credited in Safety Parameter 10, "Exit Access Corridor," and Safety Parameter 11, "Egress Routes," shall meet the smokeproof enclosure requirements.

9.5.11.2.5 Direct Exit. To be credited for direct exits, each room shall have within that unit a door that opens to the exterior at grade level or onto an exterior balcony with direct access to an exterior exit. Where such openings are directly onto grade in a location where any person egressing can move directly away from the building without further exposure, the credit for direct exit shall be given even if there are no other egress routes from the space.

9.5.12 Corridor/Room Separation. The values assigned in Safety Parameter 12, "Corridor/Room Separation," are based on the quality of separation between the room and the corridor. For purposes of this evaluation, corridor separation in educational occupancy buildings is considered as complete if it meets the requirements of 14.3.6 or 15.3.6 (NFPA *101*). For areas within educational occupancies that use an "open-plan" concept where all of the classrooms egress through an intervening space (such as a media or activity center), a separate evaluation is recommended that calculates fuel loading and available safe egress time.

9.5.12.1 Corridor/room separation is defined in 9.5.12.1.1 through 9.5.12.1.4.

9.5.12.1.1 No Separation Exists or Multiple Penetrations. The separation is judged to be nonexistent if there is no corridor leading to an exit, there are no barriers against smoke or fire spread, there are no doors between corridors and adjacent rooms, or there are multiple penetrations. Examples of penetrations include transfer grilles for air movement, transoms, and non-fire-rated glass.

9.5.12.1.2 Incomplete. The separation is judged as "incomplete" if the wall to the corridor has some unprotected openings (for example, louvers, gaps, or transfer grilles) between the floor and ceiling but these openings are minor in relation to the area of the room or are located low in walls or doors. If openings exist above the ceiling level, the separation is considered complete if the ceiling in the room is a completed membrane. In this case, the separation rating is based on the level of resistance involved in the wall/ceiling system.

9.5.12.1.3 Solid Core Doors. This parameter should be used if the corridor/room doors are solid core wood or metal doors at least 1¾ in. (44 mm) thick.

9.5.12.1.4 Doors with ≥20-Minute Fire Protection Rating. Use this parameter if doors and frames are fire protection–rated for 20 minutes or greater protection and are self-closing or automatic-closing.

9.5.13 Smoke Control.

9.5.13.1 The active smoke control value should be used when an engineered smoke control system complying with NFPA 92 is installed and the building is protected throughout by an approved, supervised automatic sprinkler system in accordance with Section 9.7 (NFPA *101*).

9.5.13.2 The passive smoke control with auto-closing doors value should be used when the building is subdivided into compartments by smoke partitions having a 1-hour fire resistance rating complying with Section 8.4 (NFPA *101*), and all doors located within the smoke partition are designed to close automatically upon the activation of the fire alarm system or the fire sprinkler system per *NFPA 72*.

9.5.13.3 The passive smoke control value should be used when the building is subdivided into compartments by smoke partitions having a 1-hour fire resistance rating complying with Section 8.4 (NFPA *101*), but not meeting the provisions of 9.5.13.2.

9.5.14 Occupant Emergency Program.

9.5.14.1 The value of this parameter is determined by the number of emergency egress and relocation drills conducted in the building each year.

9.5.14.2 To receive a parameter value other than -6, the building or zone occupants are required to take part in scenario-oriented emergency egress and relocation drills conducted in accordance with the appropriate provisions of NFPA *101*. The scenarios should be based on the hazardous conditions that could develop during a fire in the facility. The scenarios should also include planning and provisions for the evacuation or relocation of occupants with disabilities.

9.6 Worksheets for Evaluating Fire Safety in Educational Occupancies. The worksheets for evaluating fire safety in educational occupancies use a six-step process found in Figure 9.6.

9.6.1 Step 1 — Complete the Cover Sheet Using Worksheet 9.6.1. See Figure 9.6.

9.6.2 Step 2 — Determine Individual Safety Evaluations Using Worksheet 9.6.2. The following steps should be taken:

WORKSHEET 9.6.1 COVER SHEET

Fire Safety Evaluation Worksheet for Educational Occupancies

Facility Identification ______________________________

Evaluator ______________________ Date ______________________

Notes:

WORKSHEET 9.6.2 SAFETY PARAMETERS

Safety Parameters	Parameter Values							
1. Construction	Combustible					Noncombustible		
NFPA 220 Building Construction Types/ Stories in Height	Type V (000)	Type V (111)	Type IV (2HH)	Type III (200)	Type III (211)	Type II (000)	Type II (111)	Type I(442), Type I(332), Type II(222)
1 Story	1	2	2	1	2	1	2	2
2 Stories	0	1	1	0	1	0	1	2
3 Stories	–4	0	0	–4	0	–4	0	2
≥4 Stories but not High Rise	–8	–1	–1	–8	–1	–8	–1	2

Safety Parameters	Exposed to Exit System		Segregated from Exit Routes		None or No Deficiencies
2. Segregation of Hazards	Double Def.	Single Def.	Double Def.	Single Def.	
	–7	–4	–4	0	0

Safety Parameters	Open (or incomplete enclosure)			No Opening	Enclosed		
3. Vertical Openings	Connects 4 or More Stories	Connects 3 Stories	Connects 2 Stories	Single Story Building W/O Basement	Smoke Resistant or <30 min	≥30 min to <1 hr	≥1 hr
	–10	–6	–2(2)[a]	2(1)[b]	1	1	2(1)[c,d]

Safety Parameters		Partial		Complete Building	
4. Sprinklers[e]	None	Hazardous Contents Areas Only	Occupied Areas but not Throughout Unoccupied Areas	Standard Response Sprinklers	Quick Response Sprinklers
	0(–2)[f,g]	1(–1)[f,g]	6(0)[g]	10	12

Safety Parameters				
5. Detection, Alarm, and Communication[h]	None	Alarm System with Manual Initiation and Automatic Occupant Notification	Alarm System with Manual Initiation, Fire Detection in Hazardous Contents Areas, and Automatic Occupant Notification	Alarm System with Manual Initiation, Complete Smoke Detection, and Automatic Occupant Notification
	–6	0(1)[n,o]	2(3)[n,o]	6

(Worksheet 9.6.2 continues.)

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FIGURE 9.6 Worksheets for Evaluating Fire Safety in Educational Occupancies.

Worksheet 9.6.2 *Continued*

6. Emergency Forces Notification	None	Administrative	Automatic
	–1	0(–1)[i]	1(–1)[i]

7. Interior Finish in Exits (Flame-Spread Ratings)	>75 to ≤200	>25 to ≤75	≤25
	–2	–1	0

8. Interior Finish in Corridors and Lobbies (Flame-Spread Ratings)	>75 to ≤200	>25 to ≤75	≤25
	–3	–2	0

9. Interior Finish in Rooms (Flame-Spread Ratings)	>75 to ≤200	>25 to ≤75	≤25
	–2	–1	0

10. Exit Access Corridors	Max. Dead End Length		No Dead Ends >20 ft (>50 ft if Parameter 4 is ≥10) and Travel Is			
	>50 ft to ≤75 ft	>20 ft to ≤50 ft and Parameter 4 is <10	>200 ft	>150 ft to ≤200 ft	>50 ft to ≤150 ft	≤50 ft
	–2	–1	–2	–1	0	2

11. Egress Routes	Single Route	Multiple Routes			Direct Exit
		Deficient	Not Deficient	Smokeproof Enclosures	
	NV(–6)[j]	–2	0	1	5

12. Corridor/Room Separation	No Separation Exists or Multiple Penetrations	Separation Exists and Level of Protection is					
		Incomplete	Smoke Partitions		Fire-Rated Walls (≥½ hr Existing, ≥1 hr New)		
			Smoke-Resistant Door W/O Closer	Smoke-Resistant Door W/Closer	Smoke-Resistant Door W/Closer	Solid-Core Doors (no nonrated glazing) W/Closer	Doors W/≥20-min FPR
	–3	–2	–1(0)[l]	0(0)[m]	0(0)[m]	1	2

13. Smoke Control	None	Passive	Passive with Auto Closing Doors	Active
	–2	0(0)[k]	1	2

14. Occupant Emergency Program	Number of Emergency Egress and Relocation Drills Conducted		
	None	≥2 during first 2 months, plus ≥2 others spread out during remainder of school year	≥2 during first month, plus ≥1 per month during remainder of school year
	–6	–3	0

NV – Where a single egress route exists for other than a 1-story building, this FSES does not evaluate overall safety. Other analysis techniques might be applied in accordance with the equivalency concept of Section 1.4 of NFPA *101, Life Safety Code.*

[a] Use (2) if only vertical opening is in accordance with 8.6.9.1 (NFPA *101*).

[b] Use (1) if educational occupancy is existing.

[c] Use (1) if vertical opening enclosure is existing.

[d] Use (1) if building construction is Type II(000), Type III(200) or Type V(000).

[e] For sprinkler parameter values >0, sprinkler system must be electrically supervised.

[f] Use ( ) in existing educational occupancy if student occupied level below LED is not sprinklered.

[g] Use ( ) in new educational occupancy if level below LED is not sprinklered.

[h] If alternative protection system is provided in accordance with 14.3.4.2.3 or 15.3.4.2.3 (NFPA *101*), see 9.5.5.2.

[i] Use (-1) if Parameter 5 value is -6.

[j] Use (-6) for 1-story buildings only; for other than 1-story buildings the NV note applies.

[k] Use (0) if no smoke control but aggregate floor area having a common atmosphere <30,000 ft^2 and building <300 ft length and <300 ft width.

[l] Use (0) if room is normally occupied classroom and Parameter 4 is ≥10.

[m] Use (0) where door is without closer if room is normally occupied classroom and Parameter 4 is ≥10.

[n] Use ( ) in new educational occupancy if alarm system is provided with voice/alarm communication.

[o] Use ( ) in new educational occupancy if alarm system is in a building with occupant load ≥100.

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FIGURE 9.6 ***Continued***

WORKSHEET 9.6.3 INDIVIDUAL SAFETY EVALUATION

Safety Parameters	Fire Control (S_1)	Egress Provided (S_2)	General Fire Safety Provided (S_3)
1. Construction			
2. Segregation of Hazards			
3. Vertical Openings			
4. Sprinklers		$\prod 2 =$	
5. Detection, Alarm, and Communication	$\prod 2 =$		
6. Emergency Forces Notification			
7. Interior Finish in Exits	$\prod 2 =$		
8. Interior Finish in Corridors and Lobbies	$\prod 2 =$		
9. Interior Finish in Rooms	$\prod 2 =$		
10. Exit Access Corridor			
11. Egress Routes			
12. Corridor/Room Separation	$\prod 2 =$	$\prod 2 =$	
13. Smoke Control			
14. Occupant Emergency Program			
Total	$S_1 =$	$S_2 =$	$S_3 =$

WORKSHEET 9.6.4A MANDATORY SAFETY REQUIREMENTS — NEW BUILDINGS ≤ 12,000 ft² OR EXISTING BUILDINGS

Stories in Height	Control Requirement (S_a)		Egress Requirement (S_b)		General Fire Safety Requirement (S_c)	
	New	Existing	New	Existing	New	Existing
1 Story	3	0.5	3	1.5	3	–1
2 Stories	4	0.5	4	1.5	4	–1
3 Stories	3	–0.5	4	1.5	3	–2
≥4 Stories but not High Rise[a]	12	1.5	7	1.5	8	0

[a] See 9.1.3.

WORKSHEET 9.6.4B MANDATORY SAFETY REQUIREMENTS — NEW BUILDINGS > 12,000 ft²

Stories in Height	Control Requirement (S_a)	Egress Requirement (S_b)	General Fire Safety Requirement (S_c)
1 Story	9.5	5	5
2 Stories	10.5	6	6
3 Stories	9.5	6	5
≥4 Stories but not High Rise[a]	11.5	6	7

[a] See 9.1.3.

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 3 of 4)

FIGURE 9.6 ***Continued***

WORKSHEET 9.6.5 EQUIVALENCY EVALUATION

						Yes	No
Fire Control Provided (S_1)	minus	Required Control (S_a)	≥	0	S_1 ☐ – S_a ☐ = ☐		
Egress Provided (S_2)	minus	Required Egress (S_b)	≥	0	S_2 ☐ – S_b ☐ = ☐		
Gen. Fire Safety Provided (S_3)	minus	Required Gen. Fire Safety (S_c)	≥	0	S_3 ☐ – S_c ☐ = ☐		

WORKSHEET 9.6.6 FACILITY FIRE SAFETY REQUIREMENTS

	Considerations	Met	Not Met	Not Applic.
A.	Building utilities conform to the requirements of Section 9.1 (NFPA *101*).			X
B.	The air conditioning, heating, and ventilating systems conform to Section 9.2 (NFPA *101*), except for enclosure of vertical openings, which have been considered in Safety Parameter 3 of Table 9.6.2.			X
C.	Elevator installations are made in accordance with the requirements of Section 9.4 (NFPA *101*).			
D.	Rubbish chutes, incinerators, and laundry chutes are installed in accordance with Section 9.5 (NFPA *101*).			
E.	Emergency lighting is provided in accordance with the requirements of 14.2.9 and 15.2.9 (NFPA *101*).			
F.	Exit signs are provided in accordance with the requirements of 14.2.10 and 15.2.10 (NFPA *101*).			
G.	Kindergarten, first and second grade student occupancy within the building conforms to the requirements of 14.2.1.2 through 14.2.1.4 and 15.2.1.2 through 15.2.1.4 (NFPA *101*).			X
H.	Artwork on walls and ceilings conforms to the requirements of 14.7.4.3 and 15.7.4.3 (NFPA *101*).			X
I.	Carbon monoxide detection/alarm is provided in accordance with 14.3.4.4 (NFPA *101*).			

WORKSHEET 9.6.7 CONCLUSIONS

1. ☐ All of the checks in Worksheet 9.6.5 are in the "Yes" column and all applicable considerations in Worksheet 9.6.6 are identified as "Met". The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for educational occupancies.

2. ☐ All of the checks in Worksheet 9.6.5 are in the "Yes" column and all considerations identified in Worksheet 9.6.6 as "Not Met" have been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is at least equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for educational occupancies.

3. ☐ One or more of the checks in Worksheet 9.6.5 are in the "No" column or any consideration identified in Worksheet 9.6.6 as "Not Met" has NOT been evaluated and mitigated to the satisfaction of the AHJ. The level of fire safety is not shown by this system to be equivalent to that prescribed by NFPA *101*, *Life Safety Code*, for educational occupancies.

(For use with NFPA 101A-2016/NFPA *101*-2015) (p. 4 of 4)

FIGURE 9.6 ***Continued***

(1) Select and circle the safety value for each parameter in Worksheet 9.6.2, Safety Parameters, that best describes the conditions in the facility. Only one value for each of the parameters is to be chosen. If two or more values appear to apply, the one with the lowest point value governs.
(2) Transfer each of the 14 circled safety parameter values from Worksheet 9.6.2 to the available blocks corresponding to each safety parameter in Worksheet 9.6.3, Individual Safety Evaluation. Where the blocks indicate "÷2," enter one-half the value from Worksheet 9.6.2.
(3) Add each of the three columns, keeping in mind that any negative numbers need to be deducted.
(4) Transfer the resulting values for S_1, S_2, and S_3 to Worksheet 9.6.5, Equivalency Evaluation.

9.6.3 Step 3 — Determine Mandatory Requirements Using Worksheet 9.6.4A or 9.6.4B. The following steps should be taken:

(1) Circle the mandatory values in Worksheet 9.6.4A or 9.6.4B, Mandatory Safety Requirements, as appropriate for the building being evaluated.
(2) Transfer the circled values from Worksheet 9.6.4A or 9.6.4B to the boxes marked S_a, S_b, and S_c in Worksheet 9.6.5, Equivalency Evaluation.

9.6.4 Step 4 — Evaluate Fire Safety Equivalency Using Worksheet 9.6.5. The following steps should be taken:

(1) Perform the subtractions indicated in Worksheet 9.6.5. Enter the differences in the appropriate boxes.
(2) For each row, check "yes" if the value in the answer box is zero (0) or greater. Check "no" if the value in the answer box is negative.

9.6.5 Step 5 — Evaluate Other Considerations Not Previously Addressed, Using Worksheet 9.6.6. The equivalency covered by Worksheets 9.6.2 through 9.6.5 includes the majority of considerations covered by the *Life Safety Code*. Some considerations are not evaluated by this method and must be considered separately. These additional considerations are covered in Worksheet 9.6.6, Facility Fire Safety Requirements. Complete one copy of this separate worksheet for each facility.

9.6.6 Step 6 — Determine Equivalency Conclusion. Conclude whether the level of life safety is at least equivalent to that prescribed by the *Life Safety Code*, using Worksheet 9.6.7, Conclusions. Worksheet 9.6.7 combines the zone fire safety equivalency evaluation of Worksheet 9.6.5 and the additional considerations of Worksheet 9.6.6.

Annex A Explanatory Material

Annex A is not a part of the recommendations of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.3.1 The mandatory values presented in worksheets in the various FSES chapters are calibrated to measure safety against the provisions of the most current edition of NFPA *101* which, in the case of this 2016 edition of NFPA 101A, is the 2015 edition. The spreadsheets used to calculate the mandatory values serve as a record of the safety parameters and associated point values determined by the technical committee as the baseline required by the *Code*. The spreadsheets are maintained in the permanent committee files at NFPA headquarters, serve as the historical record, and are consulted when each new edition of NFPA *101* is published to determine what mandatory values need further calibration.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this guide and are not advisory in nature unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

B.1.2 Other Publications. (Reserved)

B.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not directly referenced in this guide.

National Technical Information Service (NTIS), Sales and Order Desk, 5285 Port Royal Road, Springfield, VA 22161; telephone: (800) 553-6847; (703) 605-6900; E-mail orders: orders@ntis.gov; Internet: http://www.ntis.gov/ordering.htm.

Nelson, H. E., *Fire Safety Evaluation System for NASA Office/Laboratory Buildings*, NBSIR 86-3404, National Bureau of Standards, Gaithersburg, MD, November 1986. NTIS PB87-134300.

Nelson, H. E., and A. J. Shibe, *System for Fire Safety Evaluation of Health Care Facilities,* NBSIR 78-1555-1, National Bureau of Standards, Gaithersburg, MD, May 1980. [U.S./Japan Government Cooperative Program on Natural Resources (UJNR), Fire Research and Safety, Fourth Joint Panel Meeting of UJNR Panel, February 5–9, 1979, Tokyo, Japan.] NTIS PB80-195795.

Nelson, H. E., and A. J. Shibe, *System for Fire Safety Evaluation for Multifamily Housing,* Interim Report, NBSIR 82-2562, National Bureau of Standards, Gaithersburg, MD, September 1982. NTIS PB83-119909.

Nelson, H. E., and A. J. Shibe, *Development of a Fire Safety Evaluation System for Detention and Correctional Occupancies*, NBSIR 84-2976, National Bureau of Standards, Gaithersburg, MD, January 1985. NTIS PB85-177913.

Nelson, H. E., B. M. Levin, A. J. Shibe, N. E. Groner, R. L., Paulsen, D. M. Alvord, S. D. Thorne, *Fire Safety Evaluation Systems for Board and Care Homes*, Final Report, NBSIR 83-2659, National Bureau of Standards, Gaithersburg, MD, March 1983. NTIS PB83-192674.

Nelson, H. E., A. J. Shibe, B. M. Levin, S. D. Thorne, L. Y. Cooper, *Fire Safety Evaluation System for National Park Service Overnight Accommodations*, NBSIR 84-2896, National Bureau of Standards, Gaithersburg, MD, September 1984. NTIS PB85-105518.

B.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 102

Standard for

Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures

2016 Edition

This edition of NFPA 102, *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures*, was prepared by the Technical Committee on Assembly Occupancies and Membrane Structures and released by the Correlating Committee on Safety to Life. It was issued by the Standards Council on January 28, 2015, with an effective date of February 17, 2015, and supersedes all previous editions.

This edition of NFPA 102 was approved as an American National Standard on February 17, 2015.

Origin and Development of NFPA 102

This standard is the result of a committee project inaugurated shortly after the circus fire in Hartford, CT, on July 6, 1944, in which 168 lives were lost.

A committee was organized under the joint sponsorship of the Building Officials Conference of America and the National Fire Protection Association under the procedure of the American Standards Association. As a result of extensive deliberation during the winter of 1944–1945, this committee prepared a draft of a proposed standard, which was submitted at the annual meeting of the National Fire Protection Association in June, 1945. This was then printed and sent to all of the members of the Association, to a representative group of leaders in the outdoor amusement industry, and to all others who filed requests for copies. As a result, numerous constructive suggestions were received, all duly considered by the committee in several meetings, and the 1946 standard was completed by the committee. It was then adopted by the sponsoring organizations, the National Fire Protection Association, and the Building Officials Conference of America, and approved by the American Standards Association as an American Standard on May 22, 1946.

As a result of circulation and use of the 1946 standard, various proposals were made for revision in the interest of clarification. These were considered by the committee and revisions recommended by the committee and circulated to all concerned for comment, further amended, and adopted by the National Fire Protection Association and the Building Officials Conference of America in 1948; the American Standards Association approved the 1948 edition as an American Standard on January 5, 1949.

In 1949 the committee recommended further changes to include the essential features of an earlier standard on grandstands, Z20.1, which covered certain types of grandstands not covered in the 1946–1948 standard, Z20.2, thus making the continuance of the earlier separate standard unnecessary. The 1949 revision, Z20.3, also made the standard applicable to foldable grandstands in buildings that had not been previously covered. After the usual circulation for comment, the revisions were adopted in 1949 by the sponsors, and the revised text was approved by the American Standards Association as an American Standard on April 5, 1950.

Revised editions of the standard have been prepared by the committee and adopted by the sponsors in 1957, 1966, and 1967. The 1972 edition was a reconfirmation of the 1967 edition.

The 1978 edition was prepared by the Committee on Tents, Grandstands, and Air- Supported Structures and represented a complete revision of the 1972 edition, complete with a new title, *Standard for Assembly Seating, Tents, and Air-Supported Structures*. The means of egress section was coordinated with the provisions of NFPA *101, Life Safety Code*.

The 1986 edition further coordinated with the *Life Safety Code*. It was prepared by the Technical Committee on Safety to Life through its Subcommittee on Tents and Membrane Structures. Its scope was extended beyond assembly occupancies to include tents and membrane structures used for any occupancy.

NFPA and National Fire Protection Association are registered trademarks of the National Fire Protection Association, Quincy, Massachusetts 02169.

The 1992 and 1995 editions deleted all means of egress provisions that were adequately covered by NFPA *101, Life Safety Code*, so as to avoid redundancy and inconsistencies between the two documents. The 1995 edition was retitled *Standard for Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures* to reflect more accurately the scope and contents of the document.

The 2006 edition was the first to be wholly comprised of requirements extracted from NFPA *101, Life Safety Code*, and NFPA 5000, *Building Construction and Safety Code*.

The 2011 edition continued the extract policy.

For future revision cycles, users were advised to submit public proposals on extracted text to the source documents (that is, NFPA *101* and NFPA 5000) and not to NFPA 102

The 2016 edition continues the extract policy.

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Ron Coté, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the protection of human life from fire and other circumstances capable of producing similar consequences and for the non-emergency and emergency movement of people.

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Ron Coté, NFPA Staff Liaison

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on protection of human life and property from fire and other circumstances capable of producing similar consequences, and on the non-emergency and emergency movement of people in assembly occupancies, tents, and membrane structures.

NFPA 102

Standard for

Grandstands, Folding and Telescopic Seating, Tents, and Membrane Structures

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope. This standard addresses the following:

(1) The construction, location, protection, and maintenance of grandstands and bleachers, folding and telescopic seating, tents, and membrane structures
(2) Seating facilities located in the open air or within enclosed or semi-enclosed structures such as tents, membrane structures, and stadium complexes.

1.2 Purpose. The purpose of this standard is to provide minimum requirements for life safety in relation to fire, storm, collapse, and crowd behavior in tents, membrane structures, and assembly seating as covered in Section 1.1.

1.3 Application. The requirements of this standard shall apply to the following:

(1) New facilities
(2) Existing facilities where specifically noted

1.4 Equivalency.

1.4.1 General. Nothing in this standard shall prohibit methods of construction, materials, and designs not specifically prescribed in this standard where equivalent alternatives are approved by the authority having jurisdiction (AHJ).

1.4.2 Approval of Alternatives. Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this standard.

1.4.3 Tests.

1.4.3.1 Whenever the authority having jurisdiction determines that there is insufficient evidence of proof of equivalency with the prescribed requirements of this standard, the authority having jurisdiction shall be authorized to require tests showing proof of equivalency.

1.4.3.2 Tests required by the authority having jurisdiction shall be provided by the owner at no expense to the jurisdiction.

1.4.3.3 Tests shall be conducted as specified in this standard or, where test methods are not specified in this standard, they shall be conducted as required by the authority having jurisdiction.

1.4.4 Approval. The authority having jurisdiction shall determine whether the proposed alternate methods of construction, materials, and designs are at least equivalent to the prescribed requirements of this standard.

1.5 Units.

1.5.1 SI Units. Metric units of measurement in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.5.2 Primary Values. The inch-pound value for a measurement, and the SI value given in parentheses, shall each be acceptable for use as primary units for satisfying the requirements of this standard.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2011 edition.

NFPA 54, *National Fuel Gas Code,* 2015 edition.

NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.

NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2015 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2015 edition.

NFPA *101®, Life Safety Code®,* 2015 edition.

NFPA 160, *Standard for the Use of Flame Effects Before an Audience,* 2011 edition.

NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2013 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2015 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2011 edition.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

2.3 Other Publications.

2.3.1 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE/SEI 17, *Air Supported Structures*, 1996.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A 153/A 153M, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware*, 2009.

ASTM D 2898, *Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*, 2010.

ASTM G 155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*, 2005a.

2.3.3 IAPMO Publications. International Association of Plumbing and Mechanical Officials, 5000 E. Philadelphia Street, Ontario, CA 91761.

UMC, *Uniform Mechanical Code*, 2012.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA *101®*, *Life Safety Code®*, 2015 edition.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Code. A standard that is an extensive compilation of provisions covering broad subject matter or that is suitable for adoption into law independently of other codes and standards.

3.2.4 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.5* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.6 Shall. Indicates a mandatory requirement.

3.2.7 Should. Indicates a recommendation or that which is advised but not required.

3.2.8 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Air-Inflated Structure. A structure whose shape is maintained by air pressure in cells or tubes forming all or part of the enclosure of the usable area and in which the occupants are not within the pressurized area used to support the structure. [**5000,** 2015]

3.3.2* Air-Supported Structure. A structure where shape is maintained by air pressure and in which occupants are within the elevated pressure area. [**5000,** 2015]

3.3.3* Assembly Occupancy. An occupancy (1) used for a gathering of 50 or more persons for deliberation, worship, entertainment, eating, drinking, amusement, awaiting transportation, or similar uses; or (2) used as a special amusement building, regardless of occupant load. [**5000,** 2015]

3.3.4 Bleachers. A grandstand in which the seats are not provided with backrests. [**5000,** 2015]

3.3.5* Exit. That portion of a means of egress that is separated from all other spaces of a building or structure by construction, location, or equipment as required to provide a protected way of travel to the exit discharge. [**5000,** 2015]

3.3.6 Exit Access. That portion of a means of egress that leads to an exit. [**5000,** 2015]

3.3.7 Exit Discharge. That portion of a means of egress between the termination of an exit and a public way. [**5000,** 2015]

3.3.8 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by *NFPA 5000*. [**5000,** 2015]

3.3.9 Folding and Telescopic Seating. A structure that is used for tiered seating of persons and whose overall shape and size can be reduced, without being dismantled, for purposes of moving or storing. [***101,*** 2015]

3.3.10* Grandstand. A structure that provides tiered or stepped seating. [**5000,** 2015]

3.3.11 Limited-Combustible (Material). See 7.1.4.2 of *NFPA 5000*.

3.3.12* Means of Egress. A continuous and unobstructed way of travel from any point in a building or structure to a public way consisting of three separate and distinct parts: (1) the exit access, (2) the exit, and (3) the exit discharge. [**5000,** 2015]

3.3.13 Membrane. A thin layer of construction material. [**5000,** 2015]

3.3.14 Membrane Structure. A building or portion of a building incorporating an air-inflated, air-supported, tensioned-membrane structure; a membrane roof; or a membrane-covered rigid frame to protect habitable or usable space. [**5000,** 2015]

3.3.15 Noncombustible Material. See 7.1.4.1 of *NFPA 5000*.

3.3.16 Permanent. Any object that is intended to remain in place for more than 180 days in any consecutive 12-month period. [**5000,** 2015]

3.3.17 Private Party Tent. A tent erected in the yard of a private residence for entertainment, recreation, dining, a reception, or similar function. [**5000,** 2015]

3.3.18 Professional Engineer. A person registered or licensed to practice engineering in a jurisdiction, subject to all laws and limitations imposed by the jurisdiction. [**5000,** 2015]

3.3.19 Tensioned-Membrane Structure. A membrane structure incorporating a membrane and a structural support system such as arches, columns and cables, or beams wherein the stresses developed in the tensioned membrane interact with those in the structural support so that the entire assembly acts together to resist the applied loads. [**5000,** 2015]

3.3.20* Tent. A temporary structure, the covering of which is made of pliable material that achieves its support by mechanical means such as beams, columns, poles, or arches, or by rope or cables, or both. [**5000,** 2015]

3.3.21 Weathered-Membrane Material. Membrane material that has been subjected to a minimum of 3000 hours in a weatherometer in accordance with ASTM G 155, *Standard Practice for Operating Xenon Arc Light Apparatus for Exposure of Non-Metallic Materials*, or approved equivalent. [***101,*** 2015]

Chapter 4 Means of Egress

4.1 New Facilities. New facilities included within the scope of this standard shall comply with one of the following:

(1) The means of egress provisions of NFPA *101* for the applicable occupancies
(2) The means of egress provisions of *NFPA 5000* for the applicable occupancies

4.2 Existing Facilities. Existing facilities included within the scope of this standard shall comply with the means of egress provisions of NFPA *101* for the applicable occupancies.

Chapter 5 Grandstands and Bleachers

5.1 General. Grandstands and bleachers shall comply with the requirements of this chapter. [**5000:**32.7.1]

5.2 Location. Grandstands shall be erected or otherwise located only where load-carrying capacities exist to support the loads. [**5000:**32.7.2]

5.3 Minimum Construction Requirements. [**5000:**32.7.3]

5.3.1 Grandstands and bleachers shall be permitted to be of unlimited area when of Type I or Type II construction. [**5000:**32.7.3.1]

5.3.2 Grandstands and bleachers shall be permitted to be of Type III, Type IV, or Type V construction when designed in accordance with Section 5.7. [**5000:**32.7.3.2]

5.4 Design. [**5000:**32.7.4]

5.4.1 Grandstands shall be designed to withstand the structural loading requirements of Chapter 35 of *NFPA 5000* unless otherwise permitted by 5.4.2. [**5000:**32.7.4.1]

5.4.2 The manufacturer shall comply with the requirements of 5.4.2.1 and 5.4.2.2. [**5000:**32.7.4.2]

5.4.2.1 Where required by the authority having jurisdiction, the manufacturer shall submit either of the following:

(1) Calculations verifying the design analysis prepared by a professional engineer or registered architect
(2) Report of load tests conducted by an approved, independent testing laboratory and certified by a professional engineer

[**5000:**32.7.4.2.1]

5.4.2.2 Where required by the authority having jurisdiction, the manufacturer shall certify that the equipment supplied is in accordance with the design. [**5000:**32.7.4.2.2]

5.5 Seating. [**5000:**16.4.9.2]

5.5.1 Where grandstand seating without backs is used indoors, rows of seats shall be spaced not less than 22 in. (560 mm) back-to-back. [**5000:**16.4.9.2.1]

5.5.2 The depth of footboards and seat boards in grandstands shall be not less than 9 in. (230 mm). Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided. [**5000:**16.4.9.2.2]

5.5.3 Seats and footrests of grandstands shall be supported securely and fastened in such a manner that they cannot be displaced inadvertently. [**5000:**16.4.9.2.3]

5.5.4 Individual seats or chairs shall be permitted only if secured in rows in an approved manner, unless the seats do not exceed 16 in number and are located on level floors and within railed-in enclosures, such as boxes. [**5000:**16.4.9.2.4]

5.5.5 The maximum number of seats permitted between the farthest seat in an aisle in grandstands and bleachers shall not exceed that shown in Table 5.5.5. [**5000:**16.4.9.2.5]

Table 5.5.5 Maximum Number of Seats Permitted Between Farthest Seat and an Aisle

Application	Outdoors	Indoors
Grandstands	11	6
Bleachers	20	9

[**5000:** Table 16.4.9.2.5]

5.5.6 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.9.6.7]

5.5.7 An opening between the seat board and footboard located more than 30 in. (760 mm) above grade shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.9.6.8]

5.6 Guards and Railings. [**5000:**16.4.9.6]

5.6.1 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all grandstands where the seats are more than 48 in. (1220 mm) above the floor or ground. [**5000:**16.4.9.6.1]

5.6.2 The requirement of 5.6.1 shall not apply where an adjacent wall or fence affords equivalent safeguard. [**5000:**16.4.9.6.2]

5.6.3 Where the front footrest of any grandstand is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided. [**5000:**16.4.9.6.3]

5.6.4 The railings required by 5.6.3 shall be permitted to be not less than 26 in. (660 mm) high in grandstands or where the front row of seats includes backrests. [**5000:**16.4.9.6.4]

5.6.5 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle. [**5000:**16.4.9.6.5]

5.6.6 The railings specified by 5.6.5 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle. [**5000:**16.4.9.6.6]

5.6.7 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.9.6.7]

5.6.8 An opening between the seat board and footboard located more than 30 in. (760 mm) above grade shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.9.6.8]

5.7 Special Requirements — Type III, Type IV, and Type V Grandstands. [**5000:**32.7.5]

5.7.1 An outdoor grandstand of Type III, Type IV, or Type V construction shall not be erected a distance less than two-thirds of its height from a building, but in no case shall the grandstand be erected less than 10 ft (3050 mm) from a building, unless one of the following criteria is met:

(1) The exterior wall of the building is of at least 1-hour fire resistance–rated construction with all openings protected.
(2) A fire wall of at least 1-hour fire resistance–rated construction is provided between the grandstand and the building.

[**5000:**32.7.5.1]

5.7.2 The following shall apply to outdoor grandstand units of Type III, Type IV, or Type V construction:

(1) No outdoor grandstand unit shall exceed 10,000 ft^2 (930 m^2) or 200 ft (61 m) in length.
(2) Grandstand units of the maximum size shall be placed not less than 20 ft (6100 mm) apart or shall be separated by walls with a 1-hour fire resistance rating.
(3) Not more than three units shall be erected in any one group.
(4) Each group of less than three units shall be separated from any other group by a wall of 2-hour fire resistance-rated construction extending 24 in. (610 mm) above the seat platforms or by an open space of not less than 50 ft (15 m).
(5) Where entirely constructed of labeled fire retardant–treated wood that has passed the standard rain test in ASTM D 2898, *Standard Practice for Accelerated Weathering of Fire-Retardant-Treated Wood for Fire Testing*, or where constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)], the area or length specified by 5.7.2(1) shall be permitted to be doubled.

[**5000:**32.7.5.2]

5.7.3 The highest level of seat platforms above the ground or the surface at the front of the grandstand shall be as follows:

(1) Grandstands of Type III, Type IV, or Type V construction — not more than 20 ft (6100 mm)
(2) Portable grandstands of Type III, Type IV, or Type V construction within tents or membrane structures — not more than 12 ft (3660 mm)

[**5000:**32.7.5.3]

5.7.4 Where entirely constructed of labeled fire retardant–treated wood that has passed the standard rain test in ASTM D 2898 or where constructed of members conforming to dimensions for heavy timber construction [Type IV (2HH)], the heights specified by 5.7.3 shall be permitted to be doubled. [**5000:**32.7.5.4]

5.8 Special Requirements — Portable Grandstands. Portable grandstands shall conform to the requirements of this chapter for grandstands and the special requirements of Section 5.8. [**5000:**32.7.6]

5.8.1 General. Portable grandstands shall comply with the following:

(1) Portable grandstands shall be self-contained, having within them all necessary parts to withstand and restrain all forces that might be developed during human occupancy.
(2) Portable grandstands shall be designed and manufactured so that, if any structural members required for the strength and stability of the structure have been omitted during erection, the presence of unused connection fittings shall make the omissions self-evident.
(3) The construction shall produce the strength required by the design.
(4) Portable grandstands shall not be used until all parts have been erected, or re-erected, in accordance with the approved design and specifications.
(5) The seating, walkways, railings, bracing, and supporting members shall be structurally sound.

[**5000:**32.7.6.1]

5.8.2 Placement. The following shall apply to the placement of portable grandstands:

(1) Portable grandstands shall be provided with base plates, sills, floor runners, or sleepers of such area that the allowable bearing capacity of the supporting material is not exceeded.
(2) Where portable grandstands rest directly on a base where settlement can or does occur beyond that allowed by design, mud sills of suitable material having sufficient area to prevent undue or dangerous settlement shall be installed under base plates, runners, or sleepers.
(3) All bearing surfaces shall be in full contact with each other.

[**5000:**32.7.6.2]

5.8.3 Prevention of Displacement. A-frames or other supports and seat stringers for portable grandstands shall be secured to prevent accidental displacement during occupancy. [**5000:**32.7.6.3]

5.8.4 Fasteners. The following shall apply to fasteners for portable grandstands:

(1) The use of nails, lag screws, and wood screws shall be permitted for holding wood parts together, provided that the following criteria are met:
    (a) Nails, lag screws, and wood screws shall not be used for demountable joinings.
    (b) Nails, lag screws, and wood screws shall not be used where their loosening or splitting of surrounding wood would jeopardize the structure or its occupants.
(2) Members in tension shall be connected at each end by not less than two bolts, rivets, or lag screws or by approved connectors or other approved devices.
(3) All ferrous fastenings and fastening devices shall be stainless steel or hot-dipped galvanized in accordance with ASTM A 153/A 153M, *Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.*

[**5000:**32.7.6.4]

5.9 Spaces Underneath Grandstands. Spaces underneath a grandstand shall be kept free of flammable or combustible materials, unless protected by an approved, electrically supervised automatic sprinkler system in accordance with NFPA 13 unless otherwise permitted by the following:

(1) This requirement shall not apply to accessory uses of 300 ft^2 (27.9 m^2) or less, such as ticket booths, toilet facilities, or concession booths where constructed of noncombustible, limited-combustible, or fire-resistive construction, in otherwise nonsprinklered facilities.
(2) This requirement shall not apply to rooms enclosed in not less than 1-hour fire resistance–rated construction that are of less than 1000 ft^2 (93 m^2), in otherwise nonsprinklered facilities.

[**5000:**16.4.9.5]

5.10 Maintenance. Maintenance shall be provided as follows:

(1) The owner shall provide for not less than annual inspection and required maintenance of each grandstand to ensure safe conditions.
(2) At least biennially, the inspection shall be performed by a professional engineer or registered architect.
(3) Where required by the authority having jurisdiction, the owner shall provide certification that both inspections have been performed.

[**5000:**32.7.7]

Chapter 6 Folding and Telescopic Seating

6.1 Application. Folding and telescopic seating shall be permitted only if the supporting structure has been designed to handle the loading and has the exit facilities to accommodate the occupants of the seating, as well as all other occupants. [**5000:**32.7.8.1]

6.2 Design. [**5000:**32.7.8.2]

6.2.1 Structural Loading. The design of folding and telescopic seating shall withstand the structural loading requirements of Chapter 35 of *NFPA 5000.* [**5000:**32.7.8.2.1]

6.2.2 Load Tests. Load tests in accordance with accepted engineering practice shall be permitted in lieu of the design analysis for a seating unit or part thereof. [**5000:**32.7.8.2.2]

6.2.3 Manufacturer Requirements. The manufacturer shall comply with the requirements of 6.2.3.1 and 6.2.3.2. [**5000:**32.7.8.2.3]

6.2.3.1 Where required by the authority having jurisdiction, the manufacturer shall submit either of the following:

(1) Calculations verifying the design analysis prepared by a professional engineer or registered architect
(2) Report of load tests conducted by an approved, independent testing laboratory and certified by a professional engineer

[**5000:**32.7.8.2.3.1]

6.2.3.2 Where required by the authority having jurisdiction, the manufacturer shall certify that the equipment supplied is in accordance with the design or is essentially identical to the structure tested. [**5000:**32.7.8.2.3.2]

6.3 Review and Approval. [**5000:**32.7.8.2.4]

6.3.1 Design and installation drawings shall be approved prior to installation, and seating shall be installed in conformance with such drawings. [**5000:**32.7.8.2.4.1]

6.3.2 The drawings shall include the following:

(1) Conformance with approved designs, which are permitted to refer to approved standard drawings, with any variations applicable to the job noted
(2) Location of the folding or telescopic seating units and details of attachments, if any
(3) Location of guards and details thereof
(4) Capability of means of egress to accommodate the occupants of the seating, as well as all other occupants, based on Chapter 11 of *NFPA 5000*
(5) Structural capacity of the site to support the folding and telescopic seating dead loads when closed and also to support the dead loads and live loads when open

[**5000:**32.7.8.2.4.2]

6.4 Seating. [**5000:**16.4.10.2]

6.4.1 The horizontal distance of seats, measured back-to-back, shall be not less than 22 in. (560 mm) for seats without backs, and the following requirements shall also apply:

(1) There shall be a space of not less than 12 in. (305 mm) between the back of each seat and the front of each seat immediately behind it.
(2) If seats are of the chair type, the 12 in. (305 mm) dimension shall be measured to the front edge of the rear seat in its normal, unoccupied position.
(3) All measurements shall be taken between plumb lines.

[**5000:**16.4.10.2.1]

6.4.2 The depth of footboards (footrests) and seat boards in folding and telescopic seating shall be not less than 9 in. (230 mm). [**5000:**16.4.10.2.2]

6.4.3 Where the same level is not used for both seat foundations and footrests, footrests independent of seats shall be provided. [**5000:**16.4.10.2.2]

6.4.4 Individual chair-type seats shall be permitted in folding and telescopic seating only if firmly secured in groups of not less than three. [**5000:**16.4.10.2.3]

6.4.5 The maximum number of seats permitted between the furthest seat in an aisle in folding and telescopic seating shall not exceed that shown in Table 5.5.5. [**5000:**16.4.10.2.4]

6.4.6 An opening between the seat board and footboard located more than 30 in. (760 mm) above grade shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.10.3.8]

6.5 Guards and Railings. [**5000:**16.4.10.3]

6.5.1 Guards. Guards in accordance with Chapter 11 of *NFPA 5000* shall be provided at the open sides of means of egress that exceed 30 in. (760 mm) above the floor or grade below, except as otherwise permitted by 6.5.2 through 6.5.9. [**5000:**11.1.8]

6.5.2 Railings or guards not less than 42 in. (1065 mm) above the aisle surface or footrest, or not less than 36 in. (915 mm) vertically above the center of the seat or seat board surface, whichever is adjacent, shall be provided along those portions of the backs and ends of all folding and telescopic seating where the seats are more than 48 in. (1220 mm) above the floor or ground. [**5000:**16.4.10.3.1]

6.5.3 The requirement of 6.5.2 shall not apply where an adjacent wall or fence affords equivalent safeguard. [**5000:**16.4.10.3.2]

6.5.4 Where the front footrest of folding or telescopic seating is more than 24 in. (610 mm) above the floor, railings or guards not less than 33 in. (825 mm) above such footrests shall be provided. [**5000:**16.4.10.3.3]

6.5.5 The railings required by 6.5.4 shall be permitted to be not less than 26 in. (660 mm) high where the front row of seats includes backrests. [**5000:**16.4.10.3.4]

6.5.6 Cross aisles located within the seating area shall be provided with rails not less than 26 in. (660 mm) high along the front edge of the cross aisle. [**5000:**16.4.10.3.5]

6.5.7 The railings specified by 6.5.6 shall not be required where the backs of the seats in front of the cross aisle project 24 in. (610 mm) or more above the surface of the cross aisle. [**5000:**16.4.10.3.6]

6.5.8 Vertical openings between guardrails and footboards or seat boards shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.10.3.7]

6.5.9 An opening between the seat board and footboard located more than 30 in. (760 mm) above grade shall be provided with intermediate construction so that a 4 in. (100 mm) diameter sphere cannot pass through the opening. [**5000:**16.4.10.3.8]

6.6 Maintenance and Operation of Folding and Telescopic Seating. [***101*:**12.7.11]

6.6.1 Instructions in both maintenance and operation shall be transmitted to the owner by the manufacturer of the seating or his or her representative. [***101*:**12.7.11.1]

6.6.2 Maintenance and operation of folding and telescopic seating shall be the responsibility of the owner or his or her duly authorized representative and shall include the following:

(1) During operation of the folding and telescopic seats, the opening and closing shall be supervised by responsible personnel who shall ensure that the operation is in accordance with the manufacturer's instructions.
(2) Only attachments specifically approved by the manufacturer for the specific installation shall be attached to the seating.
(3) An annual inspection and required maintenance of each folding and telescopic seating unit shall be performed to ensure safe conditions.
(4) At least biennially, the inspection shall be performed by a professional engineer, registered architect, or individual certified by the manufacturer.

[***101*:**12.7.11.2]

Chapter 7 Membrane Structures

7.1 General. [**5000:**32.2.1]

7.1.1 Scope. Chapter 7 shall apply to permanent air-supported, air-inflated, and tensioned-membrane structures, collectively known as membrane structures, that are used as complete buildings and as roofs or other portions of buildings or other types of construction, and the following also shall apply:

(1) Membrane structures also shall comply with the applicable provisions of *NFPA 5000*.
(2) Temporary membrane structures shall comply with Section 7.5.

[**5000:**32.2.1.1]

7.1.1.1 General. Membrane structures that provide the complete enclosure for the occupied space shall be considered as complete buildings and subject to the requirements of this chapter. [**5000:**32.2.1.1.1]

7.1.1.2 Height. Membrane structures shall be limited to one story in height, but height shall not be limited in number of feet (meters). [**5000:**32.2.1.1.2]

7.1.1.3 Area. For determining allowable area, the construction type for a membrane structure shall be based on the support system. [**5000:**32.2.1.1.3]

7.1.1.3.1 Air-supported membrane structures shall not exceed the allowable areas listed in Chapter 7 of *NFPA 5000* for Type II(000) unprotected construction. [**5000:**32.2.1.1.3.1]

7.1.1.3.2 Area increases in accordance with Chapter 7 of *NFPA 5000* shall be permitted. [**5000:**32.2.1.1.3.2]

7.1.2 Structural Design. Membrane structures, and portions thereof shall be designed and constructed to support, within the limitations specified by *NFPA 5000,* all loads set forth in Chapter 35 and elsewhere in *NFPA 5000* and combined in accordance with Section 35.15 of *NFPA 5000.* [**5000:**35.1.2]

7.1.3 Electrical. Electrical wiring shall comply with *NFPA 70.* [**5000:**32.2.1.3]

7.1.4 Fire Protection Systems and Equipment. All membrane structures shall be in accordance with Chapter 55 of *NFPA 5000.* [**5000:**32.2.1.4]

7.1.5 Mechanical. [**5000:**32.2.1.5]

7.1.5.1 Fuel gas heating, ventilation, and air-conditioning installations shall conform to the requirements of NFPA 54. [**5000:**32.2.1.5.1]

7.1.5.2 The installation of equipment not covered in 7.1.5.1 shall conform to the requirements of the UMC, *Uniform Mechanical Code.* [**5000:**32.2.1.5.2]

7.1.6 Occupancy Separation. A membrane structure building that is occupied by more than one use group shall comply with Chapter 6 of *NFPA 5000.* [**5000:**32.2.1.6]

7.1.7 Mixed Construction. [**5000:**32.2.1.7]

7.1.7.1 Membrane structures shall be permitted to be utilized as a portion of buildings of other types of construction as specified in this chapter. [**5000:**32.2.1.7.1]

7.1.7.2 Height and area limits shall be as specified for the type of construction and occupancy of the building. [**5000:**32.2.1.7.2]

7.2 Permanent Membrane Structures. [**5000:**32.2.2]

7.2.1 Testing. Testing of membrane materials for compliance with the requirements of this chapter for use of the categories of noncombustible and limited-combustible materials shall be performed on weathered-membrane material, as defined in Section 3.3. [***101*:**11.9.1.3]

7.2.2 Use of Membrane Materials. Membrane materials shall not be used where fire resistance ratings are required for walls or roofs, unless otherwise permitted by the following:

(1) Where every part of the roof, including the roof membrane, is not less than 20 ft (6100 mm) above any floor, balcony, or gallery, a noncombustible or limited-combustible membrane shall be permitted to be used as the roof in any type of construction.
(2) With approval of the authority having jurisdiction, membrane materials shall be permitted to be used where every part of the roof membrane is located sufficiently above every significant fire potential so that the imposed temperature will not exceed the capability of the membrane, including seams, to maintain its structural integrity.

[**5000:**32.2.2.1]

7.2.3 Flame Spread. [**5000:**32.2.2.2]

7.2.3.1 Flame spread of all membrane materials exposed within the structure shall be Class A, as defined in Chapter 10 of *NFPA 5000.* [**5000:**32.2.2.2.1]

7.2.3.2 The requirement of 7.2.3.1 shall not apply to plastic less than 20 mil (0.51 mm) in thickness located less than 30 ft (9100 mm) above any floor in greenhouses where occupancy by the general public is prohibited. [**5000:**32.2.2.3.2]

7.2.4 Flame Resistance. [**5000:**32.2.2.3]

7.2.4.1 All membrane structure fabric shall meet the requirements of Test Method 2 contained in NFPA 701. [**5000:**32.2.2.3.1]

7.2.4.2 The requirement of 7.2.4.1 shall not apply to plastic less than 20 mil (0.51 mm) in thickness located less than 30 ft (9100 mm) above any floor in greenhouses where occupancy by the general public is prohibited. [**5000:**32.2.2.3.2]

7.2.4.3 The authority having jurisdiction shall require one of the following as evidence that membrane structure fabric materials have the required flame resistance:

(1) Certificate or other evidence of acceptance by an organization acceptable to the authority having jurisdiction
(2) Report of tests made by other inspection authorities or organizations acceptable to the authority having jurisdiction

[**5000:**32.2.2.3.3]

7.2.4.4 Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material affixed at the time of manufacture to the exterior of the structure. [**5000:**32.2.2.3.4]

7.3 Tensioned-Membrane Structures. [**5000:**32.2.3]

7.3.1 Protection for Membrane Roofs. Protection for membrane roofs for structures in climates subject to freezing temperatures and ice buildup shall be as specified in 7.3.1.1 or 7.3.1.2. [**5000:**32.2.3.1]

7.3.1.1 The roof shall be composed of two layers with an air space between the layers through which heated air can be moved to guard against ice accumulation. [**5000:**32.2.3.1.1]

7.3.1.2 Any approved methods that protect against ice accumulation shall be permitted. [**5000:**32.2.3.1.2]

7.3.2* Protection for Roof Drains. Protection for roof drains shall be as specified in 7.3.2.1 and 7.3.2.2 or 7.3.2.3. [**5000:**32.2.3.2]

7.3.2.1 Roof drains shall be equipped with listed de-icing and snow-melting equipment to protect against ice buildup, which would prevent the drains from functioning. [**5000:**32.2.3.2.1]

7.3.2.2 The equipment specified in 7.3.2.1 shall be served by on-site standby electrical power in addition to the normal public service. [**5000:**32.2.3.2.2]

7.3.2.3 In lieu of de-icing and snow-melting equipment, any other approved methods that protect against ice accumulation shall be permitted. [**5000:**32.2.3.2.3]

7.4 Air-Supported, Air-Inflated Structures. [**5000:**32.2.4]

7.4.1* General. In addition to the requirements of this chapter, air-supported structures shall be designed and operated in accordance with ASCE/SEI 17, *Air Supported Structures.* [**5000:**32.2.4.1]

7.4.2 Maintenance and Operation. [**5000:**32.2.4.2]

7.4.2.1 Instructions in both operation and maintenance shall be transmitted to the owner by the manufacturer of the tensioned-membrane, air-supported, or air-inflated structure. [**5000:**32.2.4.2.1]

7.4.2.2 An annual inspection and required maintenance of each structure shall be performed. [**5000:**32.2.4.2.2]

7.4.2.3 At least biennially, the annual inspection shall be performed by a professional engineer or qualified service representative. [**5000:**32.2.4.2.3]

7.5 Temporary Membrane Structures. [**5000:**32.2.5]

7.5.1 General. Membrane structures designed to meet all the requirements of this chapter shall be permitted to be used as temporary buildings subject to the approval of the authority having jurisdiction. [**5000:**32.2.5.1]

7.5.2 Temporary Membrane Structures. Temporary membrane structures shall comply with the requirements of Section 7.5 and 7.2.4. [**5000:**32.2.5.2]

7.5.3* Temporary Tensioned-Membrane Structures. Temporary tensioned-membrane structures shall be permitted to comply with Chapter 8, provided that the following criteria are met:

(1) Roof drains shall be equipped with listed de-icing and snow-melting equipment.
(2) The de-icing and snow-melting equipment shall be served by on-site standby electrical power in addition to the normal public service.
(3) Any approved methods that protect against ice accumulation shall be permitted.

[**5000:**32.2.5.3]

7.5.4 Clearance. There shall be a minimum clearance of 36 in. (915 mm) between the membrane and the contents or equipment within the building and between the membrane and any exterior object. [**5000:**32.2.5.4]

7.5.5 Fire Hazards.

7.5.5.1 Temporary membrane structures shall be protected as specified in 7.5.5.1.1 through 7.5.5.1.4. [**5000:**32.3.5.1]

7.5.5.1.1 The finished ground level enclosed by the structure, and the surrounding finished ground level not less than 10 ft (3050 mm) outside of the structure, shall be cleared of all flammable or combustible material and vegetation. [**5000:**32.3.5.1.1]

7.5.5.1.2 The requirement of 7.5.5.1.1 shall be accomplished to the satisfaction of the authority having jurisdiction prior to the erection of tents and temporary membrane structures. [**5000:**32.3.5.1.2]

7.5.5.1.3 The premises shall be kept free from flammable or combustible materials during the period for which the premises are used by the public. [**5000:**32.3.5.1.3]

7.5.5.1.4 The requirements of 7.5.5.1.1 through 7.5.5.1.3 shall not apply to necessary support equipment. [**5000:**32.3.5.1.4]

7.5.5.2 Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any temporary membrane structure and shall be in accordance with the provisions of NFPA 58. [***101*:**11.9.5.1.3]

7.5.5.3 Tanks shall be secured in the upright position and protected from vehicular traffic. [***101*:**11.9.5.1.4]

Chapter 8 Tents

8.1 General. [***101*:**11.11.1]

8.1.1 The provisions of Chapter 8 shall apply to tents. [***101*:**11.11.1.1]

8.1.2 Tents shall be permitted only on a temporary basis. [***101*:**11.11.1.2]

8.1.3 Tents shall be erected to cover not more than 75 percent of the premises, unless otherwise approved by the authority having jurisdiction. [***101*:**11.11.1.3]

8.2 Structural Design Load Requirements. Tents, other than private party tents and camping tents, under 400 ft^2 (37.2 m^2), shall comply with the requirements of Chapter 35 of *NFPA 5000* for structural design loads. [**5000:**32.3.1, 32.3.2]

8.3 Flame Propagation Performance. [**5000:**32.3.3]

8.3.1 All tent fabric shall meet the flame propagation performance criteria of Test Method 2, as required in NFPA 701. [**5000:**32.3.3.1]

8.3.2 The authority having jurisdiction shall require one of the following as evidence that the fabric materials have the required flame propagation performance:

(1) Certificate or other evidence of acceptance by an organization acceptable to the authority having jurisdiction
(2) Report of tests made by other inspection authorities or organizations acceptable to the authority having jurisdiction

[**5000:**32.3.3.2]

8.3.3 Where required by the authority having jurisdiction, confirmatory field tests shall be conducted using test specimens from the original material affixed at the time of manufacture to the exterior of the tent. [**5000:**32.3.3.3]

8.4 Location and Spacing. [**5000:**32.3.4]

8.4.1 There shall be a minimum of 10 ft (3050 mm) between stake lines. [**5000:**32.3.4.1]

8.4.2 Adjacent tents shall meet the requirements of 8.4.2.1 and 8.4.2.2. [**5000:**32.3.4.2]

8.4.2.1 Adjacent tents shall be no closer to each other than allowed in order to provide an area to be used as a means of emergency egress as calculated in accordance with Chapter 11 of *NFPA 5000*. [**5000:**32.3.4.2.1]

8.4.2.2 Where 10 ft (3050 mm) between stake lines is not sufficient for means of egress, the distance necessary for means of egress shall govern. [**5000:**32.3.4.2.2]

8.4.3 Subject to the approval of the authority having jurisdiction, the requirements of 8.4.2 shall not apply, provided that the following criteria are met:

(1) Tents not occupied by the public and not used for the storage of combustible material shall be permitted to be erected less than 10 ft (3050 mm) from other structures.
(2) Tents, each not exceeding 1200 ft^2 (110 m^2), and located in fairgrounds or similar open spaces, shall not be required to be separated from each other.

[**5000:**32.3.4.3]

8.4.4 The placement of tents relative to other structures shall be at the discretion of the authority having jurisdiction, based on the occupancy, use, opening, exposure, and other similar factors. [**5000:**32.3.4.4]

8.5 Fire Hazards. [***101*:**11.11.4]

8.5.1 Smoking shall not be permitted in any tent unless approved by the authority having jurisdiction. [***101*:**11.11.4.2.1]

8.5.2 Tents shall be protected as specified in 8.5.2.1 through 8.5.2.4. [**5000:**32.3.5.1]

8.5.2.1 The finished ground level enclosed by the structure, and the surrounding finished ground level not less than 10 ft (3050 mm) outside of the structure, shall be cleared of all flammable or combustible material and vegetation. [**5000:**32.3.5.1.1]

8.5.2.2 The requirement of 8.5.2.1 shall be accomplished to the satisfaction of the authority having jurisdiction prior to the erection of tents and temporary membrane structures. [**5000:**32.3.5.1.2]

8.5.2.3 The premises shall be kept free from flammable or combustible materials during the period for which the premises are used by the public. [**5000:**32.3.5.1.3]

8.5.2.4 The requirements of 8.5.2.1 through 8.5.2.3 shall not apply to necessary support equipment. [**5000:**32.3.5.1.4]

8.5.3 Containers for liquefied petroleum gases shall be installed not less than 60 in. (1525 mm) from any tent and shall be in accordance with the provisions of NFPA 58. [***101*:**11.11.6.1.3]

8.5.4 Tanks shall be secured in the upright position and protected from vehicular traffic. [***101*:**11.11.6.1.4]

8.6 Portable Fire-Extinguishing Equipment. Portable fire-extinguishing equipment of approved types shall be furnished and maintained in tents in such quantity and in such locations as directed by the authority having jurisdiction. [***101*:**11.11.5]

Chapter 9 Protection

9.1 General. Facilities included within the scope of this standard shall comply with the requirements of this chapter.

9.2 Flammable Liquids and Gases. [***101*:**8.7.3]

9.2.1 The storage and handling of flammable liquids or gases shall be in accordance with the following applicable standards:

(1) NFPA 30
(2) NFPA 54
(3) NFPA 58

[***101*:**8.7.3.1]

9.2.2* No storage or handling of flammable liquids or gases shall be permitted in any location where such storage would jeopardize egress from the structure, unless otherwise permitted by 9.2.1. [***101*:**8.7.3.2]

9.3* Open Flame Devices and Pyrotechnics. No open flame devices or pyrotechnic devices shall be used in any assembly occupancy, unless otherwise permitted by the following:

(1) Pyrotechnic special effect devices shall be permitted to be used on stages before proximate audiences for ceremonial or religious purposes, as part of a demonstration in exhibits, or as part of a performance, provided that both of the following criteria are met:
    (a) Precautions satisfactory to the authority having jurisdiction are taken to prevent ignition of any combustible material.
    (b) Use of the pyrotechnic device complies with NFPA 1126.
(2) Flame effects before an audience shall be permitted in accordance with NFPA 160.
(3) Open flame devices shall be permitted to be used in the following situations, provided that precautions satisfactory to the authority having jurisdiction are taken to prevent ignition of any combustible material or injury to occupants:
    (a) For ceremonial or religious purposes
    (b) On stages and platforms where part of a performance
    (c) Where candles on tables are securely supported on substantial noncombustible bases and candle flame is protected
(4) The requirement of Section 9.3 shall not apply to heat-producing equipment complying with 9.2.2 of NFPA *101*.
(5) The requirement of Section 9.3 shall not apply to food service operations in accordance with 12.7.2 of NFPA *101*.
(6) Gas lights shall be permitted to be used, provided that precautions are taken, subject to the approval of the authority having jurisdiction, to prevent ignition of any combustible materials.

[***101*:**12.7.3]

9.4 Smoking. [***101*:**12.7.8]

9.4.1 Smoking in assembly occupancies shall be regulated by the authority having jurisdiction. [***101*:**12.7.8.1]

9.4.2 In rooms or areas where smoking is prohibited, plainly visible signs shall be posted that read as follows:

NO SMOKING

[***101*:**12.7.8.2]

9.4.3 No person shall smoke in prohibited areas that are so posted, unless permitted by the authority having jurisdiction under both of the following conditions:

(1) Smoking shall be permitted on a stage only where it is a necessary and rehearsed part of a performance.
(2) Smoking shall be permitted only where the smoker is a regular performing member of the cast.

[***101*:**12.7.8.3]

9.4.4 Where smoking is permitted, suitable ashtrays or receptacles shall be provided in convenient locations. [***101*:**12.7.8.4]

9.5 Extinguishment Requirements.

9.5.1 Enclosed stadiums, arenas, and similar structures shall be protected throughout by an approved, electrically supervised automatic sprinkler system in accordance with NFPA 13, unless otherwise permitted by the following:

(1) Where the ceiling or roof, whichever is lower, of the playing/activity area is more than 55 ft (16.7 m) above the floor, sprinklers shall not be required above the playing/activity area where permitted by the authority having jurisdiction.
(2) Sprinklers shall not be required above seating areas that view the playing/activity area.

[**5000:**32.3.5.2]

9.5.2 Any enclosed area shall be protected by an approved sprinkler system in accordance with NFPA 13 unless such an area is one of the following:

(1) Enclosed stadiums, arenas, and similar structures
(2) Press boxes of less than 1000 ft^2 (93 m^2)
(3) Storage facilities of less than 1000 ft^2 (93 m^2) if enclosed with minimum 1-hour fire resistance–rated construction
(4) Enclosed areas underneath grandstands or bleachers that comply with the exemptions of 5.9(1) or 5.9(2)

[**5000:**32.3.5.3]

9.5.3 Portable fire extinguishers shall be installed in assembly occupancies in accordance with NFPA 10 except as otherwise permitted by 9.5.3.1 through 9.5.3.4. [**5000:**16.3.5.3]

9.5.3.1 The requirement of 9.5.3 shall not apply to seating areas. [**5000:**16.3.5.3]

9.5.3.2 The requirement of 9.5.3 shall not apply to floor areas used for contest, performance, or entertainment. [**5000:**16.3.5.3]

9.5.3.3 The requirement of 9.5.3 shall not apply to outside assembly occupancy areas. [**5000:**16.3.5.3]

9.5.3.4 Portable extinguishers shall be permitted to be located in secure locations accessible to staff. [**5000:**16.3.5.3]

9.6 Detection, Alarm, and Communications Systems. [**5000:**16.3.4]

9.6.1 General. [**5000:**16.3.4.1]

9.6.1.1 Assembly occupancies with occupant loads greater than 300 and all theaters with more than one audience-viewing room shall be provided with an approved fire alarm system in accordance with the following, unless otherwise permitted by 9.6.1.2:

(1) Section 55.2 of *NFPA 5000*
(2) 9.6.2 through 9.6.3.7

[**5000:**16.3.4.1.1]

9.6.1.2 Assembly occupancies that are a part of a mixed occupancy shall be permitted to be served by a common fire alarm system, provided that the individual requirements of each occupancy are met. [**5000:**16.3.4.1.2]

9.6.2 Initiation. [**5000:**16.3.4.2]

9.6.2.1 Initiation of the required fire alarm system shall be by the following:

(1) Manual means in accordance with 55.2.2(1) of *NFPA 5000*, unless otherwise permitted by the means that follow:
    (a) The requirement of 9.6.2.1(1) shall not apply where initiation is by means of an approved automatic fire detection system in accordance with Section 55.2 of *NFPA 5000* that provides fire detection throughout the building.
    (b) The requirement of 9.6.2.1(1) shall not apply where initiation is by means of an approved automatic sprinkler system in accordance with Section 55.3 of *NFPA 5000* that provides fire detection and protection throughout the building.
(2) Where automatic sprinklers are provided, initiation of the fire alarm system by means of sprinkler system waterflow, even where manual fire alarm boxes are provided in accordance with 9.6.2.1(1)

[**5000:** 16.3.4.2.1]

9.6.2.2 The initiating device shall be capable of transmitting an alarm to a receiving station, located within the building, that is constantly attended when the assembly occupancy is occupied. [**5000:**16.3.4.2.2]

9.6.2.3* In assembly occupancies with occupant loads greater than 300, automatic detection shall be provided in all hazardous areas that are not normally occupied, unless such areas that are protected throughout by an approved, electrically supervised automatic sprinkler system installed in accordance with NFPA 13. [**5000:**16.3.4.2.3]

9.6.3 Notification. [**5000:**16.3.4.3]

9.6.3.1 The required fire alarm system shall sound an audible alarm in a constantly attended receiving station within the building when occupied for purposes of initiating emergency action. [**5000:**16.3.4.3.1]

9.6.3.2 Positive alarm sequence in accordance with 55.2.3.4 of *NFPA 5000* shall be permitted. [**5000:**16.3.4.3.2]

9.6.3.3 Occupant notification shall be by means of voice announcements in accordance with 55.2.3.9 of *NFPA 5000*, initiated by the person in the constantly attended receiving station. [**5000:**16.3.4.3.3]

9.6.3.4 Occupant notification shall be by means of visible signals in accordance with 55.2.3.5 of *NFPA 5000*, initiated by the person in the constantly attended receiving station, unless otherwise permitted by 9.6.3.5. [**5000:**16.3.4.3.4]

9.6.3.5* Where the occupant load of a single room or space exceeds 1000, visible signals shall not be required in the assembly seating area, or the floor area used for the contest, performance, or entertainment where the occupancy load exceeds 1,000 and an approved alternative visible means of occupant notification is provided *(see 55.2.3.5.5 of NFPA 5000)*. *[***5000:***16.3.4.3.5]*

9.6.3.6 The announcement shall be permitted to be made via voice communication or public address system in accordance with 55.2.3.9.2 of *NFPA 5000*. [**5000:**16.3.4.3.6]

9.6.3.7 Where the authority having jurisdiction determines that it is impractical to have a constantly attended receiving station, both of the following shall be provided:

(1) Automatically transmitted evacuation or relocation instructions shall be provided in accordance with *NFPA 72*.
(2) The system shall be monitored by a supervising station in accordance with *NFPA 72*.

[**5000:**16.3.4.3.7]

Chapter 10 Services

10.1 Electrical Systems. Electrical wiring and equipment shall be in accordance with *NFPA 70* unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101*:**9.1.2]

10.2 Heating, Ventilating, and Air-Conditioning. [***101*:**9.2]

10.2.1 Air-Conditioning, Heating, Ventilating Ductwork, and Related Equipment. Air-conditioning, heating, ventilating ductwork, and related equipment shall be in accordance with NFPA 90A or NFPA 90B as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101*:**9.2.1]

10.2.2 Ventilating or Heat-Producing Equipment. Ventilating or heat-producing equipment shall be in accordance with NFPA 91, NFPA 211, NFPA 31, NFPA 54, or *NFPA 70* as applicable, unless such installations are approved existing installations, which shall be permitted to be continued in service. [***101*:**9.2.2]

10.3 Fired Heaters. [***101*:**11.9.5.1]

10.3.1 Only labeled heating devices shall be used. [***101*:**11.9.5.1.1]

10.3.2 Fuel-fired heaters and their installation shall be approved by the authority having jurisdiction. [***101*:**11.9.5.1.2]

10.4 Electric Heaters. [***101*:**11.9.5.2]

10.4.1 Only labeled heaters shall be permitted. [***101*:**11.9.5.2.1]

10.4.2 Electric heaters, their placement, and their installation shall be approved by the authority having jurisdiction. [***101*:**11.9.5.2.2]

10.4.3 Heaters shall be connected to electricity by electric cable that is suitable for outside use and is of sufficient size to handle the electrical load. [***101*:**11.9.5.2.3]

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Code. The decision to designate a standard as a "code" is based on such factors as the size and scope of the document, its intended use and form of adoption, and whether it contains substantial enforcement and administrative provisions.

A.3.2.5 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.2 Air-Supported Structure. A cable-restrained air-supported structure is one in which the uplift is resisted by cables or webbing that is anchored by various methods to the membrane or that might be an integral part of the membrane. An air-supported structure is not a tensioned-membrane structure. [**5000:** A.3.3.631.4]

A.3.3.3 Assembly Occupancy. Assembly occupancies might include the following:

(1) Armories
(2) Assembly halls
(3) Auditoriums
(4) Bowling lanes
(5) Club rooms
(6) College and university classrooms, 50 persons and over
(7) Conference rooms
(8) Courtrooms
(9) Dance halls
(10) Drinking establishments
(11) Exhibition halls
(12) Gymnasiums
(13) Libraries
(14) Mortuary chapels
(15) Motion picture theaters
(16) Museums
(17) Passenger stations and terminals of air, surface, underground, and marine public transportation facilities
(18) Places of religious worship
(19) Pool rooms
(20) Recreation piers
(21) Restaurants
(22) Skating rinks
(23) Special amusement buildings, regardless of occupant load
(24) Theaters

[**5000:** A.3.3.445.2]

Assembly occupancies are characterized by the presence or potential presence of crowds with attendant panic hazard in case of fire or other emergency. They are generally open or occasionally open to the public, and the occupants, who are present voluntarily, are not ordinarily subject to discipline or control. Such buildings are ordinarily occupied by able-bodied persons and are not used for sleeping purposes. Special conference rooms, snack areas, and other areas incidental to, and under the control of, the management of other occupancies, such as offices, fall under the 50-person limitation. [**5000:** A.3.3.445.2]

Restaurants and drinking establishments with an occupant load of fewer than 50 persons should be classified as mercantile occupancies. [**5000:** A.3.3.445.2]

A.3.3.5 Exit. Exits include exterior exit doors, exit passageways, horizontal exits, exit stairs, and exit ramps. In the case of a stairway, the exit includes the following:

(1) Stair enclosure

(2) Door to the stair enclosure
(3) Stairs and landings inside the enclosure
(4) Door from the stair enclosure to the outside or to the level of exit discharge
(5) Any exit passageway and its associated doors, if such are provided, so as to discharge the stair directly to the outside. In the case of a door leading directly from the street floor to the street or open air, the exit comprises only the door.

[**5000:** A.3.3.205]

Doors of small individual rooms, as in hotels, while constituting exit access from the room, are not referred to as exits, except where they lead directly to the outside of the building from the street floor. [**5000:** A.3.3.205]

A.3.3.10 Grandstand. Where the term *grandstand* is preceded by an adjective denoting a material, it refers to a grandstand the essential members of which, exclusive of seating, are of the material designated. [**5000:** A.3.3.291]

A.3.3.12 Means of Egress. A means of egress comprises the vertical and horizontal travel and includes intervening room spaces, doorways, hallways, corridors, passageways, balconies, ramps, stairs, elevators, enclosures, lobbies, escalators, horizontal exits, courts, and yards. [**5000:** A.3.3.411]

A.3.3.20 Tent. A tent might also include a temporary tensioned-membrane structure. [**5000:** A.3.3.647]

A.7.3.2 UL Subject 1588, *Outline of Investigation for Roof and Gutter De-Icing Cable Units*, is used to list de-icing and snow-melting equipment intended to be installed in accordance with *NFPA 70*. [**5000:** A.32.2.3.2]

A.7.4.1 See *ASCE Guide for Tensioned Fabric Structures*. [**5000:** A.32.2.4.1]

A.7.5.3 UL Subject 1588, *Outline of Investigation for Roof and Gutter De-Icing Cable Units,* is used to list de-icing and snow-melting equipment intended to be installed in accordance with *NFPA 70*. [**5000:** A.32.2.5.3]

A.9.2.2 NFPA 58 permits portable butane-fueled appliances in restaurants and in attended commercial food catering operations where fueled by not in excess of two 10 oz (0.28 kg) LP-Gas capacity, nonrefillable butane containers having a water capacity not in excess of 1.08 lb (0.4 kg) per container. Containers are required to be directly connected to the appliance, and manifolding of containers is not permitted. Storage of cylinders is also limited to 24 containers, with an additional 24 permitted where protected by a 2-hour fire resistance–rated barrier. [***101*:** A.8.7.3.2]

A.9.3 Securely supported altar candles in churches that are well separated from any combustible material are permitted. On the other hand, lighted candles carried by children wearing cotton robes present a hazard too great to be permitted. There are many other situations of intermediate hazard where the authority having jurisdiction will have to exercise judgment. [***101*:** A.12.7.3(3)(a)]

A.9.6.2.3 The intent is to require detectors only in nonsprinklered hazardous areas that are unoccupied. When the building is occupied, the detectors in the unoccupied, unsprinklered hazardous areas will initiate occupant notification. If the building is unoccupied, the fire in the nonsprinklered hazardous area is not a life safety issue, and the detectors, upon activation, are not required to notify anyone. The signal from a detector is permitted to be sent to a control panel in an area that is occupied when the building is occupied, but that is unoccupied when the building is unoccupied, without the need for central station monitoring or the equivalent. [**5000:** A.16.3.4.2.3]

A.9.6.3.5 Examples of devices that might be used to provide alternative visible means include scoreboards, message boards, and other electronic devices. [**5000:** A.16.3.4.3.5]

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA 70®, *National Electrical Code*®, 2014 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2013 edition.

B.1.2 Other Publications.

B.1.2.1 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE Guide for Tensioned Fabric Structures, 1996.

B.1.2.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL Subject 1588, *Outline of Investigation for Roof and Gutter De-Icing Cable Units*, 2002.

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2015 edition.

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NFPA®105

Standard for

Smoke Door Assemblies and Other Opening Protectives

2016 Edition

This edition of NFPA 105, *Standard for Smoke Door Assemblies and Other Opening Protectives*, was prepared by the Technical Committee on Fire Doors and Windows. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

This edition of NFPA 105 was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 105

This publication is the result of a multiyear project by the Technical Committee on Fire Doors and Windows and is based on the acknowledgment that smoke is the principal killer in destructive fires. Historically, fire doors have been permitted to have such clearances and deflections as would permit the passage of relatively great quantities of smoke. Those fire doors, when properly installed, have proven to be adequate barriers against the passage of fire, but improvement was needed to protect against the passage of smoke.

The first (1985) edition of NFPA 105 was a recommended practice and introduced parameters for door performance that would limit smoke spread through a door opening.

The third (1993) edition incorporated new information recognizing that smoke control doors in buildings protected by automatic sprinklers would have substantially lower pressures created by a potential fire.

The 1999 edition included modifications to address the pressure differentials caused by stack effect in elevator hoistways.

The 2003 edition incorporated editorial and formatting updates to comply with the *Manual of Style for NFPA Technical Committee Documents*, as well as formatting requirements for converting from a recommended practice to a standard. The 2003 edition also included significant modifications to Chapter 4 on installation and testing requirements and to Chapter 5 on maintenance requirements. Annex A contained a considerable amount of new and updated information.

The 2007 edition expanded the scope of the document to include smoke dampers. The title of the document was revised, and new chapters on the installation, inspection, testing, and maintenance of smoke dampers were provided. Other technical changes addressed the retention of maintenance records for smoke door assemblies.

The 2010 edition included modifications to smoke damper inspection and testing requirements. The title of the document was also revised.

The 2013 edition added references to NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, for the inspection and testing requirements of smoke door assemblies. Other technical changes addressed the inspection and testing of smoke dampers and labeling of smoke damper access panels.

The 2016 edition of NFPA 105 represents a significant expansion and update of the document. For consistency with NFPA 80 and to allow for a more user-friendly document, a new chapter, Chapter 6, Swinging Doors, contains provisions specific to the installation of side-hinged and pivoted swinging smoke door assemblies. Provisions for smoke dampers have been moved to a new Chapter 7, Installation, Testing, and Maintenance of Smoke Dampers. Additional chapters will be added in future editions of NFPA 105 to address requirements for other specific types of smoke doors and opening protectives. Also for consistency with NFPA 80, the inspection, testing, and maintenance provisions for smoke door assemblies in Chapter 5 have been expanded to address multiple types of smoke doors as well as three types of testing — operational, acceptance, and periodic. A new chapter,

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Chapter 8, Smoke Protective Curtain Assemblies, addresses the installation, inspection, testing, and maintenance of smoke-protective curtain assemblies used to protect vertical openings. Significant technical changes have also been added regarding the acceptance and periodic testing of smoke dampers. Finally, new definitions for *qualified person* and *smoke protective curtain assembly* have been added along with updates to referenced publications to maintain the requirements and application of NFPA 105 current with industry trends and practices.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the installation and maintenance of fire doors, windows, shutters, and other equipment used to restrict the spread of fire, including arrangements for automatic operation in case of fire. This includes installation to protect buildings against external fire and to restrict the spread of fire within buildings. Vault and record room doors are covered by the Technical Committee on Record Protection.

NFPA 105

Standard for

Smoke Door Assemblies and Other Opening Protectives

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope. This standard shall prescribe minimum requirements for smoke door assemblies for use in providing safety to life and protection of property from smoke.

1.2* Purpose. The purpose of this standard shall be to provide a means to restrict the movement of smoke through door assemblies in order to maintain a tenable environment.

1.3* Application. This standard shall regulate the installation, maintenance, and testing of smoke door assemblies.

1.3.1* This standard shall regulate smoke door assemblies that are intended to restrict the passage of smoke at temperatures up to 400°F (204°C).

1.3.2* This standard shall not regulate elevator hoistway doors.

1.4 Retroactivity. This standard is based on product and engineering practices recognized as acceptable at the date of issue. Therefore, the provisions of this standard are not intended to be applied retroactively to installations that were in compliance at the time of installation.

1.5 Equivalency.

1.5.1 This standard shall not prohibit the development of new, modified, or improved devices that meet the intent of these requirements. It shall be the responsibility of the manufacturer to furnish the information necessary to update the requirements pertaining to such new and improved devices.

1.5.2 For devices not described in this standard, the authority having jurisdiction (AHJ) shall request descriptive information from manufacturers that is provided by a testing laboratory concerning acceptable methods for satisfactory field installation based on fire tests and engineering studies for operation and maintenance considerations, where applicable.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2016 edition.

NFPA 92, *Standard for Smoke Control Systems,* 2015 edition.

NFPA 252, *Standard Methods of Fire Tests of Door Assemblies,*2012 edition.

2.3 Other Publications.

2.3.1 BHMA Publications. Builders Hardware Manufacturers Association, 355 Lexington Avenue, 15th floor, New York, NY10017.

ANSI/BHMA A156.1, *Standard for Butts and Hinges*, 2013.

ANSI/BHMA A156.4, *Door Controls – Closers, Grade 1*, 2013.

2.3.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*, 2009.

ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*, 2009.

ANSI/UL 1784, *Air Leakage Tests of Door Assemblies*, 2009.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 72©, National Fire Alarm and Signaling Code, 2016 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2016 edition.

NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.
NFPA *101*®, *Life Safety Code*®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Qualified Person. A person who, by possession of a recognized degree, certificate, professional standing, or skill, and who, by knowledge, training, and experience, has demonstrated the ability to deal with the subject matter, the work, or the project.

3.3.2 Smoke Damper. A device within an air distribution system to control the movement of smoke.

3.3.2.1 ***Combination Fire/Smoke Damper.*** A device that meets both the fire damper and smoke damper requirements.

3.3.3 Smoke Door. The door component of a smoke door assembly.

3.3.4 Smoke Protective Curtain Assembly. Assembly typically consisting of a fabric curtain, bottom bar, guides, coil, operating and closing system.

3.3.5 Smoke Door Assembly. Any combination of a door, frame, hardware, and any other accessories that together restrict smoke movement through door openings by limiting the amount of air that can pass through the assembly.

3.3.6 Temperature.

3.3.6.1 ***Ambient Temperature.*** An assumed air temperature at the exposed face of the door at or near 75°F (24°C).

3.3.6.2* ***Elevated Temperature.*** An assumed air temperature at the exposed face of the door in excess of ambient temperature.

3.3.7* Tenable Environment. An environment in which smoke and heat are limited or otherwise restricted to maintain the impact on occupants to a level that is not life threatening. [**92**, 2015]

Chapter 4 General Requirements

4.1 General. This chapter shall cover the requirements for testing of smoke door assemblies.

4.2 Test Specimen.

4.2.1 The size of the door to be tested shall be 3 ft × 7 ft (0.9 m × 2.1 m) for a single side-hinged swinging door, and 6 ft × 7 ft (1.8 m × 2.1 m) for a pair of side-hinged swinging doors and all other doors, or shall be representative of the full range of smoke door production for that type of construction as determined by the testing laboratory.

4.2.2 For the air leakage test, fire door assemblies shall be installed in accordance with NFPA 80.

4.2.2.1 Clearances for doors without a fire protection rating shall be in accordance with the manufacturer's specifications.

4.2.3* Doors intended for installation in frames containing transoms, side lights, or side panels shall be tested with such frames.

4.2.4 Specimens of door assemblies shall be tested as they are intended to be installed.

4.3 Air Leakage Test.

4.3.1* Smoke door assemblies shall have an air leakage rating not greater than 3 $ft^3/min/ft^2$ (0.9 $m^3/min/m^2$) of door opening when tested in accordance with ANSI/UL 1784, *Air Leakage Tests of Door Assemblies*.

4.3.2* Smoke door assemblies intended for installation where pressurization is provided to control smoke movement shall not have an artificial bottom seal installed during the test.

4.3.3* Where data exists to verify that tests at ambient temperature result in a higher leakage rate, additional tests at elevated temperature shall not be required.

4.3.4* The test shall be required to be performed only at a pressure differential of 0.1, 0.2, or 0.3 ± 0.005 in. of water (25, 50, or 75 ± 1.25 Pa).

4.4* Labeling. Smoke door assemblies shall bear an "S" label indicating a maximum air leakage rate of 3 $ft^3/min/ft^2$ (0.9 $m^3/min/m^2$) and the tested pressure differential of 0.1, 0.2, or 0.3 in. of water (25, 50, or 75 Pa).

4.5 Installation.

4.5.1 Smoke doors shall be self-closing or automatic closing in accordance with NFPA 80.

4.5.2 Automatic closing smoke door assemblies shall be activated by smoke detection installed in accordance with *NFPA 72*.

4.5.3 Devices for the release of smoke doors shall be permitted to be part of an overall system, such as a fire alarm or an automatic extinguishing system, that shall release the door and shall be installed and tested in accordance with *NFPA 72*.

4.5.4 The opening between the bottom edge of the smoke door and the sill when the door is in the closed position shall not be required to be provided with a means to seal the opening.

4.5.4.1 Smoke door assemblies installed where pressurization is provided to restrict smoke movement shall be required to have a bottom seal.

4.5.5 Louvers shall not be installed in smoke door assemblies unless otherwise tested and listed.

Chapter 5 Inspection, Testing, and Maintenance of Smoke Door Assemblies

5.1 General. This chapter covers the inspection, testing, and maintenance of smoke door assemblies.

5.1.1 Application.

5.1.1.1 This chapter shall cover the inspection, testing, and maintenance of smoke door assemblies.

5.1.1.2 The requirements of this chapter shall apply to new and existing installations.

5.1.2 Removal of Smoke Doors. Where a smoke door no longer functions as an opening or is removed and not replaced, the opening shall be filled with construction to maintain the smoke partition or smoke barrier properties of the wall.

5.1.3 Operability.

5.1.3.1* Smoke doors shall be operable at all times.

5.1.3.2 Smoke doors shall be kept closed or arranged for automatic closing, unless otherwise permitted.

5.1.3.3 Where required, the doors shall be positively latched.

5.1.4 Replacement. Where it is necessary to replace all or part of a smoke door assembly, replacement components shall be installed to meet the requirements of this standard and the manufacturer's instructions.

5.1.5 Field Modifications.

5.1.5.1 Field modifications of fire-rated smoke door assemblies shall be made in accordance with NFPA 80.

5.1.5.2* Field modifications of smoke door assemblies without fire ratings shall be permitted to be made, provided the modifications are performed in accordance with the applicable requirements of this standard.

5.1.5.3 Upon completion of field modification work, smoke door assemblies shall be inspected in accordance with Section 5.2.

5.2 Inspections and Testing.

5.2.1 Upon installation, smoke door assemblies shall be inspected and tested in accordance with the following:

(1) Fire-rated smoke door assemblies shall be inspected and tested in accordance with this standard and also in accordance with Chapter 5 of NFPA 80.
(2) Door assemblies without fire ratings shall be inspected in accordance with the requirements of this standard.
(3) Inspections of smoke door assemblies without fire ratings shall be permitted to be performed at the same time as inspections for door assemblies subject to inspection under NFPA 80.
(4) All functional tests shall be conducted after the building's mechanical ventilation system has been balanced and is operating.
(5) All functional tests shall be conducted after the closing mechanism has been adjusted for the applicable maximum allowable opening force.

5.2.2* A record of all inspections and testing shall be signed by the inspector and kept for inspection by the AHJ.

5.2.2.1 Records of the acceptance tests shall be retained for the life of the assembly.

5.2.2.2* Unless a longer period is required by NFPA 80, records shall be retained for a period of at least 3 years.

5.2.2.3* The records shall be on a medium that will survive the retention period. Paper or electronic media shall be permitted. [***72:***14.6.2.3]

5.2.2.4 A record of all inspections and testing shall be provided that includes, but is not limited to, the following information:

(1) Date of inspection
(2) Name of facility
(3) Address of facility
(4) Name of person(s) performing inspections and testing
(5) Company name and address of inspecting company
(6) Signature of inspector of record
(7) Individual record of each inspected and tested [smoke] door assembly
(8)* Opening identifier and location of each inspected and tested [smoke] door assembly
(9)* Type and description of each inspected and tested [smoke] door assembly
(10)* Verification of visual inspection and functional operation
(11) Listing of deficiencies in accordance with 5.2.4

[**80:**5.2.2.4]

5.2.3 Maintenance Records.

5.2.3.1 Upon completion of maintenance, smoke door assemblies shall be inspected and tested in accordance with 5.2.4

5.2.3.2 A record of these inspections and testing shall be made in accordance with 5.2.2.

5.2.3.3 A record of maintenance performed on existing smoke door assemblies shall be provided that includes, but is not limited to, the following information:

(1) Date of maintenance
(2) Name of facility
(3) Address of facility
(4) Name of person(s) performing maintenance
(5) Company name and address of maintenance personnel
(6) Signature of maintenance personnel performing the work
(7) Individual listings of each maintained smoke door assembly
(8) Opening identifier and location of each repaired smoke door assembly
(9) Type and description of each repaired smoke door assembly
(10) Description or listing of the work performed on each smoke door assembly

5.2.4* Acceptance Testing. Acceptance testing of smoke door assemblies shall be performed by a qualified person with knowledge and understanding of the operating components of the type of assembly subject to testing.

5.2.4.1* Before testing, a visual inspection shall be performed to identify any damaged or missing parts that can create a hazard during testing or affect operation or resetting.

5.2.4.2 Acceptance testing shall include the closing of the door by all means.

5.2.4.2.1 Acceptance testing shall be conducted after the building's mechanical ventilation system has been balanced, in accordance with 5.2.1.

5.2.4.2.2 Acceptance testing shall be conducted after the closing mechanism has been adjusted for the applicable maximum allowable opening force.

5.2.4.3 A record of these inspections and testing shall be made in accordance with 5.2.2.

5.2.4.4 Swinging Smoke Door Assemblies.

5.2.4.4.1 Smoke door assemblies shall be visually inspected from both sides to assess the overall condition of the assembly.

5.2.4.4.2 As a minimum, the following items shall be verified:

(1) Labels on fire-rated smoke door assemblies are clearly visible and legible and bear the "S" label marking.
(2) Door leaves without fire protection ratings comply with 6.3.1.
(3) Door frames comply with 6.3.2.
(4) Gasketing along the vertical edges of the door and across the top of the door and, where required, at meeting edges of pairs of doors forms a continuous seal that is not cut, notched, or otherwise modified to accommodate other hardware items.
(5) Gasketing materials, where required, are intact and close the gaps between the door and frame to seal the door opening against the passage of smoke.
(6) Doors installed in pressurized applications have a bottom seal, where required.
(7) Doors equipped with bottom seals that automatically project to fully seal the gap under the door in the closed position do not interfere with the swinging of the door when retracted or the closing of the door when projected.
(8) No open holes or breaks exist in the surfaces of either the door or the frame.
(9) Glazing, vision light frames, and glazing beads are intact and securely fastened in place, if so equipped.
(10) Glazing materials and vision light kits comply with Sections 6.5 and 6.6.
(11) Glazing materials, vision light kits, and glazing beads are continuously sealed.
(12) The door, frame, hinges, and other hardware are secured, aligned, and in working order with no visible signs of damage.
(13) No parts are missing or broken.
(14) Door clearances do not exceed dimensions listed in 6.3.3 when measured on the pull side of the door(s).
(15) The self-closing device is operational; that is, the active door completely closes when operated from the full open position.
(16) If a coordinator is installed, the inactive leaf closes before the active leaf.
(17) Where positive latching is required, latching hardware operates and secures the door when the door is in the closed position.
(18) Where door leaves, other than doors arranged for automatic closing, are permitted to be held open with friction door holder devices, the door holder devices comply with 6.3.6.6.

5.2.4.5 Horizontally Sliding, Vertically Sliding, and Rolling Doors.

5.2.4.5.1 Smoke door assemblies shall be visually inspected from both sides to assess the overall condition of the door assembly.

5.2.4.5.2 The following items shall be verified:

(1) Labels are clearly visible and legible.
(2) No open holes or breaks exist in surfaces of either the door or the frame.
(3) Slats, endlocks, bottom bar, guide assembly, curtain entry, hood, and flame baffle are correctly installed and intact for rolling steel fire doors.
(4) Gasketing along the perimeter of the door forms a continuous seal that is not cut, notched, or otherwise modified.
(5) Glazing, vision light frames, and glazing beads are intact and securely fastened in place, if so equipped.
(6) Curtain, barrel, and guides are aligned, level, plumb, and true for rolling steel fire doors.
(7) Expansion clearance is maintained in accordance with manufacturer's listing.
(8) Drop release arms and weights are not blocked or wedged.
(9) Mounting and assembly bolts are intact and secured.
(10) Attachments to jambs are with bolts, expansion anchors, or as otherwise required by the listing.
(11) Smoke detectors, if equipped, are installed and operational.
(12) No parts are missing or broken.

(13)* Fusible links, if so equipped, are in the location; chain/cable, s-hooks, eyes, and so forth, are in good condition; the cable or chain is not kinked, pinched, twisted, or inflexible; and links are not painted or coated with dust or grease.
(14) Auxiliary hardware items that interfere or prohibit operation are not installed on the door or frame.
(15) No field modifications to the door assembly that void the label have been performed.
(16) Doors have an average closing speed of not less than 6 in./sec (152 mm/sec) or more than 24 in./sec (610 mm/sec).

5.2.5 Periodic Inspection and Testing.

5.2.5.1 Periodic inspection and testing shall be performed not less than annually.

5.2.5.2 As a minimum, the provisions of 5.2.4 shall be included in the periodic inspection and testing procedure.

5.2.5.3 Inspection shall include an operational test for automatic-closing doors to verify that the assembly will close under fire conditions.

5.2.5.4 The assembly shall be reset after each test.

5.2.5.5 Resetting of the release mechanism shall be done in accordance with the manufacturer's instructions.

5.2.5.6 Hardware and gaskets shall be inspected annually, and any parts found to be damaged or inoperative shall be replaced without delay.

5.2.5.7 Tin-clad and Kalamein doors shall be inspected regularly for dry rot.

5.3* Performance-Based Option.

5.3.1 As an alternative means of compliance with 5.2.5, subject to the AHJ, smoke door assemblies shall be permitted to be inspected, tested, and maintained under a written performance-based program.

5.3.2 Goals established under a performance-based program shall provide assurance that the smoke door assembly will perform its intended function when exposed to fire conditions.

5.3.3 The technical justification for inspection, testing, and maintenance intervals shall be documented in writing.

5.3.4 The performance-based option shall include historical data acceptable to the AHJ.

5.4 Maintenance.

5.4.1* Repairs shall be made, and defects that could interfere with operation shall be corrected without delay.

5.4.2 Fire-rated smoke door assemblies shall also be maintained in accordance with NFPA 80.

5.4.3 Damaged glazing material shall be replaced in accordance with the applicable codes.

5.4.4 Replacement glazing material shall be installed in accordance with its individual listing, where required, and the manufacturer’s listing.

5.4.5 Where holes are left in a door or frame due to changes or removal of hardware or plant-ons, the holes shall be sealed to resist the passage of smoke at ambient and elevated temperatures up to 400°F (204°C).

5.4.6 Where a smoke door, frame, or any part of its appurtenances is damaged to the extent that it could impair the door assembly's proper emergency function, the following actions shall be performed:

(1) The door, frame, door assembly, or any parts of its appurtenances shall be replaced with parts obtained from the original manufacturer.
(2) The door shall be tested to ensure emergency operation and closing upon completion of the repairs, in accordance with 5.2.3.

5.4.7 If repairs cannot be made with parts obtained from the original manufacturer or retrofitted, the door, the door assembly, or appurtenances shall be replaced.

5.5 Prevention of Door Blockage.

5.5.1 Door openings and the surrounding areas shall be kept clear of anything that could obstruct or interfere with the free operation and full closure of the door.

5.5.2 Blocking or wedging of doors in the open position shall be prohibited.

5.6 Maintenance of Closing Mechanisms.

5.6.1 Self-closing and automatic closing devices shall be kept in working condition at all times.

5.6.2 Care shall be taken to prevent paint accumulation on any movable parts such as, but not limited to, hinges, pivots, closer arms, and latching hardware.

Chapter 6 Swinging Doors

6.1* General. This chapter shall cover the installation of side-hinged and side-pivoted swinging smoke door assemblies.

6.2 Swinging Doors with Fire Protection Ratings. Fire door assemblies that are intended for use as smoke door assemblies shall also comply with NFPA 80.

6.3* Swinging Doors Without Fire Protection Ratings. Doors without fire protection ratings shall be permitted to be used as smoke door assemblies in door openings not required to be protected by fire doors.

6.3.1* Doors. Non-fire-rated door leaves shall be of a design that resists the passage of smoke.

6.3.1.1* Vertical edges of new composite and wood door leaves shall be square edged or beveled.

6.3.1.2 Doors installed in pairs shall be beveled or have astragals or rabbets at meeting edges.

6.3.1.3 Doors shall be flush mounted in door frames.

6.3.1.4 Dutch doors shall be permitted to be used, provided they comply with the following:

(1) Both the upper leaf and the lower leaf are equipped with a latching device.
(2) The meeting edges of the upper and lower leaves are equipped with an astragal or a rabbet.

6.3.1.5 Louvers and transfer grilles shall not be permitted in doors.

6.3.2 Door Frames. Door frames shall be labeled or comply with 6.3.2.1.

6.3.2.1 Where permitted by other standards, door frames shall be of steel construction or shall be of other designs that have been tested and reported by a nationally recognized testing agency in accordance with NFPA 252; ANSI/UL 10B, *Standard for Fire Tests of Door Assemblies*; or ANSI/UL 10C, *Standard for Positive Pressure Fire Tests of Door Assemblies*.

6.3.2.2* Door frames with terminated stops shall be permitted, provided the lowest portion of the terminated stops is not greater than 6 in. (152 mm) above the bottom of the frame.

6.3.2.3 Supporting Construction. Wall openings shall be constructed to readily accept the door frames.

6.3.2.4 The door frames shall be considered to be non–load bearing.

6.3.2.5 Frames shall be securely anchored to the wall construction.

6.3.3* Clearances. Doors in smoke partitions shall have clearances in accordance with NFPA 80.

6.3.3.1* Doors in smoke barriers shall close the opening, leaving only the minimum clearance necessary for proper operation. The clearance under the bottom of a new door shall be a maximum of ¾ in. (19 mm).

6.3.3.2 The maximum clearance between the bottom of side-hinged or -pivoted swinging smoke doors and the finished floor shall be not greater than ¾ in. (19 mm), unless otherwise permitted.

6.3.3.3 Where the bottom of the door is more than 38 in. (965 mm) above the finished floor, the maximum clearance under the door shall not exceed ⅜ in. (10 mm).

6.3.4* Latching Hardware. Where required, smoke doors without fire protection rating shall be provided with hardware that provides positive latching.

6.3.5 Operation of Doors. Doors shall be arranged to be either self-closing or automatic closing, where required, unless otherwise exempted.

6.3.5.1* Self-Closing. Self-closing doors shall swing easily and freely and shall be equipped with a closing device that closes, the door, causing it to latch, each time the door closes.

6.3.5.2 The closing mechanism shall not have a hold-open feature.

6.3.5.3 Automatic Closing. Automatic-closing doors shall be permitted to close automatically by means of the installation of a closing device and the following:

(1) Upon release of the hold-open mechanism, the leaf becomes self-closing.
(2) The release device is designed so that the leaf instantly releases manually and, upon release, becomes self-closing, or the leaf can be readily closed.
(3) The automatic releasing mechanism or medium is activated by the operation of approved smoke detectors installed in accordance with the requirements for smoke detectors for door leaf release service in *NFPA 72*.
(4) Upon loss of power to the hold-open device, the hold-open mechanism is released and the door leaf becomes self-closing.
(5) The release by means of smoke detection of one door leaf in a smokeproof enclosure or a stair enclosure results in closing all door leaves serving the enclosure.
(6) Where required, doors properly latch upon closing.

6.3.5.4 Power-Operated Doors. Power-operated doors shall be equipped with a releasing device that automatically disconnects the power operator at the time of fire, allowing a self-closing or automatic device to close the door regardless of power failure or manual operation, provided all the following criteria are met:

(1) The door is equipped with a means for keeping the door closed that is acceptable to the AHJ.
(2) The device used is capable of keeping the door fully closed if a force of 5 lbf (22 N) is applied to the latch edge of swinging doors, whether or not power is applied.

6.3.6* Builders Hardware

6.3.6.1 Conventional Hinges. Conventional hinges used on doors with closing devices shall have ball bearings or anti-friction bearings and meet the requirements of ANSI/BHMA A156.1, *Standard for Butts and Hinges*.

6.3.6.1.1 Hinges shall be sized in thickness, height, and width in accordance with the hinge manufacturer's recommended guidelines.

6.3.6.1.2 Hinges shall have brass/bronze or steel base materials or be stainless steel.

6.3.6.1.3 Doors up to 60 in. (1.52 m) in height shall be provided with two hinges and an additional hinge for each additional 30 in. (0.76 m) of door height or fraction thereof.

6.3.6.1.4 The distance between hinges shall be permitted to exceed 30 in. (0.76 m).

6.3.6.1.5 Where spring hinges are used, at least two shall be provided.

6.3.6.2 Pivots. Pivots shall be in compliance with NFPA 80.

6.3.6.3 Continuous Hinges. Continuous hinges shall be in compliance with NFPA 80.

6.3.6.4* Locks and Latches. Locking and latching shall comply with NFPA 80.

6.3.6.4.1 Where panic hardware is utilized, the latching device shall not be permitted to be mechanically held in the retracted position.

6.3.6.4.2 Latching arrangements that do not provide positive latching in the normal mode shall be permitted to be used provided that, in a fire emergency, the door becomes positively latched by means of an automatic fail-safe device that is activated by an automatic fire detector. [**80:**6.4.4.3.3]

6.3.6.4.3 Strike plates for locks and latches on pairs of doors shall not have extended lips that prevent astragals from sealing the gap at the meeting edges of the doors.

6.3.6.5 Door-Closing Devices. Door-closing devices, other than spring hinges, shall meet the requirements of ANSI/BHMA A156.4, *Door Controls — Closers, Grade 1*.

6.3.6.5.1 Where non-fire-rated doors are permitted to be held open, the door closing device shall be permitted to have an integral friction hold-open feature that permits the door to be closed when pulled or pushed.

6.3.6.5.2 Doors arranged for automatic closing shall have a closing device that meets the requirements of 6.3.5.3.

6.3.6.6 Door Holder/Release Devices.

6.3.6.6.1 Door holder/release devices for automatic-closing doors shall be installed in accordance with the manufacturer's instructions and in conformance with the individual manufacturer's published listings.

6.3.6.6.2 Where required for non-fire-rated smoke doors without door closers, only door holder devices that release when pushed or pulled shall be permitted.

6.3.6.7* Protection Plates. Doors without fire protection rating are permitted to have non-rated, factory- or field-applied protection plates of unlimited size, unless otherwise restricted by the door or protection plate manufacturers' specifications.

6.3.6.8* Attaching Hardware to Doors and Frames. Hardware items shall be attached to doors and frames in accordance with NFPA 80.

6.4 Vision Panels in Doors.

6.4.1 Glazing materials shall be capable of resisting the passage of smoke.

6.4.2 The perimeter of the glazing material and vision panel frames shall be sealed to resist the passage of smoke at temperatures up to 400°F (204°C).

6.4.3 Vision panels in smoke doors required to have a fire protection rating shall comply with NFPA 80.

6.5 Glazing in Sidelight and Transom Light Frames.

6.5.1 Glazing materials shall be capable of resisting the passage of smoke.

6.5.2* The perimeter of the glazing material and sidelight and transom frames shall be sealed to resist the passage of smoke at temperatures up to 400°F (204°C).

6.5.3 Glazing in sidelight and transom light frames that are required to be fire rated shall comply with NFPA 80.

6.6 Side Panel and Transom Panel Frames.

6.6.1 The perimeter of fixed solid panels used in side panel and transom panel frames shall be sealed to resist the passage of smoke.

6.6.2 Removable panels shall be permitted, provided they are gasketed to resist the passage of smoke.

6.7* Gasketing and Astragals.

6.7.1 Gasketing. Where required by the door listing, the gaps between the top and vertical edges of the door and frame and between the meeting edges of pairs of doors shall be closed with labeled gasketing material in accordance with the gasketing manufacturer's published listings.

6.7.1.1* Gasketing material shall form a continuous seal along the top and vertical edges of the doors and at meeting edges of pairs of doors.

6.7.1.2* Where mortising of doors to receive hardware items creates a void along the vertical or top edges of doors, soffit-mounted gasketing shall be required.

6.7.1.3 Where required, gaps between the bottom of the doors and the floor shall be closed with labeled gasketing in accordance with the gasketing manufacturer's published listing.

6.7.1.4 Automatic door bottoms that close the gap between the bottom of the door and the floor or threshold shall be permitted to be installed.

6.7.2 Astragals. Doors swinging in pairs, where located with a means of egress, shall not be equipped with astragals that inhibit the free use of either leaf.

Chapter 7 Installation, Testing, and Maintenance of Smoke Dampers

7.1* General. This chapter covers the requirements of the installation, testing, and maintenance of smoke dampers and combination fire and smoke dampers.

7.2 Definitions. (Reserved)

7.3 Installation.

7.3.1 Dampers.

7.3.1.1 Smoke dampers shall be installed within 24 in. (610 mm) of the partition and before any branch line or opening other than access panel and shall be installed in accordance with the manufacturer's installation instructions and the listing.

7.3.1.2 Damper actuator and linkage to operate the smoke damper shall be supplied and installed at the factory.

7.3.2 Dampers equipped with fusible links and/or internal operators shall be provided with an access door that is not less than 12 in.^{2} (7742 mm^2) or provided with a removable duct section.

7.3.2.1 Dampers that are installed behind registers, diffusers, or grilles shall be serviceable by removal of these covers.

7.3.2.2 A smoke damper access panel shall be labeled with the words "Smoke Damper" in letters not less than ½ in. (13 mm) in height. External insulation shall not conceal any access panel unless there is a label attached to the insulation clearly indicating the exact location of the access panel and the insulation is installed for ease of removal or ease of removal with the access panel.

7.3.2.3 Unobstructed access shall be provided through a ceiling or wall for inspection and service of the damper's working parts.

7.3.2.4 Installation of combination fire/smoke dampers shall be in accordance with the installation of fire dampers in NFPA 80, Section 19.2.

7.3.2.5 Smoke detectors used to control smoke dampers or fire/smoke dampers shall be spaced and installed per the requirements of *NFPA 72*.

7.4 Operational Test.

7.4.1 Smoke and Combination Fire/Smoke Dampers. An operational test shall be conducted after the building's HVAC system has been balanced.

7.4.1.1 The test shall be adequate to determine that the damper has been installed and functions as intended.

7.4.1.2 The operational test shall be conducted under normal HVAC airflow conditions as well as static flow conditions. The damper shall fully close/seal under both test conditions.

7.4.1.3 The operational test shall verify that there are no obstructions to the operation of the dynamic combination damper.

7.4.1.4 The operational test shall verify that there is full and unobstructed access to the dynamic combination damper and all appurtenances.

7.4.1.5 All indicating devices shall be verified to work properly and report to the intended location.

7.4.1.6 Combination fire/smoke dampers shall also meet the testing requirements contained in NFPA 80, Section 19.3.

7.5 Acceptance Testing.

7.5.1 Acceptance testing of smoke dampers shall be performed by a qualified person with knowledge and understanding of the operating components of the type of assembly to be tested.

7.5.2 Before testing, a visual inspection shall be performed to identify any damaged or missing parts that could create a hazard during testing or affect operation or resetting.

7.5.3* Acceptance testing shall include the closing of the damper by every means.

7.5.4 Acceptance testing shall be conducted after the building mechanical ventilation system has been balanced, and in operation under maximum air flow, if equipped with a variable air volume system in accordance with 5.2.1.

7.5.5 A record of these inspections and testing shall be made in accordance with 5.2.2.

7.6 Periodic Inspection and Testing.

7.6.1 General.

7.6.1.1 Smoke dampers for dedicated and nondedicated smoke control systems shall be inspected and tested in accordance with NFPA 92

7.6.1.2 Combination fire/smoke dampers shall be inspected and tested in accordance with NFPA 80.

7.6.2* Testing Frequency.

7.6.2.1 Each damper shall be tested and inspected 1 year after installation.

7.6.2.2* The test and inspection frequency shall then be every 4 years, except in buildings containing a hospital, where the frequency shall be every 6 years.

7.6.3 Test Method.

7.6.3.1 All tests shall be completed in a safe manner by personnel wearing personal protective equipment (PPE).

7.6.3.2 Fans shall not be permitted to be shut down during the test.

7.6.3.3 Dampers with Motorized Actuators. Testing of dampers with actuators shall comply with the following procedure:

(1) Visually confirm that the damper is in the fully-open position.
(2) Verify that all obstructions, including hands, are out of the path of the damper blades and then remove electrical power or air pressure from the actuator to allow the actuator's spring return feature to close the damper.
(3) Visually confirm that the damper closes completely.
(4) Reapply electrical power or air pressure to reopen the damper.
(5) Visually confirm that the damper is in the fully-open position.

7.6.4 Documentation.

7.6.4.1 All inspections and testing shall be documented indicating the location of the damper, date of inspection, name of inspector, and deficiencies discovered.

7.6.4.2 The documentation shall have space to indicate when and how the deficiencies were corrected.

7.6.4.3 All documentation shall be maintained for at least three test cycles and made available for review by the AHJ.

7.7 Maintenance.

7.7.1 Any reports of abrupt changes in airflow or noise from the duct system shall be investigated to verify that it is not related to damper operation.

7.7.2* All exposed moving parts of the damper shall be dry lubricated as required by the manufacturer.

7.7.3 If the damper is not operable, repairs shall begin as soon as possible.

7.7.4 Following any repairs, the damper shall be tested for proper operation in accordance with Section 7.6.

7.7.5 Smoke damper actuation shall be initiated at a time interval recommended by the actuator manufacturer.

7.7.6 All maintenance shall be documented and records shall be retained in accordance with 7.6.4.

Chapter 8 Smoke Protective Curtain Assemblies

8.1 General.

8.1.1* This chapter shall cover the installation, inspection, testing, and maintenance of smoke protective curtain assemblies installed to protect vertical openings.

8.1.2 Smoke protective curtain assemblies that are protecting vertical openings shall be air leakage tested in accordance with ANSI/UL 1784, *Air Leakage Tests of Door Assemblies.*

8.1.3 Smoke protective curtain assembles shall be identified by an "S" label attached to the bottom bar of the curtain indicating a maximum air leakage rate of 3 ft^3 /min/ft^2 (0.9 m^3/min /m^2) and the tested pressure differential of 0.1 in., 0.2 in., or 0.3 in. of water (25 Pa, 50 Pa, 75 Pa).

8.2 Mounting of Smoke Protective Curtain Assemblies.

8.2.1 Smoke protective curtain assemblies shall be mounted to supporting construction in accordance with their listing and with the manufacturer's installation instructions.

8.2.2 Items that are not a part of a smoke protective curtain assembly shall not be field attached to any component of a smoke protective curtain assembly.

8.2.3 Access to, and clearances between, surrounding construction and a smoke protective curtain assembly shall allow for required testing and maintenance.

8.3 Assembly Components.

8.3.1 Smoke protective curtain assemblies shall be either self-closing or automatic-closing.

8.3.1.1 Smoke protective curtain assemblies shall not have a delay in the initiation of closing of more than 10 seconds.

8.3.1.2 Smoke protective curtain assemblies shall have an average closing speed of not less than 6 in./sec (152 mm/sec) or more than 24 in./sec (610 mm/sec).

8.3.2* Curtains shall be permitted to be sewn by qualified persons in accordance with the manufacturer's instructions.

8.4 Power Operators. Power operators shall be provided with a standby or an emergency power source to close the curtain upon activation or shall be capable of closing the curtain without power.

8.5 Installation. Smoke protective curtain assemblies shall be installed in accordance with their listing and with the manufacturer's installation instructions.

8.6 Inspection, Testing, and Maintenance.

8.6.1 Following completion of installation, smoke protective curtains shall be inspected and tested in accordance with Section 8.7.

8.6.2 A record of all inspections and testing shall be signed by the inspector and kept for inspection by the AHJ.

8.6.2.1 Records of acceptance testing following completion of installation shall be retained for the life of the assembly.

8.6.2.2 Records of periodic inspections and testing shall be retained for a period of at least 3 years.

8.6.2.3 The records shall be on a medium that will survive the retention period. Paper or electronic media shall be permitted. [***72:***14.6.2.3]

8.6.2.4 A record of all inspections and testing shall be provided that includes, but is not limited to, the following information:

(1) Date of inspection
(2) Name of facility
(3) Address of facility
(4) Name of person(s) performing inspections and testing
(5) Company name and address of inspecting company
(6) Signature of inspector of record
(7) Individual record of each inspected and tested smoke protective curtain assembly
(8) Opening identifier and location of each inspected and tested smoke protective curtain
(9) Type and description of each inspected and tested smoke protective curtain
(10) Verification of visual inspection and functional operation
(11) Listing of any deficiencies

8.6.2.5 Upon completion of maintenance work, smoke protective curtain assemblies shall be inspected and tested in accordance with Section 8.7.

8.7 Acceptance Testing.

8.7.1 Acceptance testing of smoke protective curtain assemblies shall be performed by a qualified person with knowledge and understanding of the operating components of the type of assembly being subject to testing.

8.7.2 Before testing, a visual inspection shall be performed to identify any damaged or missing parts that can create a hazard during testing or affect operation or resetting.

8.7.3 Acceptance testing shall include the closing of the smoke protective curtain assembly by all means of activation.

8.7.4 A record of these inspections and testing shall be made in accordance with Section 8.6.

8.7.5 The following items shall be verified:

(1) Labels are clearly visible and legible.
(2) No open holes or breaks exist in surfaces of the curtain or in the stitching of the curtain.
(3) Curtain, guides, and coil are aligned, level, plumb, and true.
(4) Mounting and assembly bolts are intact and secured.
(5) Attachments to jambs are with bolts, expansion anchors, or as otherwise required by the listing.
(6) Smoke detectors, if equipped, are installed, operational, and in accordance with *NFPA 72*
(7) No parts are missing or broken.
(8) Auxiliary hardware items that interfere or prohibit operation are not installed on the curtain or frame.
(9) No field modifications to the smoke protective curtain assembly have been performed that void the label.
(10) Smoke protective curtain assemblies have an average closing speed of not less than 6 in./ sec (152 mm/sec) or more than 24 in./sec (610 mm/sec).

8.7.6 Smoke protective curtain assemblies shall be drop-tested twice.

8.7.7 Fusible links, release devices, and other movable parts shall not be painted or coated with other materials that could interfere with the operation of the assembly.

8.8 Closing Devices.

8.8.1 Smoke protective curtain assemblies shall be inspected and tested to check for proper operation and full closure.

8.8.2 Resetting of the automatic-closing device shall be performed in accordance with the manufacturer's instructions.

8.9 Periodic Inspection and Testing.

8.9.1 Periodic inspections and testing of smoke protective curtain assemblies shall be performed not less than annually.

8.9.2 As a minimum, the provisions of Section 8.7 shall be included in the periodic inspection and testing procedure.

8.10 Maintenance.

8.10.1 Repairs shall be made, and defects that could interfere with operation shall be corrected without delay.

8.10.2 Any breaks in the face covering of curtains shall be repaired in accordance with manufacturer's requirements without delay.

8.10.3 Where a smoke protective curtain assembly or any part of its appurtenances is damaged to the extent that it could impair the assembly's proper emergency function, the following actions shall be performed:

(1) The smoke protective curtain assembly or any part of its appurtenances shall be repaired with labeled parts or parts obtained from the original manufacturer.
(2) The smoke protective curtain assembly shall be tested to ensure emergency operation and closing upon completion of the repairs.

8.10.4 If repairs cannot be made with labeled components or parts obtained from the original manufacturer, the smoke protective curtain assembly or appurtenances shall be replaced.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.2 For the purposes of this standard, smoke can be considered to be airborne particulates and gases resulting from combustion. Therefore, to understand smoke movement it is only necessary to understand air movement. Hot smoke, however, will be buoyant and will be located above the neutral plane in the fire compartment. As it moves away from the fire source, it will cool, lose its buoyancy, and become less stratified. Beyond the immediate influence of the fire, smoke will behave just as warm or cool air would behave. It will be driven by pressure differentials within the building, or it will follow air currents created by the heating, ventilating, and air-conditioning (HVAC) system or smoke management system in the building. Pressure differentials can be the result of the following:

(1) Fire pressure buildup, which would drive only the smoke out of the compartment or area of origin
(2) Stack effect due to temperature differentials between the interior and exterior of the building
(3) Wind
(4) Pressures created mechanically using HVAC systems, exhaust fans, supply or pressurization fans, vents, and smoke management systems

This standard has its beginnings in measurements from test results reported in *Operation School Burning* and from NFPA Technical Paper No. 341, "Factors in Controlling Smoke in High Buildings," where tenable or tolerable smoke concentration lists were established. Since the publication of *Operation School Burning* in 1959, considerable effort in the field of fire protection has been focused upon smoke movement in the built environment. NFPA *101* and NFPA 90A recognize that smoke control can be either active or passive. The passive approach recognizes the long-standing compartmentation concept, which requires that fans shut down and fire/smoke dampers in ductwork close under fire conditions. The active approach utilizes the building's HVAC systems to create differential pressures to prevent smoke migration from the fire area and to exhaust the products of combustion to the outside. Active smoke control systems use passive barrier components that include smoke door assemblies to create zones or areas for effective smoke movement as an essential component.

Smoke management utilizing active and passive methods in combination to modify smoke movement must be engineered into a system and focused on protection of property or people. While passive methods of smoke management do exist *(see* NFPA 204*)*, dynamic smoke control systems using mechanical equipment to meet design goals dominate. NFPA 92 is used for the design, installation, testing, operation, and maintenance of systems for smoke control and provides methodologies for determining smoke development in large spaces.

Smoke door assemblies are intended to maintain egress, allow for the rescue of the occupants, or allow occupants to remain in an area of refuge. The required duration of smoke protection can be equated with the path of egress. Evacuation typically starts in a room, progresses through a corridor, perhaps passes through a smoke barrier or horizontal exit, and proceeds through an entrance to the exit, which can be a stair enclosure, exit passageway, or the exit discharge. As with fire door assemblies, the longest time of protection is generally required at the entrance to an exit enclosure or horizontal exit, with shorter durations appropriate for preceding doors.

This path-of-egress arrangement is compatible with the protect-in-place concept as occupants are expected to be moved from one compartment to another for protection or, in some cases, protected in rooms other than the room of fire origin.

Occupancies not typical of this scenario include atria, malls, and open office plans. Areas of this sort can be adequately protected by reasonably tight-fitting doors without specific smoke door ratings because of the large volume of space involved.

A.1.3 While the use of smoke door assemblies will be helpful in reducing the flow of airborne gases, it is not assumed that using this standard obviates the concern over toxic combustion products.

NFPA *101* and building codes include specific requirements for smoke door assemblies and should be consulted in every instance. NFPA should be followed where fire door assemblies are used as smoke door assemblies.

The leakage characteristics of adjacent wall, ceiling, and floor assemblies should be considered. It is generally viewed to be of marginal benefit to install smoke door assemblies in locations where adjacent walls, ceilings, or floors do not effectively resist the passage of smoke. (For additional information, see ASHRAE/ICC/SFPE/NFPA *Handbook of Smoke Control Engineering.*)

For protection against smoke migration into spaces of large volume, a reasonably tight-fitting door can be considered adequate because of the relatively long time it would take for such a space to become untenable due to smoke. Conversely, the average 8 ft (2.4 m) high by 4 ft to 6 ft (1.2 m to 1.8 m) wide corridor can become untenable in less than 2 minutes, as shown in a test conducted in California and documented in *Operation School Burning*, where the fire room door was open.

Tests indicate that listed gaskets, if properly installed and maintained in accordance with manufacturer's instructions, do a good job of reducing smoke infiltration to a sufficient level to provide protection against smoke infiltration through the door assembly. In a fire condition, there would normally be a room of fire origin, and temperatures would be high in this area. Immediately outside the room of origin there might be warm smoke.

A.1.3.1 Smoke door assemblies used in locations likely to be in proximity to a fire can be exposed to elevated temperatures, including door assemblies separating rooms and corridors. Such door assemblies, whether rated as fire doors or not, should restrict the passage of smoke that can be heated to a temperature of 400°F (204°C). In a fully sprinklered building, protection against elevated-temperature smoke might not be necessary, and the criteria for protection against ambient-temperature smoke might be appropriate.

Mention should be made of the effects of automatic sprinkler protection on smoke. The activation of an automatic sprinkler occurs early in a flaming fire condition, usually within approximately 5 minutes after visible flaming is observed. Temperatures immediately drop to almost ambient, and smoke is driven to the floor and diffused throughout the available space. Smoke production rate is reduced as the fire size decreases and the temperature of the flame plume is reduced. The temperature of the smoke is also reduced to near ambient. Thus, in a sprinklered building it can be appropriate to treat smoke as if it were at or near ambient temperature. Fewer mitigating measures might be needed to control smoke movement since the production rate of smoke will be reduced. However, under a smoldering fire condition, sprinkler activation can be delayed and this, too, should be considered.

Fire door assemblies protecting stair enclosures and vestibules adjacent to stair enclosures, for example, are more likely to be exposed to ambient temperature smoke, provided there are no combustible materials in the enclosure. These doors can form part of a control system involving pressurized stairwells or vestibules. The air leakage characteristics of such door assemblies are an essential part of smoke control design.

A.1.3.2 See NFPA 92 for additional information on protection of elevator openings.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.6.2 Elevated Temperature. Depending on the function of the door, its location in relation to the fire, and the movement of hot gases and air, door assemblies might be exposed to elevated smoke temperatures. Warm smoke has an assumed temperature at the exposed face of the door at or near 400°F (204°C); hot smoke has an assumed temperature at the exposed face of the door in excess of 400°F (204°C). A nationally recognized standard test for measuring hot smoke temperature leakage does not exist.

It has been determined from many full-scale fire tests of compartments that the maximum instantaneous pressure differential created by an uncontrolled fire can approach 0.15 in. of water (37.5 Pa). More typically, a pressure differential of 0.06 in. of water to 0.10 in. of water (15 Pa to 25 Pa) is achieved over the period of most intense burning in light fire loading occupancies such as residential, health care, and business (offices).

In sprinklered buildings where the fire will be controlled, it is anticipated that the maximum pressure differential generated should not exceed 0.05 in. of water (12.5 Pa).

Typical stair pressurization systems can often result in pressure differentials as high as 0.25 in. of water to 0.50 in. of water (62.5 Pa to 125 Pa) across the door assembly.

Stack effect can also play a major role in determining pressure that must be overcome in order to pressurize shafts, such as elevators and stairs, to prevent smoke infiltration. Pressure differentials between the exterior and unvented shafts can range from virtually nothing to as much as 0.5 in. of water to 1.0 in. of water (125 Pa to 250 Pa) or more, depending on the location of the building neutral pressure plane, the height of the building, and the outside temperature. The ASHRAE/SFPE handbook, *Principles of Smoke Management,* addresses smoke management applications including pressurized stairwells, pressurized elevators, and pressure differentials that designers are likely to encounter.

The quantity of air movement through a door gap can be determined by the following general formula:

[A.3.3.4.2]

$$Q = KAP^{\frac{1}{N}}$$

where:
Q = volume flow rate of air
K = orifice coefficient for the gap around the door perimeter
A = area of the gap
P = pressure differential across the door
N = number between 1 and 2 that can be determined empirically

(For more information, see NFPA's *Fire Protection Handbook.*)

A.3.3.7 Tenable Environment. It is not expected that a tenable environment will be completely free of smoke. [**92**, 2015]

A.4.2.3 Hardware requiring extensive door mortising that could provide considerable air leakage through the door panel should be tested if required by the testing laboratory.

A.4.3.1 Smoke management systems both affect and are affected by smoke door assemblies. Pressurized stair enclosures, for example, are more easily engineered when leakage through the stair doors is reduced. In other areas, pressurization can inhibit smoke flow so that reasonably tight-fitting doors unrated for smoke protection can be entirely appropriate.

Complete sealing of doors is not always desirable. A disadvantage of complete sealing is the difficulty of opening or closing doors because of the pressure differential. Some smoke management designs call for some areas to be pressurized. A small pressure acting across the full area of a door can exert sufficient force to make opening a door difficult. A seal must be first broken to equalize the pressure on both sides of the door before the door can be opened easily.

Smoke doors should take the entire smoke management system into account. The amount of leakage tolerated will vary according to the degree of compartmentation, whether smoke management systems are used, and whether the building is protected by sprinklers.

An engineering evaluation should be performed when the volume of the space to be protected is known so that the values can be modified to restrict smoke leakage in terms of a specified smoke tenability level. In assessing tenability, the evaluation should include, but not be limited to, fuel load, pressurization, stack effect, presence of smoke control systems, and construction, as well as smoke leakage.

A.4.3.2 The artificial door bottom is used during the air-leakage tests of ANSI/UL 1784, *Air Leakage Tests of Door Assemblies*, to better ascertain the amount of air leakage along the vertical edges and across the top edge(s) of the doors. An example of an artificial door bottom is duct tape used to seal the gap between the bottom of the door and the sill during the air-leakage test. The application of gasketing at the door bottom on installed smoke door assemblies is sometimes required in areas that are pressurized for smoke control. In the majority of cases, it is not necessary to seal the gap under the door.

A.4.3.3 Test data exists for certain door types demonstrating that air leakage at ambient temperature is greater than warm air temperature leakage. In such instances, the air leakage rate for ambient temperature could also apply for warm temperatures when additional data tests are not conducted at elevated temperature.

A.4.3.4 Pressure differentials of at least 0.04 in. of water (10 Pa) are developed in the upper parts of rooms that are involved in fire. Considerably higher pressure differentials can exist in rooms, corridors, and stair enclosures due to the action of air-handling systems, stack effect, and wind.

In sprinklered buildings where the fire will be controlled, it is anticipated that the maximum pressure differential generated should not exceed 0.05 in. of water (12.5 Pa). See pressure differences discussed in NFPA 92 and ASHRAE/ICC/SFPE/NFPA *Handbook of Smoke Control Engineering*.

A.4.4 Non-fire-rated smoke doors might not be marked with an "S" label or any other markings that indicate the maximum air leakage rate. Gasketing manufacturers might be able to provide anecdotal information based on the testing of their products. Due to the size, shape, material, and configuration of gasketing products, the label frequently is marked on the packaging of the gasketing material rather than on the product. Verifying the maximum air leakage rate of a smoke door without a fire protection rating might require additional research if the door does not carry an "S" label.

A.5.1.3.1 Smoke door assemblies, both fire-rated and non-fire-rated, should be operable under normal conditions. Operability includes closing easily and completely and, where required, positively latching in the closed position. Operability, in the case of smoke door assemblies, also includes the sealing of the door against the passage of smoke. Fire-rated doors are not required to be operable after exposure to a fire. Similarly, non-fire-rated doors should not be expected to be operable after exposure to a fire.

A.5.1.5.2 Generally, the replacement of hardware components on swinging doors (hinges, pivots, door closers, etc.) is not considered to be a field modification, provided the replacement hardware does not require additional cutting, mortising, or boring into the doors and frames and the hardware meets the criteria specified elsewhere in the standard. Likewise, the installation of surface-mounted items like protection plates is not considered to be a field modification. Cutting doors for vision panels, enlarging existing cutouts for vision panels, and trimming doors in height or width are examples of field modifications, as is installing hardware components that require additional cutting and mortising of the doors or frames.

A.5.2.2 Newer technology includes the use of bar codes and other electronic devices. This section recognizes that completed and filed bar code reports should be considered signed by the inspector.

A.5.2.2.2 In many cases, AHJs are not able to inspect every building in their jurisdiction each year. Inspection and testing records need to be retained during the intervening periods between the AHJ's formal visits to provide evidence that the inspections and testing were performed as required by this standard. Additionally, maintenance records documenting that the necessary corrective actions have been made in accordance with this standard should be stored with the inspection and testing records for the same period of time. Retaining the records for 7 years allows the AHJ to look back over an extended period of time to verify that the smoke door assemblies are being properly maintained.

A.5.2.2.3 Installation of new smoke door assemblies should be documented in the same manner and level of detail as the periodic inspections and testing of smoke door assemblies required by 5.2.4 and 5.2.5. Records of new smoke door assemblies should be retained with the periodic inspections and testing records for the facility.

A.5.2.2.4(8) Each smoke door assembly in a facility should be assigned a unique identifier code (e.g., door number) that can be used to track the assembly's compliance and maintenance records throughout the lifetime of its installation. Identifier codes could be a door assembly number, bar code, or other code that is unique to each smoke door assembly in the facility.

A.5.2.2.4(9) To aid the AHJ during the review of the inspections and testing reports, the records should include a description of the smoke door assembly. The following door types are listed in NFPA 80 and could have application under this section:

(1) Swinging doors with builders hardware
(2) Swinging doors with fire door hardware
(3) Horizontally sliding doors
(4) Special purpose horizontally sliding accordion or folding doors
(5) Vertically sliding fire doors
(6) Rolling steel doors
(7) Fire shutters
(8) Service counter fire doors
(9) Hoistway doors for elevators and dumbwaiters
(10) Chute doors
(11) Access doors
(12) Fabric fire safety curtain

A.5.2.2.4(10) Functional operation of smoke door assemblies should include testing of the closing device, complete closure of the door from the full-open position, and full engagement of latch(es) where required by door type. Functional testing of automatic-closing or power-operated smoke door assemblies and electrically controlled latching hardware might need to be coordinated with the facility during other electrically controlled system tests. Where required by other standards, the force to open a door should be recorded using a door pressure gauge.

A.5.2.4 Visual inspection and functional testing of smoke door assemblies require the persons performing the inspections and testing to be thoroughly knowledgeable of the various components and systems that are used to create the assemblies. Inspectors of swinging doors should be able to recognize which components can or cannot be used on specific assemblies, which requires training and experience on the part of the persons performing the inspections. Additionally, AHJs should be able to rely on the competency, expertise, experience, and knowledge of the smoke door inspectors in their jurisdiction.

A.5.2.4.1 Any smoke door assembly or component that has a history of recurring failures should be evaluated for possible replacement or other corrective measures.

A.5.2.4.5.2(13) Fusible links should not be coated with any materials such as fireproofing, drywall compound, or spray texturing.

A.5.3 See Annex B for information regarding performance-based inspection, testing, and maintenance options for smoke door assemblies.

A.5.4.1 The determination of the time required for corrective action should be based on a risk analysis and the availability of replacement materials.

A.6.1 Swinging smoke door assemblies fall into two categories, fire rated and non–fire rated. Fire-rated smoke door assemblies are also required to comply with NFPA 80. Where there are conflicting requirements for fire-rated doors, NFPA 80's requirements take precedence over all other requirements. Additionally, building, fire, and life safety codes contain specific requirements that affect the design and installation of swinging smoke door assemblies. Some of the requirements of Chapter 6 have been adapted from the requirements found in Chapter 8 of NFPA 101.

Generally, swinging smoke door assemblies without fire protection rating are composed of many of the same components that are used on swinging fire door assemblies. In many cases, the internal construction of the door leaves is the main difference between the two categories of smoke door assemblies. Each type of swinging smoke door assembly utilizes the same types of frames, doors, and builders hardware (hinges, latching hardware, closing devices, etc.) and are virtually identical except for the labels that indicate the door is fire rated. For that reason, many of the requirements of Chapter 6 refer directly to NFPA 80 or otherwise adapt applicable NFPA 80 requirements for use on non-fire-rated swinging smoke door assemblies.

Many of the components used in non-fire-rated smoke door assemblies are not specifically tested or listed by nationally recognized testing laboratories for use on smoke door assemblies, with the exception of gasketing materials and products that have been subjected to testing in accordance with ANSI/UL1784, *Air Leakage Tests of Door Assemblies.*

Users of this standard are encouraged to review related codes and standards to determine the applicable requirements for a specific smoke door assembly. When competing requirements are found in the related codes and standards, the AHJ should be consulted to determine which requirements take precedence.

A.6.3 Non-fire-rated doors used as smoke doors in door openings that are not required to be protected by fire doors might be constructed of aluminum, fiberglass, hollow metal, steel, wood, or other suitable materials. Generally, non-fire-rated smoke door assemblies are required to be self-closing or automatic closing and swing easily and freely, which requires ball bearing or anti-friction bearing hinges or pivots. Smoke door assemblies are required to have positive latching hardware, unless otherwise specifically exempted by the applicable building, fire, or life safety code.

A.6.3.1 Door leaves used in smoke door assemblies without fire protection rating should be constructed of a design that resists the passage of smoke. Such doors might be 1 ¾ in. (44 mm) thick solid-bonded wood core doors, which include, but are not limited to, particleboard, agrifiber, structural composite lumber (SCL), and stave core doors. ANSI/WDMA I.S. 1A, *Industry Standard for Interior Architectural Wood Flush Doors*, and ANSI/WDMA I.S. 6A, *Industry Standard for Architectural Stile and Rail Doors*, give specifications governing the construction of solid-bonded wood core doors. Door leaves constructed of aluminum, fiberglass reinforced polyester (FRP), glass, hollow metal, and steel might also be acceptable for use in smoke door assemblies without fire protection ratings; manufacturers' technical data should be consulted to confirm the use of such door leaves in smoke door assemblies.

A.6.3.1.1 Beveling the vertical edges of composite and wood door leaves permits the door leaves to be undersized in width, from the nominal width of the door opening. This is less than doors that have squared vertical edges, thus reducing the clearance dimension between the vertical edges of the doors and the rabbets of the door frames. Industry practice is to bevel the vertical edges of doors ⅛ in.:2 in. (3 mm:51 mm), which results in a bevel of 3 degrees.

A.6.3.2.2 Door stops in the door frames are necessary elements that provide support for the installation of gasketing materials. Door frames with terminated stops are sometimes used in rooms and spaces where the floors are subject to frequent cleaning. Terminated stops convert the lowest portion of the door frames to a flat profile, eliminating corners where dirt and debris might be trapped. In these cases, smoke and draft control gasketing should extend the full height of the shortened frame soffit or door stop. See Figure A.6.3.2.2.

A.6.3.3 Additional information regarding clearances for doors can be found in ANSI/WDMA I.S. 1A, *Industry Standard for Interior Architectural Wood Flush Doors.* Clearances for stile and rail wood doors should be in accordance with ANSI/WDMA I.S. 6A, *Industry Standard for Architectural Stile and Rail Doors.* Clearances for standard hollow metal doors should be in accordance with ANSI/SDI A250.8, *Recommended Specifications for Standard Steel Doors and Frames*(SDI-100). Clearances for custom hollow metal doors should be in accordance with HMMA 840-07, *Guide Specification for Installation and Storage of Hollow Metal Doors and Frames.*

A.6.3.3.1 In some occupancies, the clearance between the bottom horizontal edge of the door and the floor covering is permitted to be a maximum of 1 in. (25 mm) on doors without fire protection ratings.

A.6.3.4 In most cases, doors are required to be equipped with positive-latching hardware. In some occupancy groups, building, fire, and life safety codes permit positive-latching hardware to be omitted on doors in smoke partitions to rooms such as toilet rooms, bathrooms, shower rooms, sink closets, and similar auxiliary spaces that do not contain flammable or combustible materials.

A.6.3.5.1 Typically, non-fire-rated interior side-hinged and pivoted doors with door closers, including smoke doors without fire protection rating, are required to have a reduced opening force of a maximum of 5 lbf (22 N) once the door leaves are set in motion, to meet accessibility standards such as ANSI A117, *Standard for Accessible and Usable Buildings and Facilities,* or the *Americans with Disabilities Act Accessibility Guidelines (ADAAG).* In some cases, a door closer with a reduced opening force might not be able to completely close a fully gasketed smoke door reliably, due to the additional pressure applied to the door when the face of the door contacts the perimeter gasketing during closing. Additionally, when positive-latching hardware is required, the door closer needs to overcome the friction of the latching hardware at the end of the closing cycle to completely close the door and cause it to latch.

Fire-rated doors are exempt from the 5 lbf (22 N) reduced opening force due to the recognized need for fire doors to reliably close and latch every time. Similarly, smoke doors without fire protection rating should be exempt from the reduced opening force requirement since their ability to resist the passage of smoke is compromised when the doors fail to close. The AHJ should be consulted for guidance when smoke doors without fire protection rating are not able to close reliably because they are equipped with reduced opening force door closers.

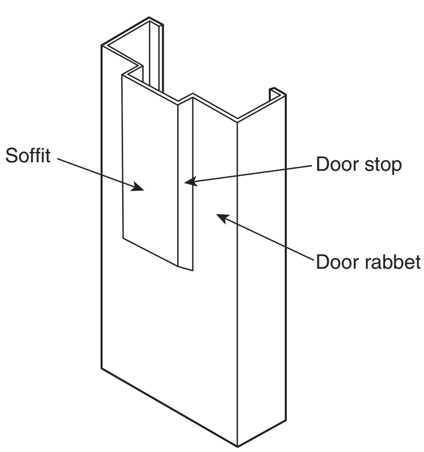

FIGURE A.6.3.2.2 Hollow Metal Door Frame with Terminated Stops.

A.6.3.6 Generally, builders hardware products include door hardware components such as conventional hinges, continuous hinges, pivots, floor concealed door closers, flush and automatic door bolts, bored and mortise locks and latches, fire exit hardware and panic hardware, surface-mounted door closers, low energy door operators, protection plates, door stops, and other hardware items. Smoke gasketing and intumescent gasketing products are considered to be builders hardware components. Builders hardware components are sold separately from the door frames and door leaves and are designed to fit into standardized preparations in the doors and frames in accordance with the ANSI/BHMA A156 series of product standards.

A.6.3.6.4 In general, NFPA 80's requirements for locks and latches are commensurate with industry practices for the installation of positive-latching hardware in smoke doors without fire protection rating and should be applied uniformly, where applicable, to smoke door assemblies.

Latching hardware devices include, but are not limited, to the following:

(1) Bored, mortise, and interconnected locks and latches
(2) Panic hardware
(3) Fire exit hardware
(4) Automatic flush bolts

A.6.3.6.6.2 In some occupancy groups, door-closing devices are not required to be installed on smoke door assemblies without fire protection ratings. In the absence of a means of holding doors open, occupants might block doors open with chocks, furniture, tie-downs, drop-down/plunger-type devices or other means. Examples of permitted door holder devices include friction catches (e.g., wall mounted, floor mounted, or overhead mounted) and magnetic catches.

Door holder/release devices for swinging doors should, wherever possible, be installed at the top of the door as close as possible to the lock edge and should be located to avoid interference with any other hardware. If necessary, the holder/release device can be located at the bottom of the door as close as possible to the lock edge, with the device installed on the wall or floor.

A.6.3.6.7 Armor, kick, mop, stretcher, and edge guards are types of protection plates. Protection plates should not be permitted to be used to conceal damage that compromises the structural integrity of the doors (i.e., split or delaminating vertical edges) or to conceal cutouts resulting from the removal of hardware items.

A.6.3.6.8 In most cases, the means of fastening for builders hardware products installed on non-fire-rated door assemblies is the same as the means of fastening for builders hardware products installed on fire-rated door assemblies. Installation practices such as drilling pilot holes or tapping holes in steel doors and frames are the same for fire-rated and non-fire-rated doors.

Some fasteners for builders hardware products have specially designed or undercut heads that are necessary to allow the fasteners to seat properly when installed. Use of fasteners from sources other than the respective hardware manufacturers should not be permitted to be used, since their use might affect door operation and might void the warranties of the affected hardware items.

A.6.5.2 The space between the glazing material and its frame or glazing bead should be completely filled with a material that is rated up to 400°F (204°C), forming a continuous seal around the perimeter of the vision panel, that resists the passage of smoke. Similarly, the space between the vision panel frame and the face of the door should be tightfitting or filled with the same material to resist the passage of smoke.

A.6.7 Gasketing for smoke door assemblies is available in a wide variety of sizes, shapes, materials, colors, and configurations. Some gasketing products are designed to be installed between the rabbet and door stops of the door frames and the doors with adhesive. Other gasketing products include aluminum or stainless steel channels of various profiles that are surface-mounted to the soffit of the door frame by means of mechanical fasteners such as sheet metal screws or self-drilling/self-tapping screws. Gasketing materials in soffit-mounted products include materials such as silicone and neoprene bulbs and sponges and nylon brushes.

A.6.7.1.1 Regardless of the design of gasketing applied to smoke door assemblies, the gasketing is of little value if it is not installed properly. The gasketing material should form an unbroken seal along the full height of the side jambs and across the head jambs and the full height of meeting edges of pairs of doors. Gasketing materials should not be permitted to be cut or notched to fit around other soffit-mounted hardware items such as door closer brackets (e.g., parallel arm brackets) or strikes for panic hardware and fire exit hardware devices. Similarly, astragals applied to the face of doors should not be permitted to be cut out or notched around protruding strike plate lips. Gasketing products should be installed in accordance with the gasketing manufacturer's installation instructions.

When properly installed, gasketing should contact the surface of the door, whether the gasketing is applied to the rabbets and stops or to the soffit area of the frame. A bright concentrated beam of light can be used to verify that the gasketing material blocks the light from passing through to the ungasketed side of the door, which should be indicative of the gasketing's ability to block the passage of smoke and gases.

A.6.7.1.2 Voids created in the door leaves, such as mortising the top rail of doors for overhead stops or concealed overhead door closers, require soffit-mounted gasketing to seal the top edge of the door. See Figure A.6.7.1.2.

A.6.7.1.3 Complete sealing of doors is not always desirable. A disadvantage of complete sealing is the difficulty of opening or closing doors because of the pressure differential. Some smoke management designs call for some areas to be pressurized. A small pressure acting across the full area of the door can exert sufficient force to make opening the door difficult. A seal must be first broken to equalize the pressure on both sides of the door before the door can be opened easily.

A.7.1 Smoke dampers are installed in ducts passing through, or air outlet openings terminating at, smoke barriers, shaft walls, horizontal exit walls, corridor walls, corridor ceilings, and other fire partitions designed to resist the spread of smoke as required by the model building code and other applicable NFPA codes and standards.

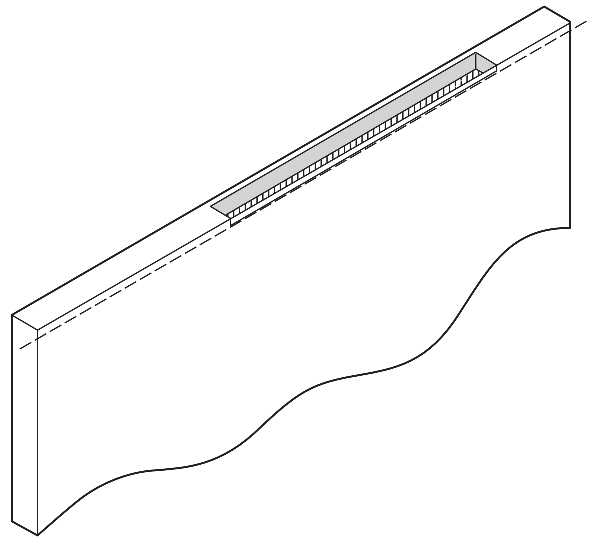

FIGURE A.6.7.1.2 Mortise Cutout in Top of Door Leaf for Overhead Door Stop. The dotted line represents the height of the door stop on the door frame. Gasketing should be installed on the soffit of the door frame so that it contacts the surface of the door below the cutout.

A.7.5.3 If the damper is equipped with a fusible link, it is not required to activate the link by heat to test the damper. Visual inspection should be made after the fusible link has been reinstalled to ensure it will not impede closing of the damper.

A.7.6.2 If the damper is arranged to be activated automatically, such as by a smoke detector or other device or system, the periodic test required by 7.6.2need not involve initiation of the detector or other device or system. The damper can be actuated and cycled as part of the associated smoke detector testing in accordance with *NFPA 72*. However, such testing does not meet all the testing and inspection requirements of NFPA 105. The *NFPA 72* testing could be combined with the inspection and testing requirements of NFPA 105, provided that all testing requirements of NFPA 105 are met. If operational issues are discovered during *NFPA 72* testing, they should be reported to the building owner for corrective measures as required by NFPA 105. For additional information, refer to NFPA 4.

A.7.6.2.2 See A.7.6.2.

A.7.7.2 Each damper should be examined to ensure that it is not rusted or blocked, with particular attention given to hinges and other moving parts.

A.8.1.1 Smoke protective curtain assemblies are not to be confused with fabric fire safety curtain assemblies, which are intended for use specifically on proscenium openings.

A.8.3.2 Sections of a smoke protective curtain may be sewn together when such joints are included in the assembly that was tested in accordance with UL 1784, *Air Leakage Tests of Door Assemblies.*

Annex B Performance-Based Option for the Inspection, Testing, and Maintenance of Smoke Door Assemblies

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 This annex provides the option to adopt a performance-based method as an alternative means of compliance with Section 5.2. Equivalent levels of performance can be demonstrated through quantitative performance-based analyses. This annex provides a basis for implementing a performance-based program acceptable under this option, provided that approval is obtained from the AHJ.

B.2 The concept of a performance-based program is to establish the type and frequency of inspection to demonstrate that the assembly is operational. The goal is to balance the inspection frequency with the proven reliability of the assembly. The goal of a performance-based inspection program is also to adjust test and inspection frequencies commensurate with documented historical equipment performance and desired reliability. Frequencies of tests and inspections under a performance-based program can be extended or reduced from the once-per-year test requirement in 5.2.5 when continued testing of door assemblies in 5.2.4, 5.2.4.4, or 5.2.4.5, as applicable, has been documented indicating a higher or lower degree of reliability compared with the AHJ's and the owner's expectations of performance. Additional program attributes that should be considered in the adjustment of test and inspection frequencies include the following:

(1) Door maintenance programs
(2) Door usage frequencies
(3) History of door repairs
(4) Building condition
(5) Consequence of failure

B.3 Fundamental to implementing a performance-based program is that adjusted test and inspection frequencies should be technically defensible to the AHJ and supported by evidence of higher or lower reliability. Data collection and retention should be established so that the data utilized to alter frequencies are representative, statistically valid, and evaluated against firm criteria. Frequencies cannot be arbitrarily extended or reduced without suitable rationale.

B.4 It must be noted that transitioning to a performance-based program requires an expenditure of resources in order to collect and analyze failure data, coordinate review efforts, change program documents, and seek approval from the AHJ. The following factors should be considered in determining whether a transition to a performance-based test program as permitted in Section 5.3 is warranted:

(1) *Past door reliability.* Have problems routinely been identified during the prescriptive test requirements of Section 5.2, or have doors consistently performed with minimal discrepancies noted?
(2) *Resource expenditures.* Do the recurring resource expenditures necessary to implement the prescriptive test requirements in Section 5.2 justify the consideration of conducting the detailed analyses needed to support a performance-based testing program?
(3) *Administrative burden.* Is there an increase to the administrative burden for implementing, documenting, and monitoring a performance-based program?

B.5 A performance-based program requires that a maximum allowable failure rate be established and approved by the AHJ in advance of implementation. The use of historic documented smoke door inspection records can be utilized to determine failure rates. One method of calculating the failure rate of smoke door assemblies is based on the following equation:

[B.5]

$$SDFR(t) = \frac{NF}{NC * t}$$

where:
$SDFR(t)$ = smoke door failure rate (failures per year)
NF = number of failures
NC = total number of smoke door assemblies inspected or tested
t = time interval of review (years)

B.6 Example. Data are collected for 50 smoke doors over a 5-year period. The testing is conducted annually as described in 5.2.5. A review of the data identifies five failures: total components, 50; data collection period, 5 years; total failures, 5.

[B.6]

$$SDFR = \frac{5}{50 \times 5} = 0.020 \text{ per year}$$

B.7 A fundamental requirement of a performance-based program is the continual monitoring of the door component failure rates and determining if they exceed the maximum allowable failure rates as agreed on with the AHJ. The process used to complete this review should be documented and repeatable.

B.8 Coupled with the ongoing review is a requirement for a formalized method of increasing or decreasing the frequency of testing and inspection when the door assemblies exhibit either a higher than expected failure rate or an increase in reliability as a result of a decrease in failures.

B.9 A formal process for reviewing the failure rates and increasing or decreasing the frequency of testing should be well documented. The frequency required for future tests can be reduced to the next inspection frequency and maintained there for a period equaling the initial data review or until the ongoing review indicates that the failure rate is no longer being exceeded.

B.10 Increases and decreases in inspection frequency should be initiated on a step approach such that increments do not exceed 50 percent of the required frequency in 5.2.4, that is, 6 months for any given period under consideration. An example would be going from annual to semi-annual testing when the failure rate exceeds the AHJ's expectations or from annual testing to testing every 18 months when the failure trend indicates an increase in reliability. The maximum time period between inspections regardless of performance should not exceed 36 months. Changes in occupancy, facility management, or ownership that could result in changes in performance should be reassessed by the AHJ to determine if continued acceptability of a performance-based inspection program is warranted.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2016 edition.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2016 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2015 edition.

NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 204, *Standard for Smoke and Heat Venting*, 2015 edition.

Operation School Burning, Official Report on a Series of School Fire Tests Conducted April 16, 1959, to June 30, 1959, by the Los Angeles Fire Department, 1959.

NFPA *Fire Protection Handbook*, 20th edition.

NFPA Technical Paper No. 341, "Factors in Controlling Smoke in High Buildings."

C.1.2 Other Publications.

C.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI A117, *Standard for Accessible and Usable Buildings and Facilities*, 2009.

C.1.2.2 ASHRAE Publications. ASHRAE, 1791 Tullie Circle, N.E., Atlanta, GA 30329-2305.

Handbook of Smoke Control Engineering, 2012.

Principles of Smoke Management, 2002.

C.1.2.3 BHMA Publications. Builders Hardware Manufacturers Association, 355 Lexington Avenue, 15th floor, New York, NY 10017.

ANSI/BHMA A156 Series of standards, 2013.

C.1.2.4 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 1784, *Air Leakage Tests of Door Assemblies*, 2009.

C.1.2.5 United States Access Board. 1331 F Street NW, Suite 1000, Washington DC, 20004-1111. www.accessboard.gov

Americans with Disabilities Act Accessibility Guidelines.

C.1.2.6 WDMA Publications. Window and Door Manufacturers Association, 2025 M Street, NW, Suite 800, Washington, DC, 20036-3309.

ANSI/WDMA I.S. 1A, *Industry Standard for Architectural Wood Flush Doors*, 2013.

ANSI/WDMA I.S. 6A, *Industry Standard for Interior Architectural Stile and Rail Doors*, 2013.

C.1.2.7 Other Publications. HMMA 840-07, *Guide Specification for Installation and Storage of Hollow Metal Doors and Frames*, 2007.

ANSI/SDI A250.8, *Recommended Specifications for Standard Steel Doors and Frames (SDI-100)*, 2014.

C.2 Informational References. (Reserved)

C.3 References for Extracts in Informational Sections.

NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.

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NFPA®110

Standard for

Emergency and Standby Power Systems

2016 Edition

This edition of NFPA 110, *Standard for Emergency and Standby Power Systems,* was prepared by the Technical Committee on Emergency Power Supplies and released by the Correlating Committee on National Electrical Code®. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

This edition of NFPA 110 was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 110

The Technical Committee on Emergency Power Supplies was organized in 1976 by NFPA in recognition of the demand for viable guidelines for the assembly, installation, and performance of electrical power systems used to supply critical and essential needs during outages of the primary power source. The intent was to establish the equipment requirements necessary to achieve an on-site auxiliary electrical power source suitable to the needs of the applicable requirements and user criteria.

In 1979, the Committee's report proposing adoption of NFPA 110 was published but withdrawn because of issues involving the scope of the committee. In 1981, a revised report was returned to the Committee to resolve differences with other NFPA documents. At the 1982 NFPA Fall Meeting, the Committee's report was adopted as a tentative standard (NFPA 110T-1983) in order to expose the document to public review.

NFPA 110 was formally adopted as a standard at the 1984 NFPA Fall Meeting and designated as the 1985 edition, which clarified scope statements, prototype testing, battery and bypass-isolation switch requirements, and revised maintenance requirements.

The 1988 edition included several new definitions and further clarified transfer switch and installation testing requirements.

The 1993 edition reflected the adoption of NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems,* a basic requirement for one-step loading for all prime movers, an update on battery technology, restrictions on unnecessary transferring of loads, and the need for battery maintenance.

The 1996 edition added revised monthly load testing requirements for generator sets, consideration for potential wet stacking, various types of fuel tanks and spillage considerations, restrictions on the types of permitted batteries, and working space requirements. It also clarified the minimum number of cranks that an engine must be capable of completing, cooling system requirements, and timing devices in health care facilities for testing a generator.

The 1999 edition deleted the testing of generator sets at 50 percent of the emergency power supply system load because the relevant measure is the nameplate rating. The exception for wet stacking was also deleted. Exhaust temperature monitoring was added because it is an acceptable performance measure of proper emergency power supply loading.

The 2002 edition was restructured to comply with the *Manual of Style for NFPA Technical Committee Documents.* Introductory material in Chapter 1 was formatted for consistency among all NFPA documents. Referenced publications were relocated from the last chapter to Chapter 2, resulting in the renumbering of chapters. Definitions in Chapter 3 were made consistent with definitions in other NFPA documents, systematically aligned, and individually numbered. Paragraphs were revised to provide one mandatory requirement per section, subsection, or paragraph. Information that accompanied many of the requirements was moved to Annex A, Explanatory Material. Many exceptions were deleted or rephrased into mandatory text.

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Changes in the 2002 edition included definitive and broad-based requirements regarding electrical installations in accordance with *NFPA 70®, National Electrical Code®*; additional EPS controls and safeguards, such as alerting staff of impending failure of the EPS to start; access and working space around the generator set; ventilation; energy converters; and EPSS testing requirements.

The 2005 edition revised clearance distances between transfer switches and service equipment, revised the definitions for both lead-acid (flooded) and valve-regulated lead-acid (VRLA) batteries, and changed the testing and maintenance section to include testing for spark-ignited engines that parallels those for diesel. Changes also included new annex material for diesel fuel testing and maintenance procedures, as well as transfer switches.

Significant revisions to the 2010 edition included the following:

(1) Clarified that the requirements to systems classed as optional standby is not mandatory
(2) Clarified that the operation testing and routine maintenance requirements of Chapter 8 cover both new and existing EPSSs
(3) Aligned the definitions of transfer switch types with NFPA 111 and relevant product standards
(4) Revised the Chapter 7 requirements for acceptance testing and differentiated what is required for new and unoccupied buildings and facilities from what is required for existing occupied buildings and facilities
(5) Revised the Chapter 8 requirements for operational test durations, loading conditions, and method of test initiation for the emergency power supply

A noteworthy change for the 2013 edition was the deletion of the mandatory 96-hour fuel supply requirement (5.1.2) for seismic categories. The need for continued operation and the minimum operational time without refueling is a design consideration or is directed by another standard. Several references to ASTM standards and additional annex material were added to address fuel quality and storage issues. The prime mover cooling and ventilation system construction and installation requirements were reorganized.

The 2016 edition prohibits the installation of an automatically actuated valve into the fuel lines, in order to prevent the inadvertent cutoff of fuel at critical times. The proper operation of systems connected in parallel has been addressed by adding acceptance testing and maintenance items for paralleling gear. In order to test all transfer switches, a requirement to rotate the transfer switch initiating the monthly test has been added where multiple transfer switches are installed. A new section consolidates record management and defines record retention requirements.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on minimizing the risk of electricity as a source of electric shock and as a potential ignition source of fires and explosions. It shall also be responsible for text to minimize the propagation of fire and explosions due to electrical installations.

Technical Committee on Emergency Power Supplies

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on performance criteria for the selection and assembly of the components for emergency and standby power systems in buildings and facilities, including categories of power supplies, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary or accessory equipment needed to supply emergency or standby power to the utilization equipment. The Committee also shall be responsible for criteria on the maintenance and testing of the system. This Committee does not cover requirements for the application of emergency power systems, self-contained emergency lighting units, and electrical wiring, except that wiring that is an integral part of the system up to the load side of the transfer switch(es). This Committee shall report to Technical Correlating Committee of the National Electrical Code.

NFPA 110

Standard for

Emergency and Standby Power Systems

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope. This standard contains requirements covering the performance of emergency and standby power systems providing an alternate source of electrical power to loads in buildings and facilities in the event that the primary power source fails.

1.1.1 Power systems covered in this standard include power sources, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary and accessory equipment needed to supply electrical power to the load terminals of the transfer equipment.

1.1.2 This standard covers installation, maintenance, operation, and testing requirements as they pertain to the performance of the emergency power supply system (EPSS).

1.1.3 This standard does not cover the following:

(1) Application of the EPSS
(2) Emergency lighting unit equipment
(3) Distribution wiring
(4) Utility service when such service is permitted as the EPSS
(5) Parameters for stored energy devices
(6) The equipment of systems that are not classed as Level 1 or Level 2 systems in accordance with Chapter 4 of this standard

1.1.4* This standard does not establish criteria for stored energy systems.

1.1.5 The selection of any of the following is not within the scope of this standard:

(1) Specific buildings or facilities, or both, requiring an EPSS
(2) Specific loads to be served by the EPSS
(3)* Assignment of type, class, or level to any specific load

1.2 Purpose. This standard contains performance requirements for an EPSS.

1.2.1 It is the role of other NFPA standards to specify which occupancies require an EPSS and the applicable level, type, and class. This standard does not specify where an EPSS is required.

1.2.2 This standard also is intended to provide guidance for inspectors, designers, installers, manufacturers, and users of EPSSs and to serve as a vehicle for communication between the parties involved. It is not intended as a design manual.

1.2.3 Compliance with this standard is not intended to exempt the parties involved from their respective responsibilities for the design, installation, maintenance, performance, or compliance with other applicable standards and codes.

1.3 Application. This document applies to new installations of EPSSs, except that the requirements of Chapter 8 shall apply to new and existing systems. Existing systems shall not be required to be modified to conform, except where the authority having jurisdiction determines that nonconformity presents a distinct hazard to life.

1.4 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this standard.

1.4.1* Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.
NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2014 edition.
NFPA 54, *National Fuel Gas Code,* 2015 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.
NFPA 70®, National Electrical Code®, 2014 edition.
NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.
NFPA 99, *Health Care Facilities Code,* 2015 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.

2.3 Other Publications.

2.3.1 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191.

ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures,* 2010.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code,*2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents*.

3.3 General Definitions.

3.3.1* Battery Certification. The certification by a battery manufacturer that a battery is built to industry standards.

3.3.2 Black Start. Where the stored energy system has the capability to start the prime mover without using energy from another source.

3.3.3* Emergency Power Supply (EPS). The source of electric power of the required capacity and quality for an emergency power supply system (EPSS).

3.3.4* Emergency Power Supply System (EPSS). A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power.

3.3.5 Fuel Tank.

3.3.5.1 ***Day Fuel Tank.*** A fuel tank, located inside a structure, that provides fuel to the engine.

3.3.5.2 ***Enclosed Fuel Tank.*** A fuel tank located within a separate room, separated from other equipment.

3.3.5.3 ***Integral Fuel Tank in EPS Systems.*** A fuel tank furnished by the EPS supplier and mounted on the engine or under as a subbase.

3.3.5.4 ***Main Fuel Tank.*** A separate, main fuel tank for supplying fuel to the engine or a day tank.

3.3.6 Lamp. An illuminating indicator.

3.3.7 Lead-Acid Battery.

3.3.7.1* ***Valve-Regulated (VRLA).*** A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount. [**1:**2015]

3.3.7.2* ***Vented (Flooded).*** A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte.

3.3.8 Occupancy Category. See ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures.*

3.3.9 Qualified Person. One who has skills and knowledge related to the operation, maintenance, repair, and testing of the EPSS equipment and installations and has received safety training to recognize and avoid the hazards involved.

3.3.10 Switch.

3.3.10.1 ***Automatic Transfer Switch (ATS).*** Self-acting equipment for transferring the connected load from one power source to another power source.

3.3.10.2 ***Bypass-Isolation Switch.*** A manually operated device used in conjunction with an automatic transfer switch to provide a means of directly connecting load conductors to a power source and disconnecting the automatic transfer switch.

3.3.10.3 ***Nonautomatic Transfer Switch.*** A device, operated manually by a physical action or electrically by either a local or remote control, for transferring a common load between a normal and alternate supply.

Chapter 4 Classification of Emergency Power Supply Systems (EPSSs)

4.1* General. The EPSS shall provide a source of electrical power of required capacity, reliability, and quality to loads for a length of time as specified in Table 4.1(a) and within a specified time following loss or failure of the normal power supply as specified in Table 4.1(b).

4.2* Class. The class defines the minimum time, in hours, for which the EPSS is designed to operate at its rated load without being refueled or recharged. *[See Table 4.1(a).]*

4.3 Type. The type defines the maximum time, in seconds, that the EPSS will permit the load terminals of the transfer switch to be without acceptable electrical power. Table 4.1(b) provides the types defined by this standard.

4.4* Level. This standard recognizes two levels of equipment installation, performance, and maintenance.

4.4.1* Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

4.4.2* Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

4.4.3* All equipment shall be permanently installed.

4.4.4* Level 1 and Level 2 systems shall ensure that all loads served by the EPSS are supplied with alternate power that meets all the following criteria:

(1) Of a quality within the operating limits of the load
(2) For a duration specified for the class as defined in Table 4.1(a)
(3) Within the time specified for the type as defined in Table 4.1(b)

Table 4.1(a) Classification of EPSSs

Class	Minimum Time
Class 0.083	0.083 hr (5 min)
Class 0.25	0.25 hr (15 min)
Class 2	2 hr
Class 6	6 hr
Class 48	48 hr
Class X	Other time, in hours, as required by the application, code, or user

Table 4.1(b) Types of EPSSs

Designation	Power Restoration
Type U	Basically uninterruptible (UPS systems)
Type 10	10 sec
Type 60	60 sec
Type 120	120 sec
Type M	Manual stationary or nonautomatic — no time limit

Chapter 5 Emergency Power Supply (EPS): Energy Sources, Converters, and Accessories

5.1 Energy Sources.

5.1.1* The following energy sources shall be permitted to be used for the emergency power supply (EPS):

(1)* Liquid petroleum products at atmospheric pressure as specified in the appropriate ASTM standards and as recommended by the engine manufacturer
(2)* Liquefied petroleum gas (liquid or vapor withdrawal) as specified in the appropriate ASTM standards and as recommended by the engine manufacturer
(3)* Natural or synthetic gas

Exception: For Level 1 installations in locations where the probability of interruption of off-site fuel supplies is high, on-site storage of an alternate energy source sufficient to allow full output of the EPSS to be delivered for the class specified shall be required, with the provision for automatic transfer from the primary energy source to the alternate energy source.

5.1.2 The energy sources listed in 5.1.1 shall be permitted to be used for the EPS where the primary source of power is by means of on-site energy conversion, provided that there is separately dedicated energy conversion equipment on-site with a capacity equal to the power needs of the EPSS.

5.1.3* A public electric utility that has a demonstrated reliability shall be permitted to be used as the EPS where the primary source is by means of on-site energy conversion.

5.2 Energy Converters — General.

5.2.1 Energy converters shall consist only of rotating equipment as indicated in 5.2.4.

5.2.1.1 Level 1 energy converters shall be representative products built from components that have proven compatibility and reliability and are coordinated to operate as a unit.

5.2.1.2 The capability of the energy converter, with its controls and accessories, to survive without damage from common and abnormal disturbances in actual load circuits shall be demonstrable by tests on separate prototype models, or by acceptable tests on the system components as performed by the component suppliers, or by tests performed in the listing process for the assembly.

5.2.1.3 A separate prototype unit shall be permitted to be utilized in a Level 1 or Level 2 installation, provided that all prototype tests produce no deleterious effects on the unit, and the authority having jurisdiction, the owner, and the user are informed that the unit is the prototype test unit.

5.2.2* The rotating equipment prototype unit shall be tested with all typical prime mover accessories that affect its power output in place and operating, including, but not limited to, the following:

(1) Battery-charging alternator
(2) Water pump
(3) Radiator fan for unit-mounted radiators or oil coolers (or comparable load)
(4) Fuel pump and fuel filter(s)
(5) Air filter(s)
(6) Exhaust mufflers or restriction simulating the maximum backpressure recommended by the prime mover manufacturer

5.2.3 The energy converter for Level 1 systems shall be specifically designed, assembled, and tested to ensure system operation under the following conditions:

(1) Short circuits
(2) Load surges due to motor starting
(3) Elevator operations
(4) Silicon controlled rectifier (SCR) controllers
(5) X-ray equipment
(6) Overspeed, overtemperature, or overload
(7) Adverse environmental conditions

5.2.4 Rotating equipment shall consist of a generator driven by one of the following prime mover types:

(1) Otto cycle (spark ignited)
(2) Diesel cycle
(3) Gas turbine cycle

5.2.4.1 Other types of prime movers and their associated equipment meeting the applicable performance requirements of this standard shall be permitted, if acceptable to the authority having jurisdiction.

5.2.4.2 Where used for Level 1 applications, the prime mover shall not mechanically drive any equipment other than its operating accessories and its generator.

5.2.5 The EPS shall be installed in accordance with *NFPA 70, National Electrical Code*.

5.3 Energy Converters — Temperature Maintenance.

5.3.1 The EPS shall be heated as necessary to maintain the water jacket and battery temperature determined by the EPS manufacturer for cold start and load acceptance for the type of EPSS.

5.3.2 All prime mover heaters shall be automatically deactivated while the prime mover is running. *(For combustion turbines, see 5.3.5.)*

5.3.2.1 Air-cooled prime movers shall be permitted to employ a heater to maintain lubricating oil temperature as recommended by the prime mover manufacturer.

5.3.3 Antifreeze protection shall be provided according to the manufacturer's recommendations.

5.3.4 Ether-type starting aids shall not be permitted.

5.3.5 The ambient air temperature in the EPS equipment room or outdoor housing containing Level I rotating equipment shall be not less than 4.5°C (40°F).

5.4* Energy Converters — Capacity. The energy converters shall have the required capacity and response to pick up and carry the load within the time specified in Table 4.1(b) after loss of primary power.

5.5 Energy Converters — Fuel Supply.

5.5.1 The fuel supplies specified in 5.1.1(1) and 5.1.1(2) for energy converters intended for Level 1 use shall not be used for any other purpose. *(For fuel system requirements, see Section 7.9.)*

5.5.1.1 Enclosed fuel tanks shall be permitted to be used for supplying fuel for other equipment, provided that the drawdown level or other passive features are designed into the fuel system to guarantee that the required quantity of fuel is available for the EPSS.

5.5.1.2 Vapor-withdrawal LP-Gas systems shall have a dedicated fuel supply.

5.5.2* A low-fuel sensing switch shall be provided for the main fuel supply tank(s) using the energy sources listed in 5.1.1(1) and 5.1.1(2) to indicate when less than the minimum fuel necessary for full load running, as required by the specified class in Table 4.1(a), remains in the main fuel tank.

5.5.3* The main fuel tank shall have a minimum capacity of at least 133 percent of either the low-fuel sensor quantity specified in 5.5.2 or the quantity required to support the duration of run specified in Table 4.1(a).

5.6 Rotating Equipment.

5.6.1 General. Prime movers and accessories shall comply with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, except as modified in this standard.

5.6.2 Prime Mover Ratings. Proper derating factors, such as altitudes, ambient temperature, fuel energy content, accessory losses, and site conditions as recommended by the manufacturer of the generator set shall be used in determining whether or not brake power meets the connected load requirements.

5.6.3 Prime Mover Accessories.

5.6.3.1 Governors shall maintain a bandwidth of rated frequency for any constant load (steady-state condition) that is compatible with the load.

5.6.3.1.1 The frequency droop between no load and full load shall be within the range for the load.

5.6.3.1.2 The frequency dip upon one-step application of the full load shall not be outside the range for the load, with a return to steady-state conditions occurring within the requirements of the load.

5.6.3.2 Solenoid valves, where used, both in the fuel line from the supply or day tank closest to the generator set and in the water-cooling lines, shall operate from battery voltage.

5.6.3.2.1 Solenoid valves shall have a manual (nonelectric) operation, or a manual bypass valve shall be provided.

5.6.3.2.1.1 The manual bypass valve shall be visible and accessible and its purpose identified.

5.6.3.2.1.2 The fuel bypass valve shall not be the valve used for malfunction or emergency shutdown.

5.6.3.3 The prime mover shall be provided with the following instruments:

(1) Oil pressure gauge to indicate lubricating oil pressure when a pressurized lubricating system is provided
(2) Temperature gauge to indicate cooling medium temperature when a liquid medium cooling system is used
(3) Hour meter to indicate actual total running time
(4) Battery-charging meter indicating performance of prime mover–driven battery charging means
(5) Other instruments as recommended or provided by the prime mover manufacturer where required for maintenance

5.6.3.4 The instruments required in 5.6.3.3(1) through 5.6.3.3(4) shall be placed on an enclosed panel, located in proximity to or on the energy converter, in a location that allows maintenance personnel to observe them readily. The enclosed panel shall be mounted by means of antishock vibration mountings if mounted on the energy converter.

5.6.3.5 All wiring for connection to the control panel shall be harnessed or flexibly enclosed, shall be securely mounted on the prime mover to prevent chafing and vibration damage, and shall terminate at the control panel in an enclosed box or panel. *(For control panel requirements, see 5.6.5.)*

5.6.3.6 The generator set shall be fitted with an integral accessory battery charger, driven by the prime mover and automatic voltage regulator, and capable of charging and maintaining the starting battery unit (and control battery, where used) in a fully charged condition during a running condition.

5.6.3.6.1 A battery charger driven by the prime mover shall not be required, provided the automatic battery charger has a high-low rate capable of fully charging the starting battery during running conditions as specified in 5.6.3.6.

5.6.4 Prime Mover Starting Equipment.

5.6.4.1 Starting Systems. Starting shall be accomplished using either an electric starter or a stored energy starting system.

5.6.4.1.1 Electric starter systems shall start using a positive shift solenoid to engage the starter motor and to crank the prime mover for the period specified in 5.6.4.2 without overheating, at a speed at least equal to that recommended by the manufacturer of the prime mover and at the lowest ambient temperature anticipated at the installation site.

5.6.4.1.2 Other types of stored energy starting systems (except pyrotechnic) shall be permitted to be used where recommended by the manufacturer of the prime mover and subject to approval of the authority having jurisdiction, under the following conditions:

(1) Where two complete periods of cranking cycles are completed without replacement of the stored energy
(2) Where a means for automatic restoration from the emergency source of the stored energy is provided
(3) Where the stored energy system has the cranking capacity specified in 5.6.4.2.1
(4) Where the stored energy system has a "black start" capability in addition to normal discharge capability

5.6.4.2* Otto or Diesel Cycle Prime Movers. For otto or diesel cycle prime movers, the type and duration of the cranking cycle shall be as specified in Table 5.6.4.2.

5.6.4.2.1 A complete cranking cycle shall consist of an automatic crank period of approximately 15 seconds followed by a rest period of approximately 15 seconds. Upon starting and running the prime mover, further cranking shall cease.

5.6.4.2.2 Two means of cranking termination shall be utilized so that one serves as backup to prevent inadvertent starter engagement.

5.6.4.2.3 Otto cycle prime movers of 15 kW and lower and all diesel prime movers shall be permitted to use continuous cranking methods.

5.6.4.3* Number of Batteries. Each prime mover shall be provided with both of the following:

(1) Storage battery units as specified in Table 5.6.4.2
(2) A storage rack for each battery or battery unit

Table 5.6.4.2 Starting Equipment Requirements

	Starting Equipment Requirements	Level 1	Level 2
(a)	Battery unit	X	X
(b)	Battery certification	X	NA
(c)	Cycle cranking	X or O	O
(d)	Cranking limiter time-outs		
	Cycle crank (3 cycles)	75 sec	75 sec
	Continuous crank	45 sec	45 sec
(e)	Float-type battery charger	X	X
	dc ammeter	X	X
	dc voltmeter	X	X
(f)	Recharge time	24 hr	36 hr
(g)	Low battery voltage alarm contacts	X	X

X: Required. O: Optional. NA: Not applicable.

5.6.4.4* Size of Batteries. The battery unit shall have the capacity to maintain the cranking speed recommended by the prime mover manufacturer through two complete periods of cranking limiter time-outs as specified in Table 5.6.4.2, item (d).

5.6.4.5 Type of Battery. The battery shall be of the nickel-cadmium or lead-acid type.

5.6.4.5.1* Lead-acid batteries shall be furnished as charged when wet. Drain-dry batteries or dry-charged lead-acid batteries shall be permitted.

5.6.4.5.2 When furnished, vented nickel-cadmium batteries shall be filled and charged and shall have listed flip-top, flame arrester vent caps.

5.6.4.5.3 The manufacturer shall provide installation, operation, and maintenance instructions and, for batteries shipped dry, electrolyte mixing instructions.

5.6.4.5.4 Batteries shall not be installed until the battery charger is in service.

5.6.4.5.5 All batteries used in this service shall have been designed for this duty and shall have demonstrable characteristics of performance and reliability acceptable to the authority having jurisdiction.

5.6.4.5.6 Batteries shall be prepared for use according to the battery manufacturer's instructions.

5.6.4.6* Automatic Battery Charger. In addition to the prime mover– (engine-) driven charger required in 5.6.3.6.1, a battery charger(s), as required in Table 5.6.4.2, shall be supplied for maintaining a charge on both the starting and control battery unit.

5.6.4.7 All chargers shall include the following characteristics, which are to be accomplished without manual intervention (i.e., manual switch or manual tap changing):

(1) At its rated voltage, the charger shall be capable of delivering energy into a fully discharged battery unit without damaging the battery.
(2) The charger shall be capable of returning the fully discharged battery to 100 percent of its ampere-hour rating within the time specified in Table 5.6.4.2, item (f).
(3) As specified in Table 5.6.4.2, item (e), meters with an accuracy within 5 percent of range shall be furnished.

(4) The charger shall be permanently marked with the following:
   (a) Allowable range of battery unit capacity
   (b) Nominal output current and voltage
   (c) Sufficient battery-type data to allow replacement batteries to be obtained
(5) The battery charger output and performance shall be compatible with the batteries furnished.

5.6.5 Control Functions.

5.6.5.1 A control panel shall be provided and shall contain the following:

(1) Automatic remote start capability
(2) "Run-off-automatic" switch
(3) Shutdowns as required by 5.6.5.2(3)
(4) Alarms as required by 5.6.5.2(4)
(5) Controls as required by 5.6.5.2(5)

5.6.5.2 Where a control panel is mounted on the energy converter, it shall be mounted by means of antivibration shock mounts, if required, to maximize reliability. An automatic control and safety panel shall be a part of the EPS containing the following equipment or possess the following characteristics, or both:

(1) Cranking control equipment to provide the complete cranking cycle described in 5.6.4.2 and required by Table 5.6.4.2
(2) Panel-mounted control switch(es) marked "run–off–automatic" to perform the following functions:
   (a) Run: Manually initiate, start, and run prime mover
   (b) Off: Stop prime mover or reset safeties, or both
   (c) Automatic: Allow prime mover to start by closing a remote contact and stop by opening the remote contact
(3) Controls to shut down and lock out the prime mover under any of the following conditions:
   (a) Failing to start after specified cranking time
   (b) Overspeed
   (c) Low lubricating-oil pressure
   (d) High engine temperature (An automatic engine shutdown device for high lubricating-oil temperature shall not be required.)
   (e) Operation of remote manual stop station
(4) Individual alarm indication to annunciate any of the conditions listed in Table 5.6.5.2 and with the following characteristics:
   (a) Battery powered
   (b) Visually indicated
   (c) Have additional contacts or circuits for a common audible alarm that signals locally and remotely when any of the itemized conditions occurs
   (d) Have a lamp test switch(es) to test the operation of all alarm lamps
(5) Controls to shut down the prime mover upon removal of the initiating signal or manual emergency shutdown
(6) The ac instruments listed in 5.6.9.9

5.6.5.3 Engines equipped with a maintaining shutdown device (air shutdown damper) shall have a set of contacts that monitor the position of this device, with local alarm indication and remote annunciation in accordance with Table 5.6.5.2.

5.6.5.4 The control panel in 5.6.5.2(4) shall be specifically approved for either a Level 1 or a Level 2 EPS consistent with the installation.

5.6.5.5 The cranking cycle shall be capable of being initiated by any of the following:

(1) Manual start initiation as specified in 5.6.5.2(2)(a).
(2) Loss of normal power at any automatic transfer switch (ATS) considered a part of the EPSS. Prime mover shall start upon closing of a remote switch or contacts and shall stop, after appropriate time delays, when switch or contacts are opened.
(3) Clock exerciser located in an ATS or in the control panel.
(4) Manually operated (test) switch located in each ATS that simulates a loss of power and causes automatic starting and operation until this switch is reset, to cause the engine circuit to duplicate its functions in the same manner commercial power is restored after a true commercial power failure.

5.6.5.6* All installations shall have a remote manual stop station of a type to prevent inadvertent or unintentional operation located outside the room housing the prime mover, where so installed, or elsewhere on the premises where the prime mover is located outside the building.

5.6.5.6.1 The remote manual stop station shall be labeled.

5.6.6* Remote Controls and Alarms. A remote, common audible alarm shall be provided as specified in 5.6.5.2(4).

5.6.6.1 Alarms and annunciation shall be powered by the prime mover starting battery unless operational constraints make this impracticable. In that circumstance an alternate source from the EPS, such as a storage battery, UPS, or branch circuit supplied by the EPSS, shall be permitted.

5.6.6.2 The following annunciation shall be provided at a minimum:

(1) For Level 1 EPS, local annunciation and facility remote annunciation, or local annunciation and network remote annunciation
(2) For Level 2 EPS, local annunciation

5.6.6.3 For the purposes of defining the types of annunciation in 5.6.6.2, the following shall apply:

(1) Local annunciation is located on the equipment itself or within the same equipment room.
(2) Facility remote annunciation is located on site but not within the room where the equipment is located.
(3) Network remote annunciation is located off site.

5.6.6.4 An alarm-silencing means shall be provided, and the panel shall include repetitive alarm circuitry so that, after the audible alarm has been silenced, it reactivates after the fault condition has been cleared and has to be restored to its normal position to be silenced again.

5.6.6.5 In lieu of the requirement in 5.6.6.4, a manual alarm-silencing means shall be permitted that silences the audible alarm after the occurrence of the alarm condition, provided such means do not inhibit any subsequent alarms from sounding the audible alarm again without further manual action.

5.6.7 Prime Mover Cooling Systems. Cooling systems for prime movers shall be either forced-air or natural convection, liquid-cooled, or a combination thereof.

Table 5.6.5.2 Safety Indications and Shutdowns

	Level 1			Level 2		
Indicator Function (at Battery Voltage)	**CV**	**S**	**RA**	**CV**	**S**	**RA**
(a) Overcrank	X	X	X	X	X	O
(b) Low water temperature	X	NA	X	X	NA	O
(c) High engine temperature pre-alarm	X	NA	X	O	NA	NA
(d) High engine temperature	X	X	X	X	X	O
(e) Low lube oil pressure	X	X	X	X	X	O
(f) Overspeed	X	X	X	X	X	O
(g) Low fuel main tank	X	NA	X	O	NA	O
(h) Low coolant level	X	O	X	X	O	X
(i) EPS supplying load	X	NA	NA	O	NA	NA
(j) Control switch not in automatic position	X	NA	X	X	NA	X
(k) High battery voltage	X	NA	NA	O	NA	NA
(l) Low cranking voltage	X	NA	X	O	NA	O
(m) Low voltage in battery	X	NA	NA	O	NA	NA
(n) Battery charger ac failure	X	NA	NA	O	NA	NA
(o) Lamp test	X	NA	NA	X	NA	NA
(p) Contacts for local and remote common alarm	X	NA	X	X	NA	X
(q) Audible alarm silencing switch	NA	NA	X	NA	NA	O
(r) Low starting air pressure	X	NA	NA	O	NA	NA
(s) Low starting hydraulic pressure	X	NA	NA	O	NA	NA
(t) Air shutdown damper when used	X	X	X	X	X	O
(u) Remote emergency stop	NA	X	NA	NA	X	NA

CV: Control panel–mounted visual. S: Shutdown of EPS indication. RA: Remote audible. X: Required. O: Optional. NA: Not applicable.
Notes:
(1) Item (p) shall be provided, but a separate remote audible signal shall not be required when the regular work site in 5.6.6 is staffed 24 hours a day.
(2) Item (b) is not required for combustion turbines.
(3) Item (r) or (s) shall apply only where used as a starting method.
(4) Item (i) EPS ac ammeter shall be permitted for this function.
(5) All required CV functions shall be visually annunciated by a remote, common visual indicator.
(6) All required functions indicated in the RA column shall be annunciated by a remote, common audible alarm as required in 5.6.5.2(4).
(7) Item (g) on gaseous systems shall require a low gas pressure alarm.
(8) Item (b) shall be set at 11°C (20°F) below the regulated temperature determined by the EPS manufacturer as required in 5.3.1.

5.6.7.1 Forced-air-cooled diesel or otto cycle engines shall have an integral fan selected to cool the prime mover under full load conditions.

5.6.7.2 Liquid-cooled prime movers for Level 1 applications shall be arranged for closed-loop cooling and consist of one of the following types:

(1) Unit-mounted radiator and fan
(2) Remote radiator
(3) Heat exchanger (liquid-to-liquid)

5.6.7.3 Cooling systems shall prevent overheating of prime movers under conditions of highest anticipated ambient temperature at the installed elevation (above sea level) when fully loaded.

5.6.7.4* Power for fans and pumps on remote radiators and heat exchangers shall be supplied from a tap at the EPS output terminals or ahead of the first load circuit overcurrent protective device.

5.6.7.5 The secondary side of heat exchangers shall be a closed-loop cycle, that is, one that recycles the cooling agent.

5.6.7.6 The installed EPS cooling system shall be designed to cool the prime mover at full-rated load while operating in the particular installation circumstances of each EPS.

5.6.7.7 A full-load on-site test shall not result in activation of high-temperature pre-alarm or high-temperature shutdown.

5.6.7.8 For EPSS cooling systems requiring intermittent or continuous waterflow or pressure, or both, a utility, city, or other water supply service shall not be used.

5.6.7.9 The EPSS cooling system shall be permitted to use utility or city water for filling or makeup water.

5.6.7.10 Design of the EPS cooling system shall consider the following factors:

(1) Remote radiator or heat exchanger sizing
(2) Pipe sizing
(3) Pump sizing
(4) Sufficient shutoffs to isolate equipment to facilitate maintenance
(5) The need for and sizing of de-aeration and surge tanks
(6) Drain valves for cleaning and flushing the cooling system
(7) Type of flexible hoses between the prime mover and the cooling system piping

5.6.8 Prime Mover Exhaust Piping. Where applicable, the exhaust system shall include a muffler or silencer sized for the unit and a flexible exhaust section.

5.6.9 Generators, Exciters, and Voltage Regulators. Generators shall comply with Article 445 of *NFPA 70*, *National Electrical Code*, and with the requirements of 5.6.9.1 through 5.6.9.9.

5.6.9.1* The generator shall be of dripproof construction and have amortisseur windings.

5.6.9.2 The generator shall be suitable for the environmental conditions at the installation location.

5.6.9.3 The generator systems shall be factory tested as a unit to ensure operational integrity of all of the following:

(1) Generator
(2) Exciter
(3) Voltage regulator

5.6.9.4 EPS voltage output, or the output of the transformer immediately down-line from the EPS, at full load shall match the nominal voltage of the normal source at the transfer switch(es).

5.6.9.5 Exciters, where furnished, shall be of either the rotating type or the static type.

5.6.9.6 Voltage regulators shall be capable of responding to load changes to meet the system stability requirements of 5.6.9.8.

5.6.9.7 If the system stability requirements of 5.6.9.8 cannot be accomplished, anti-hunt provisions shall be included.

5.6.9.8 Generator system performance (i.e., prime mover, generator, exciter, and voltage regulator, as applicable when prototype tested as specified in 5.2.1.2) shall be as follows:

(1) Stable voltage and frequency at all loads shall be provided to full-rated loads.
(2) Values consistent with the user's needs for frequency droop and voltage droop shall be maintained.
(3) Voltage dip at the generator terminals for the maximum anticipated load change shall not cause disruption or relay dropout in the load.
(4) Frequency dip and restoration to steady state for any sudden load change shall not exceed the user's specified need.

5.6.9.9 The generator instrument panel for Level 1 applications shall contain the following:

(1) An ac voltmeter(s) for each phase or a phase selector switch
(2) An ac ammeter(s) for each phase or a phase selector switch
(3) A frequency meter
(4) A voltage-adjusting feature to allow ± 5 percent voltage adjustment

5.6.10 Miscellaneous Requirements.

5.6.10.1 Where applicable, the prime mover and generator shall be factory mounted on a common base, rigid enough to maintain the dynamic alignment of the rotating element of the system prior to shipment to the installation site.

5.6.10.2 A certification shall be supplied with the unit that verifies the torsional vibration compatibility of the rotating element of the prime mover and generator for the intended use of the energy converter.

5.6.10.3* Vibration isolators shall be furnished where necessary to minimize vibration transmission to the permanent structure.

5.6.10.4 The manufacturer of the EPS shall submit complete schematic, wiring, and interconnection diagrams showing all terminal and destination markings for all EPS equipment, as well as the functional relationship between all electrical components.

5.6.10.5 The energy converter supplier shall stipulate compliance and performance with this standard for the entire unit when installed.

5.6.10.6 Where requested, the short circuit current capability at the generator output terminals shall be furnished.

Chapter 6 Transfer Switch Equipment

6.1 General.

6.1.1* Switches shall transfer electric loads from one power source to another.

6.1.2* The electrical rating shall be sized for the total load that is designed to be connected.

6.1.3 Each switch shall be in a separate enclosure or compartment.

6.1.4 The switch, including all load current-carrying components, shall be listed for all load types to be served.

6.1.5 The switch, including all load current-carrying components, shall be designed to withstand the effects of available fault currents.

6.1.6* Where available, each switch shall be listed for emergency service as a completely factory-assembled and factory-tested apparatus. Medium voltage transfer of central plant or mechanical equipment not including life safety, emergency, or critical branch loads shall be permitted to be transferred by electrically interlocked medium voltage circuit breakers.

6.2 ATS Features.

6.2.1* General. Automatic transfer switches shall be capable of all of the following:

(1) Electrical operation and mechanical holding
(2) Transfer and retransfer of the load automatically
(3) Visual annunciation when “not-in-automatic”

6.2.2 Source Monitoring.

6.2.2.1* Undervoltage-sensing devices shall be provided to monitor all ungrounded lines of the primary source of power as follows:

(1) When the voltage on any phase falls below the minimum operating voltage of any load to be served, the transfer switch shall automatically initiate engine start and the process of transfer to the EPS.
(2)* When the voltage on all phases of the primary source returns to within specified limits for a designated period of time, the process of transfer back to primary power shall be initiated.

6.2.2.2 Both voltage-sensing and frequency-sensing equipment shall be provided to monitor one ungrounded line of the EPS.

6.2.2.3 Transfer to the EPS shall be inhibited until the voltage and frequency are within a specified range to handle loads to be served.

6.2.2.3.1 Sensing equipment shall not be required in the transfer switch, provided it is included with the engine control panel.

6.2.2.3.2 Frequency-sensing equipment shall not be required for monitoring the public utility source where used as an EPS, as permitted by 5.1.3.

6.2.3* Interlocking. Mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the primary power supply and the EPS, or any two separate sources of power.

6.2.4* Manual Operation. Instruction and equipment shall be provided for safe manual nonelectric transfer in the event the transfer switch malfunctions.

6.2.5* Time Delay on Starting of EPS. A time-delay device shall be provided to delay starting of the EPS. The timer shall prevent nuisance starting of the EPS and possible subsequent load transfer in the event of harmless momentary power dips and interruptions of the primary source.

6.2.6 Time Delay at Engine Control Panel. Time delays shall be permitted to be located at the engine control panel in lieu of in the transfer switches.

6.2.7 Time Delay on Transfer to EPS. An adjustable time-delay device shall be provided to delay transfer and sequence load transfer to the EPS to avoid excessive voltage drop when the transfer switch is installed for Level 1 use.

6.2.7.1 Time Delay Commencement. The time delay shall commence when proper EPS voltage and frequency are achieved.

6.2.7.2 Time Delay at Engine Control Panel. Time delays shall be permitted to be located at the engine control panel in lieu of in the transfer switches.

6.2.8* Time Delay on Retransfer to Primary Source. An adjustable time-delay device with automatic bypass shall be provided to delay retransfer from the EPS to the primary source of power and to allow the primary source to stabilize before retransfer of the load.

6.2.9 Time Delay Bypass If EPS Fails. The time delay shall be automatically bypassed if the EPS fails.

6.2.9.1 The transfer switch shall be permitted to be programmed for a manually initiated retransfer to the primary source to provide for a planned momentary interruption of the load.

6.2.9.2 If used, the arrangement in 6.2.9.1 shall be provided with a bypass feature to allow automatic retransfer in the event that the EPS fails and the primary source is available.

6.2.10 Time Delay on Engine Shutdown. A minimum time delay of 5 minutes shall be provided for unloaded running of the EPS prior to shutdown to allow for engine cooldown.

6.2.10.1 The minimum 5-minute delay shall not be required on small (15 kW or less) air-cooled prime movers.

6.2.10.2 A time-delay device shall not be required, provided it is included with the engine control panel, or if a utility feeder is used as an EPS.

6.2.11 Engine Generator Exercising Timer. A program timing device shall be provided to exercise the EPS as described in Chapter 8.

6.2.11.1 Transfer switches shall transfer the connected load to the EPS and immediately return to primary power automatically in case of an EPS failure.

6.2.11.2 Exercising timers shall be permitted to be located at the engine control panel in lieu of in the transfer switches.

6.2.11.3 A program timing device shall not be required in health care facilities that provide scheduled testing in accordance with NFPA 99, *Health Care Facilities Code*.

6.2.12 Test Switch. A test means shall be provided on each ATS that simulates failure of the primary power source and then transfers the load to the EPS.

6.2.13* Indication of Transfer Switch Position. Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate the transfer switch position.

6.2.14 Motor Load Transfer. Provisions shall be included to reduce currents resulting from motor load transfer if such currents could damage EPSS equipment or cause nuisance tripping of EPSS overcurrent protective devices.

6.2.15* Isolation of Neutral Conductors. Provisions shall be included for ensuring continuity, transfer, and isolation of the primary and the EPS neutral conductors wherever they are separately grounded to achieve ground-fault sensing.

6.2.16* Nonautomatic Transfer Switch Features. Switching devices shall be mechanically held and shall be operated by direct manual or electrical remote manual control.

6.2.16.1 Interlocking. Reliable mechanical interlocking or an approved alternate method shall prevent the inadvertent interconnection of the primary power source and the EPS.

6.2.16.2 Indication of Transfer Switch Position. Two pilot lights with identification nameplates or other approved position indicators shall be provided to indicate the switch position.

6.3 Load Switching (Load Shedding). When two or more engine generator sets are paralleled for emergency power, the paralleled system shall be arranged to inhibit connection of EPS-damaging loads.

6.3.1 Each transfer switch shall have a continuous current rating and interrupting rating for all classes of loads to be served.

6.3.2 The transfer switch shall be capable of withstanding the available fault current at the point of installation.

6.3.3 The transfer of loads to the EPS shall be sequenced as follows:

(1) First-priority loads shall be switched to the emergency bus upon sensing the availability of emergency power on the bus.
(2) Each time an additional engine generator set is connected to the bus, a remaining load shall be connected in

order of priority until all emergency loads are connected to the bus.

(3) The system shall be designed so that, upon failure of one or more engine generator sets, the load is automatically reduced, starting with the load of least priority and proceeding in ascending priority, so that the last load affected is the highest-priority load.

6.4 Bypass-Isolation Switches.

6.4.1 Bypassing and Isolating Transfer Switches. Bypass-isolation switches shall be permitted for bypassing and isolating the transfer switch and shall be installed in accordance with 6.4.2, 6.4.3, and 6.4.4.

6.4.2 Bypass-Isolation Switch Rating. The bypass-isolation switch shall have a continuous current rating and a current rating compatible with that of the associated transfer switch.

6.4.3* Bypass-Isolation Switch Classification. Each bypass-isolation switch shall be listed for emergency electrical service as a completely factory-assembled and factory-tested apparatus.

6.4.4* Operation. With the transfer switch isolated or disconnected, the bypass-isolation switch shall be designed so it can function as an independent nonautomatic transfer switch and allow the load to be connected to either power source.

6.4.5 Reconnection of Transfer Switch. Reconnection of the transfer switch shall be possible without a load interruption greater than the maximum time, in seconds, specified by the type of system.

6.5 Protection.

6.5.1* General. The overcurrent protective devices in the EPSS shall be coordinated to optimize selective tripping of the circuit overcurrent protective devices when a short circuit occurs.

6.5.2 Short Circuit Current. The maximum available short circuit current from both the utility source and the emergency energy source shall be evaluated for the ability to satisfy this coordination capability.

6.5.3* Overcurrent Protective Device Rating. The overcurrent protective device shall have an interrupting rating equal to or greater than the maximum available short circuit current at its location.

6.5.4 Accessibility. Overcurrent devices in EPSS circuits shall be accessible to authorized persons only.

Chapter 7 Installation and Environmental Considerations

7.1 General.

7.1.1* This chapter shall establish minimum requirements and considerations relative to the installation and environmental conditions that have an effect on the performance of the EPSS equipment such as the following:

(1) Geographic location
(2) Building type
(3) Classification of occupancy
(4) Hazard of contents

7.1.2* Minimizing the probability of equipment or cable failure within the EPSS shall be a design consideration to reduce the disruption of loads served by the EPSS.

7.1.3 The EPSS equipment shall be installed as required to meet the user's needs and to be in accordance with all of the following:

(1) This standard
(2) The manufacturer's specifications
(3) The authority having jurisdiction

7.1.4 EPSS equipment installed for the various levels of service defined in this standard shall be designed and assembled for such service.

7.1.5 When the normal power source is not available, the EPS shall be permitted to serve optional loads other than system loads, provided that the EPS has adequate capacity or automatic selective load pickup and load shedding are provided as needed to ensure adequate power to (1) the Level 1 loads, (2) the Level 2 loads, and (3) the optional loads, in that order of priority. When normal power is available, the EPS shall be permitted to be used for other purposes such as peak load shaving, internal voltage control, load relief for the utility providing normal power, or cogeneration.

7.2 Location.

7.2.1 Indoor EPS Installations. The EPS shall be installed in a separate room for Level 1 installations.

7.2.1.1 The EPS room shall be separated from the rest of the building by construction with a 2-hour fire resistance rating.

7.2.1.2 EPSS equipment shall be permitted to be installed in the EPS room.

7.2.1.3 No other equipment, including architectural appurtenances, except those that serve this space, shall be permitted in the EPS room.

7.2.2 Outdoor EPS Installations.

7.2.2.1 The EPS shall be installed in a suitable enclosure located outside the building and capable of resisting the entrance of snow or rain at a maximum wind velocity as required by local building codes.

7.2.2.2 EPSS equipment shall be permitted to be installed in the EPS enclosure.

7.2.2.3 No other equipment, including architectural appurtenances, except those that serve this space, shall be permitted in the EPS enclosure.

7.2.3* Level 1 EPSS equipment shall not be installed in the same room with the normal service equipment, where the service equipment is rated over 150 volts to ground and equal to or greater than 1000 amperes.

7.2.4* The rooms, enclosures, or separate buildings housing Level 1 or Level 2 EPSS equipment shall be designed and located to minimize damage from flooding, including that caused by the following:

(1) Flooding resulting from fire fighting
(2) Sewer water backup
(3) Other disasters or occurrences

7.2.5* Minimizing the possibility of damage resulting from interruptions of the emergency source shall be a design consideration for EPSS equipment.

7.2.6 The EPS equipment shall be installed in a location that permits ready accessibility and a minimum of 0.9 m (36 in.)

from the skid rails' outermost point in the direction of access for inspection, repair, maintenance, cleaning, or replacement. This requirement shall not apply to units in outdoor housings.

7.2.7 Design considerations shall minimize the effect of the failure of one energy converter on the continued operation of other units.

7.3 Lighting.

7.3.1 The Level 1 or Level 2 EPS equipment location(s) shall be provided with battery-powered emergency lighting. This requirement shall not apply to units located outdoors in enclosures that do not include walk-in access.

7.3.2 The emergency lighting charging system and the normal service room lighting shall be supplied from the load side of the transfer switch.

7.3.3* The minimum average horizontal illumination provided by normal lighting sources in the separate building or room housing the EPS equipment for Level 1 shall be 32.3 lux (3.0 ft-candles) measured at the floor level, unless otherwise specified by a requirement recognized by the authority having jurisdiction.

7.4 Mounting.

7.4.1 Rotating energy converters shall be installed on solid foundations to prohibit sagging of fuel, exhaust, or lubricating-oil piping and damage to parts resulting in leakage at joints.

7.4.1.1 Such foundations or structural bases shall raise the engine at least 150 mm (6 in.) above the floor or grade level and be of sufficient elevation to facilitate lubricating-oil drainage and ease of maintenance.

7.4.2 Foundations shall be of the size (mass) and type recommended by the energy converter manufacturer.

7.4.3 Where required to prevent transmission of vibration during operation, the foundation shall be isolated from the surrounding floor or other foundations, or both, in accordance with the manufacturer's recommendations and accepted structural engineering practices.

7.4.4 The EPS shall be mounted on a fabricated metal skid base of the type that shall resist damage during shipping and handling. After installation, the base shall maintain alignment of the unit during operation.

7.5* Vibration. Vibration isolators, as recommended by the manufacturer of the EPS, shall be installed either between the rotating equipment and its skid base or between the skid base and the foundation or inertia base.

7.6* Noise. Design shall include consideration of noise control regulations.

7.7 Heating, Cooling, and Ventilating.

7.7.1* With the EPS running at rated load, ventilation airflow shall be provided to limit the maximum air temperature in the EPS room or the enclosure housing the unit to the maximum ambient air temperature required by the EPS manufacturer.

7.7.1.1 Consideration shall be given to all the heat emitted to the EPS equipment room by the energy converter, uninsulated or insulated exhaust pipes, and other heat-producing equipment.

7.7.2 Air shall be supplied to the EPS equipment for combustion.

7.7.2.1* For EPS supplying Level 1 EPSS, ventilation air shall be supplied directly from a source outside the building by an exterior wall opening or from a source outside the building by a 2-hour fire-rated air transfer system.

7.7.2.2 For EPS supplying Level 1 EPSS, discharge air shall be directed outside the building by an exterior wall opening or to an exterior opening by a 2-hour fire-rated air transfer system.

7.7.2.3 Fire dampers, shutters, or other self-closing devices shall not be permitted in ventilation openings or ductwork for supply or return/discharge air to EPS equipment for Level 1 EPSS.

7.7.3 Ventilation air supply shall be from outdoors or from a source outside the building by an exterior wall opening or from a source outside the building by a 2-hour fire-rated air transfer system.

7.7.4 Ventilation air shall be provided to supply and discharge cooling air for radiator cooling of the EPS when running at rated load.

7.7.4.1 Ventilation air supply and discharge for radiator-cooled EPS shall have a maximum static restriction of 125 Pa (0.5 in. of water column) in the discharge duct at the radiator outlet.

7.7.4.2 Radiator air discharge shall be ducted outdoors or to an exterior opening by a 2-hour rated air transfer system.

7.7.5 Motor-operated dampers, when used, shall be spring operated to open and motor closed. Fire dampers, shutters, or other self-closing devices shall not be permitted in ventilation openings or ductwork for supply or return/discharge air to EPS equipment for Level 1 EPSS.

7.7.6 Units housed outdoors shall be heated as specified in 5.3.5.

7.7.7 Design of the heating, cooling, and ventilation system for the EPS equipment room shall include provision for factors including, but not limited to, the following:

(1) Heat
(2) Cold
(3) Dust
(4) Humidity
(5) Snow and ice accumulations around housings
(6) Louvers
(7) Remote radiator fans
(8) Prevailing winds blowing against radiator fan discharge air

7.8 Installed EPS Cooling System.

7.8.1 Makeup water hose bibs and floor drains, where required by other codes and standards, shall be installed in EPS equipment rooms.

7.8.2 Where duct connections are used between the prime mover radiator and air-out louvers, the ducts shall be connected to the prime movers by means of flexible sections.

7.9 Fuel System.

7.9.1 Fuel tanks shall be sized to accommodate the specific EPS class.

7.9.1.1* All fuel tanks and systems shall be installed and maintained in accordance with NFPA 30, *Flammable and Combustible Liquids Code*; NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*; NFPA 54, *National Fuel Gas Code*; and NFPA 58, *Liquefied Petroleum Gas Code*.

7.9.1.2* Fuel system design shall provide for a supply of clean fuel to the prime mover.

7.9.1.3 Tanks shall be sized so that the fuel is consumed within the storage life, or provisions shall be made to remediate fuel that is stale or contaminated or to replace stale or contaminated fuel with clean fuel.

7.9.2 Fuel tanks shall be close enough to the prime mover for the fuel lift (suction head) of the prime mover fuel pump to meet the fuel system requirements, or a fuel transfer pump and day tank shall be provided.

7.9.2.1 If the engine manufacturer's fuel pump static head pressure limits are exceeded when the level of fuel in the tank is at a maximum, a day tank shall be utilized.

7.9.3 Fuel piping shall be of compatible metal to minimize electrolysis and shall be properly sized, with vent and fill pipes located to prevent entry of groundwater or rain into the tank.

7.9.3.1* Galvanized fuel lines shall not be used.

7.9.3.2 Approved flexible fuel lines shall be used between the prime mover and the fuel piping.

7.9.4 Day tanks on diesel systems shall be installed below the engine fuel return elevation.

7.9.4.1 The return line to the day tank shall be below the fuel return elevation.

7.9.4.2 Gravity fuel oil return lines between the day tank and the main supply tank shall be sized to handle the potential fuel flow and shall be free of traps so that fuel can flow freely to the main tank.

7.9.5 Integral tanks of the following capacities shall be permitted inside or on roofs of structures, or as approved by the authority having jurisdiction:

(1) Maximum of 2498 L (660 gal) diesel fuel
(2) Maximum of 95 L (25 gal) gasoline fuel

7.9.6* The fuel supply for gas-fueled and liquid-fueled prime movers shall be installed in accordance with applicable standards.

7.9.7* Where the gas supply is connected to the building gas supply system, it shall be connected on the supply side of the main gas shutoff valve and marked as supplying an emergency generator.

7.9.8 The building's main gas shutoff valve shall be marked or tagged to indicate the existence of the separate EPS shutoff valve.

7.9.9 The fuel supply for gas-fueled and liquid-fueled prime movers shall be designed to meet the demands of the prime mover for all of the following factors:

(1) Sizing of fuel lines
(2) Valves, including manual shutoff
(3) Battery-powered fuel solenoids
(4) Gas regulators
(5) Regulator vent piping
(6) Flexible fuel line section
(7) Fuel line filters
(8) Fuel vaporizers (LP-Gas)
(9) Ambient temperature effect of fuel tank vaporization rates of LP-Gas where applicable

7.9.10 The fuel storage and supply lines for an EPSS shall be in accordance with this standard or with the specific authority having jurisdiction, or both.

7.9.11 All manual fuel system valves shall be of the indicating type.

7.9.12 Listed generator subbase secondary containment fuel tanks of 2498 L (660 gal) capacity and below shall be permitted to be installed outdoors or indoors without diking or remote impounding.

7.9.12.1 A minimum clearance of 0.9 m (36 in.) shall be maintained on all sides.

7.9.13 Automatically actuated valves shall not be permitted in the fuel oil supply or fuel oil return lines.

7.10 Exhaust System.

7.10.1 The exhaust system equipment and installation, including piping, muffler, and related accessories, shall be in accordance with NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, and other applicable standards.

7.10.2 Exhaust system installation shall be gastight to prevent exhaust gas fumes from entering inhabited rooms or buildings and terminate in such a manner that toxic fumes cannot reenter a building or structure, particularly through windows, air ventilation inlets, or the engine air-intake system.

7.10.3* Exhaust piping shall be connected to the prime mover by means of a flexible connector and shall be independently supported thereafter so that no damaging weight or stress is applied to the engine exhaust manifold or turbocharger.

7.10.3.1 A condensate trap and drain valve shall be provided at the low point(s) of the piping unless the piping is self-draining.

7.10.3.2 Design consideration shall be given to thermal expansion and the resultant movement of the piping.

7.10.3.3 For reciprocating engines, mufflers shall be placed as close as practicable to the engine, in a horizontal position if possible.

7.10.3.4 An approved thimble(s) shall be used where exhaust piping passes through combustible walls or partitions.

7.10.3.5 For reciprocating engines, the piping shall terminate in any of the following:

(1) Rain cap
(2) Tee
(3) Ell, pointing downwind from the prevailing wind
(4) Vertically upward-oriented stack with suitable provisions for trapping and draining rain and snow water

7.10.3.6 Design consideration shall be given to the potential heat effect due to proximity to all of the following:

(1) Conduit runs
(2) Fuel piping
(3) Lighting fixtures

7.10.3.7 Design consideration shall be given to insulating the engine exhaust systems in buildings after the flexible section.

7.10.4 For maximum efficiency, operation economy, and prevention of engine damage, the exhaust system shall be designed to eliminate excessive backpressure on the engine by properly selecting, routing, and installing the piping size, connections, and muffler.

7.10.4.1 Exhaust systems shall be installed to ensure satisfactory EPS operation and meet the requirements of the manufacturer.

7.11 Protection.

7.11.1 The room in which the EPS equipment is located shall not be used for other purposes that are not directly related to the EPS. Parts, tools, and manuals for routine maintenance and repair shall be permitted to be stored in the EPS room.

7.11.2* Where fire suppression systems are installed in EPS equipment rooms or separate buildings, the following systems shall not be used:

(1) Carbon dioxide or halon systems, unless prime mover combustion air is taken from outside the structure
(2) An automatic dry chemical system, unless the manufacturers of the EPS certify that the dry chemical system cannot damage the EPS system, hinder its operation, or reduce its output

7.11.3 Where the EPS rooms or separate buildings are equipped with fire detection systems, the installation shall be in accordance with *NFPA 72, National Fire Alarm and Signaling Code*.

7.11.4 Where outdoor and/or rooftop Level 1 EPS installations are required to be protected from lightning, the lightning protection system(s) shall be installed in accordance with NFPA 780, *Standard for the Installation of Lightning Protection Systems*.

7.11.5* In recognized seismic risk areas, EPS and EPSS components, such as electrical distribution lines, water distribution lines, fuel distribution lines, and other components that serve the EPS, shall be designed to minimize damage from earthquakes and to facilitate repairs if an earthquake occurs.

7.11.6* For systems in seismic risk areas, the EPS, transfer switches, distribution panels, circuit breakers, and associated controls shall be capable of performing their intended function during and after being subjected to the anticipated seismic shock.

7.12 Distribution.

7.12.1 The distribution and wiring systems within EPSS shall be installed in accordance with *NFPA 70, National Electrical Code*.

7.12.2 When EPSSs are installed in health care facilities, the installation of the EPSS shall also be in compliance with NFPA 99, *Health Care Facilities Code*.

7.12.3 The wiring between the EPS output terminals and the first distribution overcurrent protective device terminals within the EPSS shall be located at a minimal distance to ensure system reliability and safety.

7.12.4 If the conduit's point of attachment to the EPS is on the forcing function side of the EPS vibration isolation system, a flexible conduit section(s) shall be installed between the EPS unit(s) and any of the following, so attached:

(1) The transfer switch
(2) The control and annunciator wiring
(3) Any accessory supply wiring such as jacket water heaters

7.12.4.1 Stranded wire of adequate size shall be used to minimize breakage due to vibration.

7.12.4.2 Bushings shall be installed to protect wiring from abrasion with conduit terminations.

7.12.5 All ac-powered support and accessory equipment necessary to the operation of the EPS shall be supplied from the load side of the ATSs, or the output terminals of the EPS, ahead of the main EPS overcurrent protection to ensure continuity of the EPSS operation and performance.

7.12.6 The starting battery units shall be located next to the prime mover starter to minimize voltage drop.

7.12.6.1 Battery cables shall be sized to minimize voltage drop in accordance with the manufacturer's recommendations and accepted engineering practices.

7.12.6.2 Battery charger output wiring shall be permanently connected to the primary side of the starter solenoid (positive) and the EPS frame (negative), or other grounding location.

7.13 Installation Acceptance.

7.13.1 Upon completion of the installation of the EPSS, the EPS shall be tested to ensure conformity to the requirements of the standard with respect to both power output and function.

7.13.2 An on-site acceptance test shall be conducted as a final approval test for all EPSSs.

7.13.2.1 For new Level 1 installations, the EPSS shall not be considered as meeting this standard until the acceptance tests have been conducted and test requirements met.

7.13.2.2 The test shall be conducted after completion of the installation with all EPSS accessory and support equipment in place and operating.

7.13.3 The authority having jurisdiction shall be given advance notification of the time at which the acceptance test is to be performed so that the authority can witness the test.

7.13.4 The EPSS shall perform within the limits specified in this standard.

7.13.4.1 The on-site installation acceptance test shall be conducted in accordance with 7.13.4.1.1 through 7.13.4.1.4.

7.13.4.1.1* In a new and unoccupied building or facility, with the prime mover in a cold start condition and the emergency load at operating level, a normal power failure shall be initiated by opening all switches or circuit breakers supplying the normal power to the building or facility.

7.13.4.1.2* In an existing occupied building or facility, with the prime mover in a cold start condition and the emergency load at operating level, a normal power failure shall be simulated by operating at least one transfer switch test function or initiated by opening all switches or breakers supplying normal power to all ATSs that are part of the EPSS being commissioned by this initial acceptance test.

7.13.4.1.3 When the EPSS consists of paralleled EPSs, the system control function for paralleling and load shedding shall be verified in accordance with system design documentation.

7.13.4.1.4 The tests conducted in accordance with 7.13.4.1.1 and 7.13.4.1.2 shall be performed in accordance with (1) through (12).

(1) When the EPSS consists of paralleled EPSs, the quantity of EPSs intended to be operated simultaneously shall be tested simultaneously with building load for the test period identified in 7.13.4.1.4(10).
(2) The test load shall be all loads that are served by the EPSS. There is no minimum loading requirement for this portion of the test.
(3) The time delay on start shall be observed and recorded.
(4) The cranking time until the prime mover starts and runs shall be observed and recorded.
(5) The time taken to reach operating speed shall be observed and recorded.
(6)* The engine start function shall be confirmed by verifying operation of the initiating circuit of all transfer switches supplying EPSS loads.
(7) The time taken to achieve a steady-state condition with all switches transferred to the emergency position shall be observed and recorded.
(8) The voltage, frequency, and amperes shall be recorded.
(9) Where applicable, the prime mover oil pressure and water temperature shall be recorded.
(10) The load test with building load, or other loads that simulate the intended load as specified in Section 5.4, shall be continued for not less than 1.5 hours, and the run time shall be recorded.
(11) When normal power is restored to the building or facility, the time delay on retransfer to normal power for each switch with a minimum setting of 5 minutes shall be recorded.
(12) The time delay on the prime mover cooldown period and shutdown shall be recorded.

7.13.4.2 After completion of the test performed in 7.13.4.1, the prime mover shall be allowed to cool for not less than 5 minutes.

7.13.4.3* A load shall be applied for a 2-hour, full-load test. The building load shall be permitted to serve as part or all of the load, supplemented by a load bank of sufficient size to provide a load equal to 100 percent of the nameplate kW rating of the EPS, less applicable derating factors for site conditions.

7.13.4.3.1* This full-load test shall be initiated after the test specified in 7.13.4.1.4 by any method that starts the prime mover and, upon reaching rated rpm, picks up not less than 30 percent of the nameplate kW rating for the first 30 minutes, not less than 50 percent of the nameplate kW rating for the next 30 minutes, and 100 percent of the nameplate kW rating for the next 60 minutes, less applicable derating factors for site conditions.

7.13.4.3.2 A unity power factor shall be permitted for on-site testing, provided that rated load tests at the rated power factor have been performed by the manufacturer of the EPS prior to shipment.

7.13.4.3.3 Where the EPS is a paralleled multi-unit EPS, each unit shall be permitted to be tested individually at its rating.

7.13.4.3.4 The data specified in 7.13.4.1.4(4), 7.13.4.1.4(5), and 7.13.4.1.4(7) shall be recorded at first load acceptance of the test period identified in 7.13.4.1.4(10).

7.13.4.3.5 The data specified in 7.13.4.1.4(8) and 7.13.4.1.4(9) shall be recorded at first load acceptance and every 15 minutes thereafter until the completion of the test period identified in 7.13.4.1.4(10).

7.13.4.4 Any method recommended by the manufacturer for the cycle crank test shall be utilized to prevent the prime mover from running.

7.13.4.4.1 The control switch shall be set at “run” to cause the prime mover to crank.

7.13.4.4.2 The complete crank/rest cycle specified in 5.6.4.2 and Table 5.6.4.2 shall be observed.

7.13.4.4.3 The battery charge rate shall be recorded at 5-minute intervals for the first 15 minutes or until charge rate stabilization.

7.13.4.5 All safeties specified in 5.6.5 and 5.6.6 shall be tested on site as recommended by the manufacturer.

Exception: It shall be permitted for the manufacturer to test and document overcrank, high engine temperature, low lube oil pressure and overspeed safeties prior to shipment.

7.13.4.6 Items (1) through (4) shall be made available to the authority having jurisdiction at the time of the acceptance test:

(1) Evidence of the prototype test as specified in 5.2.1.2 (for Level 1 systems)
(2) A certified analysis as specified in 5.6.10.2
(3) A letter of compliance as specified in 5.6.10.5
(4) A manufacturer’s certification of a rated load test at rated power factor with the ambient temperature, altitude, and fuel grade recorded

Chapter 8 Routine Maintenance and Operational Testing

8.1* General.

8.1.1 The routine maintenance and operational testing program shall be based on all of the following:

(1) Manufacturer's recommendations
(2) Instruction manuals
(3) Minimum requirements of this chapter
(4) The authority having jurisdiction

8.1.2 Consideration shall be given to temporarily providing a portable or alternate source whenever the emergency generator is out of service and the criteria set forth in Section 4.3 cannot be met.

8.2* Manuals, Special Tools, and Spare Parts.

8.2.1 At least two sets of instruction manuals for all major components of the EPSS shall be supplied by the manufacturer(s) of the EPSS and shall contain the following:

(1) A detailed explanation of the operation of the system
(2) Instructions for routine maintenance
(3) Detailed instructions for repair of the EPS and other major components of the EPSS
(4) An illustrated parts list and part numbers

(5) Illustrated and schematic drawings of electrical wiring systems, including operating and safety devices, control panels, instrumentation, and annunciators

8.2.2 For Level 1 systems, instruction manuals shall be kept in a secure, convenient location, one set near the equipment, and the other set in a separate location.

8.2.3 Special tools and testing devices necessary for routine maintenance shall be available for use when needed.

8.2.4 Replacement for parts identified by experience as high mortality items shall be maintained in a secure location(s) on the premises.

8.2.4.1 Consideration shall be given to stocking spare parts as recommended by the manufacturer.

8.3 Maintenance and Operational Testing.

8.3.1* The EPSS shall be maintained to ensure to a reasonable degree that the system is capable of supplying service within the time specified for the type and for the time duration specified for the class.

8.3.2 A routine maintenance and operational testing program shall be initiated immediately after the EPSS has passed acceptance tests or after completion of repairs that impact the operational reliability of the system.

8.3.2.1 The operational test shall be initiated at an ATS and shall include testing of each EPSS component on which maintenance or repair has been performed, including the transfer of each automatic and manual transfer switch to the alternate power source, for a period of not less than 30 minutes under operating temperature.

8.3.3 A written schedule for routine maintenance and operational testing of the EPSS shall be established.

8.3.4* Transfer switches shall be subjected to a maintenance and testing program that includes all of the following operations:

(1) Checking of connections
(2) Inspection or testing for evidence of overheating and excessive contact erosion
(3) Removal of dust and dirt
(4) Replacement of contacts when required

8.3.5* Paralleling gear shall be subject to an inspection, testing, and maintenance program that includes all of the following operations:

(1) Checking connections
(2) Inspecting or testing for evidence of overheating and excessive contact erosion
(3) Removing dust and dirt
(4) Replacing contacts when required
(5) Verifying that the system controls will operate as intended

8.3.6* Storage batteries, including electrolyte levels or battery voltage, used in connection with systems shall be inspected weekly and maintained in full compliance with manufacturer's specifications.

8.3.6.1 Maintenance of lead-acid batteries shall include the monthly testing and recording of electrolyte specific gravity. Battery conductance testing shall be permitted in lieu of the testing of specific gravity when applicable or warranted.

8.3.6.2 Defective batteries shall be replaced immediately upon discovery of defects.

8.3.7* A fuel quality test shall be performed at least annually using appropriate ASTM standards.

8.4 Operational Inspection and Testing.

8.4.1* EPSSs, including all appurtenant components, shall be inspected weekly and exercised under load at least monthly.

8.4.1.1 If the generator set is used for standby power or for peak load shaving, such use shall be recorded and shall be permitted to be substituted for scheduled operations and testing of the generator set, providing the same record as required by 8.3.4.

8.4.2* Diesel generator sets in service shall be exercised at least once monthly, for a minimum of 30 minutes, using one of the following methods:

(1) Loading that maintains the minimum exhaust gas temperatures as recommended by the manufacturer
(2) Under operating temperature conditions and at not less than 30 percent of the EPS standby nameplate kW rating

8.4.2.1 The date and time of day for required testing shall be decided by the owner, based on facility operations.

8.4.2.2 Equivalent loads used for testing shall be automatically replaced with the emergency loads in case of failure of the primary source.

8.4.2.3* Diesel-powered EPS installations that do not meet the requirements of 8.4.2 shall be exercised monthly with the available EPSS load and shall be exercised annually with supplemental loads at not less than 50 percent of the EPS nameplate kW rating for 30 continuous minutes and at not less than 75 percent of the EPS nameplate kW rating for 1 continuous hour for a total test duration of not less than 1.5 continuous hours.

8.4.2.4 Spark-ignited generator sets shall be exercised at least once a month with the available EPSS load for 30 minutes or until the water temperature and the oil pressure have stabilized.

8.4.2.4.1 The date and time of day for required testing shall be decided by the owner, based on facility operations.

8.4.2.4.2 Equivalent loads used for testing shall be automatically replaced with the emergency loads in case of failure of the primary source.

8.4.3 The EPS test shall be initiated by simulating a power outage using the test switch(es) on the ATSs or by opening a normal breaker. Opening a normal breaker shall not be required.

8.4.3.1* Where multiple ATSs are used as part of an EPSS, the monthly test initiating ATSs shall be rotated to verify the starting function on each ATS.

8.4.4 Load tests of generator sets shall include complete cold starts.

8.4.5 Time delays shall be set as follows:

(1) Time delay on start:
    (a) 1 second minimum
    (b) 0.5 second minimum for gas turbine units

(2) Time delay on transfer to emergency: no minimum required
(3) Time delay on restoration to normal: 5 minutes minimum
(4) Time delay on shutdown: 5 minutes minimum

8.4.6 Transfer switches shall be operated monthly.

8.4.6.1* The monthly test of a transfer switch shall consist of electrically operating the transfer switch from the primary position to the alternate position and then a return to the primary position.

8.4.6.2 The criteria set forth in Section 4.3 and in Table 4.1(b) shall not be required during the monthly testing of the EPSS. If the criteria are not met during the monthly test, a process shall be provided to annually confirm the capability of the system to comply with Section 4.3.

8.4.7* EPSS circuit breakers for Level 1 system usage, including main and feed breakers between the EPS and the transfer switch load terminals, shall be exercised annually with the EPS in the "off" position.

8.4.7.1 Circuit breakers rated in excess of 600 volts for Level 1 system usage shall be exercised every 6 months and shall be tested under simulated overload conditions every 2 years.

8.4.8 EPSS components shall be maintained and tested by qualified person(s).

8.4.9* Level 1 EPSS shall be tested at least once within every 36 months.

8.4.9.1 Level 1 EPSS shall be tested continuously for the duration of its assigned class *(see Section 4.2)*.

8.4.9.2 Where the assigned class is greater than 4 hours, it shall be permitted to terminate the test after 4 continuous hours.

8.4.9.3 The test shall be initiated by operating at least one transfer switch test function and then by operating the test function of all remaining ATSs, or initiated by opening all switches or breakers supplying normal power to all ATSs that are part of the EPSS being tested.

8.4.9.4 A power interruption to non-EPSS loads shall not be required.

8.4.9.5 The minimum load for this test shall be as specified in 8.4.9.5.1, 8.4.9.5.2, or 8.4.9.5.3.

8.4.9.5.1* For a diesel-powered EPS, loading shall be not less than 30 percent of the nameplate kW rating of the EPS. A supplemental load bank shall be permitted to be used to meet or exceed the 30 percent requirement.

8.4.9.5.2 For a diesel-powered EPS, loading shall be that which maintains the minimum exhaust gas temperatures as recommended by the manufacturer.

8.4.9.5.3 For spark-ignited EPSs, loading shall be the available EPSS load.

8.4.9.6 The test required in 8.4.9 shall be permitted to be combined with one of the monthly tests required by 8.4.2 and one of the annual tests required by 8.4.2.3 as a single test.

8.4.9.7* Where the test required in 8.4.9 is combined with the annual load bank test, the first 3 hours shall be at not less than the minimum loading required by 8.4.9.5 and the remaining hour shall be at not less than 75 percent of the nameplate kW rating of the EPS.

8.5 Records.

8.5.1 Records shall be created and maintained for all EPSS inspections, operational tests, exercising, repairs, and modifications.

8.5.2 Records required in 8.5.1 shall be made available to the authority having jurisdiction on request.

8.5.3 The record shall include the following:

(1) The date of the maintenance report
(2) Identification of the servicing personnel
(3) Notation of any unsatisfactory condition and the corrective action taken, including parts replaced
(4) Testing of any repair in the time recommended by the manufacturer

8.5.4 Records shall be retained for a period of time defined by the facility management or by the authority having jurisdiction.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.4 See NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems.*

A.1.1.5(3) See Chapter 4.

A.1.4.1 Assignment of degree of reliability of the recognized EPSS, or equivalency of other methods, depends on the careful evaluation of the variables at each particular installation. One source of information on quantitative methods for assessing power system reliability is ANSI/IEEE 493, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems.*

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Battery Certification. One such certifier of batteries is the American Association of Battery Manufacturers.

A.3.3.3 Emergency Power Supply (EPS). For rotary energy converters, components of an EPS include the following:

(1) Prime mover
(2) Cooling system
(3) Generator
(4) Excitation system
(5) Starting system
(6) Control system
(7) Fuel system
(8) Lube system, if required

The EPS includes all the related electrical and mechanical components of the proper size and/or capacity required for the generation of the required electrical power at the EPS output terminals.

A.3.3.4 Emergency Power Supply System (EPSS). See Annex B for diagrams of typical systems.

A.3.3.7.1 Valve-Regulated (VRLA). In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).

A.3.3.7.2 Vented (Flooded). Flooded lead-acid batteries might have a provision for the user to add water to the cell and are equipped with a flame-arresting vent that permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell.

A.4.1 This standard specifies requirements for the EPSS as a complete functioning system in terms of types, classes, and levels. It is not the intent of this standard to recommend the EPSS most suitable for any given application. The terms *emergency power supply systems* and *standby power supply systems* as used in this standard include, but are not limited to, such terms as the following:

(1) Alternate power systems
(2) Standby power systems
(3) Legally required standby systems
(4) Alternate power sources

Since this standard specifies the installation, performance, maintenance, and test requirements in terms of types, classes, and levels, any of these terms might be appropriate for describing the application or use, depending on the need and the preference of the parties involved.

A.4.2 Selection of the class of the EPSS should take into account past outage records and fuel delivery problems due to weather, shortages, and other geographic and environmental conditions. Class "X" is a calculated value that usually represents between 48 and 96 hours of fuel for a Level 1 facility. Where the seismic design category is C, D, E, or F, as determined in accordance with ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures,* the EPS supplying a Level 1 EPSS should be capable of a minimum 96 hours of operation without refueling if it is determined that EPS operation is necessary for this period.

A.4.4 It is recognized that EPSSs are utilized in many different locations and for many different purposes. The requirement for one application might not be appropriate for other applications.

A.4.4.1 Typically, Level 1 systems are intended to automatically supply illumination or power, or both, to critical areas and equipment in the event of failure of the primary supply or in the event of danger to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life. Other NFPA codes and standards, such as NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, NFPA 99, *Health Care Facilities Code*, and NFPA *101*, *Life Safety Code*, provide specific requirements on where Level 1 systems are required.

Essential electrical systems can provide power for the following essential functions:

(1) Life safety illumination
(2) Fire detection and alarm systems
(3) Elevators
(4) Fire pumps
(5) Public safety communications systems
(6) Industrial processes where current interruption would produce serious life safety or health hazards
(7) Essential ventilating and smoke removal systems

A.4.4.2 Typically, Level 2 systems are intended to supply power automatically to selected loads (other than those classed as emergency systems) in the event of failure of the primary source.

Level 2 systems typically are installed to serve loads, such as the following, that, when stopped due to any interruption of the primary electrical supply, could create hazards or hamper rescue or fire-fighting operations:

(1) Heating and refrigeration systems
(2) Communications systems
(3) Ventilation and smoke removal systems
(4) Sewage disposal
(5) Lighting
(6) Industrial processes

A.4.4.3 The intent is not to prohibit the use of portable or alternate equipment whenever the permanent EPSS is out of service. *(See8.1.2.)*

A.4.4.4 It is important to recognize that an EPSS might react substantially differently from commercial power during transient and short circuit conditions due to the relatively small capacities of the EPSS compared to the primary commercial power source. *[See ANSI C 84.1, Standard for Electric Power Systems and Equipment — Voltage Ratings (60 hertz).]*

A.5.1.1 Examples of probability of interruption could include the following: earthquake, flood damage, or a demonstrated utility unreliability.

A.5.1.1(1) The grade of diesel fuel selected for use in a prime mover should be based on recommendations from the diesel engine manufacturer and ASTM D 975, *Standard Specification for Diesel Fuel Oils*. Where possible, the purchaser of fuel for the prime mover should specify a diesel fuel that does not contain biodiesel, which can accelerate the degradation of the diesel fuel if stored longer than 6 months. If diesel fuel is stored outside for long-term storage, it can be necessary to use a winter or arctic grade of diesel fuel or to take precautions such as insulating and heat-tracing fuel tanks and lines to ensure that fuel will flow to the prime mover under the coldest possible conditions.

A.5.1.1(2) ASTM D 1835, *Standard Specification for Liquified Petroleum (LP) Gases*, is a recognized standard covering LP-Gas.

A.5.1.1(3) ASTM does not have a standard specification for natural or synthetic gas. Industry generally uses pipeline specifications for natural gas quality.

A.5.1.3 On-site energy conversion is not restricted to rotating-type generating systems. Other types of continuous energy conversion systems can be used, including fuel-cell systems.

A.5.2.2 The following devices are typical of energy converters and energy sources that should be reviewed carefully as part of Level 1 EPSs:

(1) Motor-generator/engine
(2) Motor-generator/flywheel
(3) Steam turbine

Connection to the primary power source ahead of the primary source main service disconnect and a separate service should be excluded as a sole source of EPS.

A.5.4 It is recognized that in some installations, part or all of the output of the EPS might be used for peak shaving or part of the output might be used for driving nonessential loads during loss of the primary power source. Load shedding of these loads when the output of the energy converter is needed is one way of meeting the requirements of Section 5.4. The load should be reviewed to ascertain that load growth has not exceeded EPS capability.

A.5.5.2 The low-fuel alarm point for liquid-fueled engines is defined as the point when the main fuel tank contains insufficient fuel to meet the required full load operating hours and is the point at which this condition is signaled.

A.5.5.3 Consideration should be given to sizing tanks in order to meet minimum fuel supplier delivery requirements, particularly for small tanks. Consideration also should be given to oversizing tanks. More important, biodiesel blends up to B5 (ASTM D 975, *Standard Specification for Diesel Fuel Oils)* have much shorter shelf lives than conventional diesel fuel [ultra-low sulfur diesel (ULSD)] and can accelerate degradation processes, endangering the entire diesel fuel supply. Where fuel is stored for extended periods of time (e.g., more than 12 months), it is recommended that fuels be periodically pumped out and used in other services and replaced with fresh fuel. Prudent disaster management could require much larger on-site temporary or permanent fuel storage, and several moderate-sized tanks can be preferable to a single very large tank.

A.5.6.4.2 See Figure A.5.6.4.2 for a diagram of cranking cycles.

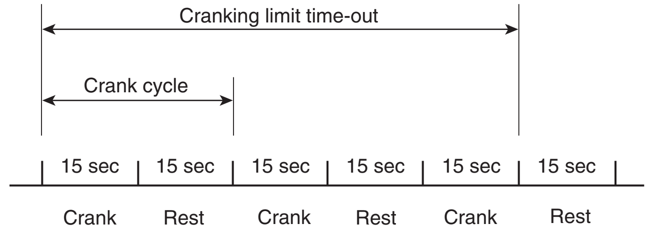

FIGURE A.5.6.4.2 Diagram of Cranking Cycles.

A.5.6.4.3 A battery unit is one or more batteries or a group of cells, a series, or a parallel series connected to provide the required battery unit voltage and capacity.

A.5.6.4.4 Cold-cranking amperes, or cranking performance, are the number of amperes a fully charged battery at -17.8°C (0°F) can continuously deliver for 30 seconds while maintaining 1.2 V per cell.

A.5.6.4.5.1 It is recommended that lead-acid starting batteries be replaced every 24 to 30 months.

A.5.6.4.6 It is intended that the battery charger be factory-built, adjusted, and approved for the specific type, construction, and capacity of the battery. For lead-acid batteries, the battery charger should be tested for the specific gravity, type, and concentration of grid alloys, such as high or low gravity, high or low antimony, calcium, or none.

A.5.6.5.6 For systems located outdoors, the manual shutdown should be located external to the weatherproof enclosure and should be appropriately identified.

A.5.6.6 The minimum "remote alarm annunciation" is to alert personnel at a constantly attended station somewhere on the site when the facility is in use as a Level 1 system. If the site is not continuously occupied, "network remote" should allow people at another site to know the operating status of the equipment.

The preferred method of remote annunciation is to notify personnel both somewhere on the site and at other locations via a network such as LAN, WAN, or Internet, including the ability to initiate auto-dial and send predefined text messages.

A.5.6.7.4 Adding remote parasitic equipment loads into the overall load to be supplied by the EPS is a factor that should be included in the overall EPSS design.

A.5.6.9.1 See ANSI/NEMA MG1, *Standard for Motors and Generators*, and ANSI/NEMA MG2, *Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators.*

A.5.6.10.3 Where unusual vibration conditions are anticipated, adequate isolation treatment should be supplied.

A.6.1.1 Electrical switching is electrical equipment or devices used to do any or all of the following:

(1) Transfer connected electrical loads from one power source to another
(2) Perform load-switching functions
(3) Bypass, isolate, and test the transfer switch

A.6.1.2 Electrical protection equipment is sensing and overcurrent protective devices used to protect against damage due to fault or overload to conductors and equipment connected to the output of the emergency energy source, up to and including the load terminals of the transfer switch(es).

A.6.1.6 See Section 695.10 of *NFPA 70, National Electrical Code*, and Section 10.8 of NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, for listing and installation requirements for transfer switches used with fire pumps.

A.6.2.1 For most applications in this standard, the automatic transfer switch (ATS) is used to transfer a load from a primary source of supply to an engine generator set.

An ATS might include circuit breakers, contactors, switches, or vacuum and solid-state power devices operating in conjunction with automatic-sensing and logic devices to perform the defined function.

A.6.2.2.1 Where special loads require more rapid detection of power loss, underfrequency monitoring also might be provided. Upon frequency decay below the lower limit necessary for proper operation of the loads, the transfer switch should automatically initiate transfer to the alternate source. *(See A.6.2.15.)*

A.6.2.2.1(2) See 6.2.5 and 6.2.7.

A.6.2.3 Certain installations might use automatic transfer switch equipment with momentary closed transition or soft-loading capabilities. This equipment should be applied with the approval of the local utility and authority having jurisdiction.

A.6.2.4 Authorized personnel should be available and familiar with manual operation of the transfer switch and should be capable of determining the adequacy of the alternate source of power prior to manual transfer.

A.6.2.5 For most applications, a nominal delay of 1 second is adequate. The time delay should be short enough so that the generator can start and be on line within the time specified for the type classification.

A.6.2.8 It is recommended that the timer for delay on retransfer to the primary source be set for 30 minutes. The 30-minute recommendation is to establish a "normalized" engine temperature when it is beneficial for the engine. *NFPA 70, National Electrical Code*, establishes a minimum time requirement of 15 minutes.

A.6.2.13 For maintenance purposes, consideration should be given to a transfer switch counter.

A.6.2.15 ATSs can be provided with accessory controls that provide a signal to operate remote motor controls that disconnect motors prior to transfer and to reconnect them after transfer when the residual voltage has been substantially reduced. Another method is to provide in-phase monitors within the ATS in order to prevent retransfer to the primary source until both sources are nearly synchronized. A third method is to use a programmed neutral position transfer switch. See Section 230.95 of *NFPA 70, National Electrical Code*.

A.6.2.16 Standards for nonautomatic transfer switches are similar to those for ATSs, as defined in 3.3.10.1 and 3.3.10.3, with the omission of automatic controls.

A.6.4.3 See Section 700.6 of *NFPA 70, National Electrical Code*.

A.6.4.4 Consideration should be given to the effect that load interruption could have on the load during maintenance and service of the transfer switch.

A.6.5.1 It is important that the various overcurrent devices be coordinated, as far as practicable, to isolate faulted circuits and to protect against cascading operation on short circuit faults. In many systems, however, full coordination is not practicable without using equipment that could be prohibitively costly or undesirable for other reasons. Primary consideration also should be given to prevent overloading of equipment by limiting the possibilities of large current inrushes due to instantaneous reestablishment of connections to heavy loads.

A.6.5.3 See 9.6.5 of NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection.*

A.7.1.1 The performance of the EPS and the EPSS is dependent on many factors, one of which is correct initial installation, primarily as the installation relates to the location and environmental conditions. Although this standard is not intended to serve as a design standard for EPSS installation and environmental considerations, certain minimum standards are recognized as essential for successful startup and performance, safe operation, and utilization of the EPSS where required.

A.7.1.2 The environmental conditions to be considered in the EPSS design should include, but not be limited to, heating, ventilating, and air-conditioning systems; protection from floods, fire, vandalism, wind, earthquakes, lightning, and other similar or applicable environmental conditions common to geographic locations; and other factors affecting the location of the EPSS equipment.

The probability and frequency of power failures that do or can occur as a result of lightning, wind, and rain produced by thunderstorms, hurricanes, tornadoes, and similar weather conditions associated with the user's geographic location should be considered.

A.7.2.3 The intent of this requirement is to provide maximum fire protection to the most critical, high energy systems. Consideration should be given to the potential fire hazard when locating Level 2 EPSS equipment in the normal electrical service room, or to Level 1 systems below 1000 amperes and 150 volts to ground.

A.7.2.4 EPSS equipment should be located above known previous flooding elevations where possible.

A.7.2.5 When installing the EPSS equipment and related auxiliaries, environmental considerations should be given, particularly with regard to the installation of the fuel tanks *(see A.7.9.1.2)* and exhaust lines, or the EPS building, or both.

To protect against disruption of power in the facility, it is recommended that the transfer switch be located as close to the load as possible. The following are examples of external influences:

(1) Natural conditions such as the following:
    (a) Storms
    (b) Floods
    (c) Earthquakes
    (d) Tornadoes
    (e) Hurricanes
    (f) Lightning
    (g) Ice storms
    (h) Wind
    (i) Fire

(2) Human-caused conditions such as the following:
  (a) Vandalism
  (b) Sabotage
  (c) Other similar occurrences
(3) Material and equipment failures

For natural conditions, EPSS design should consider the "100-year storm" flooding level or the flooding level predicted by the Sea, Lake, and Overland Surges from Hurricanes (SLOSH) models for a Category 4 hurricane. For further information refer to FEMA 543 and FEMA 577, both dated August 11, 2013.

A.7.3.3 Where units housed outdoors are used, it is recommended that a flashlight or battery-powered light with a flexible cord be maintained in the housing.

A.7.5 Generally, integral rubber vibration isolators are used on the rotating energy converters, and spring-type or pad-type isolators are used on the larger energy converter units. In some cases, high deflection spring-type isolators should be used where a high degree of vibration attenuation is required. The EPS manufacturer should be consulted during consideration of the specific type of vibration control. Inertia bases should be considered where unusual vibration conditions are anticipated.

A.7.6 Generally, exhaust noises can be attenuated by using the proper mufflers. The mufflers used should be in accordance with the EPS manufacturer's recommendations. Depending on the degree of silencing required, the muffler should be rated accordingly for "commercial," "semicritical," and "critical" (high degree of silencing) service. To attenuate other noises, line-of-sight barriers having acoustical treatment or total acoustical enclosures can be used. The EPS should be installed away from critical areas.

A.7.7.1 During operation, EPS and related equipment reject considerable heat that needs to be removed by proper ventilation or air-cooling. In some cases, outdoor installations rely on natural air circulation, but enclosed installations need properly sized, properly positioned ventilation facilities, to prevent recirculation of cooling air. The optimum position of air-supply louvers and radiator air discharge is on opposite walls, both to the outdoors.

A.7.7.2.1 The ventilation calculation for an EPS should consider the following:

(1) Radiator airflow (when installed in the EPS room)
(2) Combustion airflow consumed by the engine
(3) Maximum potential ambient temperature of air entering the EPS room for ventilation
(4) Radiated heat load from the EPS
(5) Radiated heat load from EPS exhaust system whether it is insulated or not insulated
(6) Other heat loads in the room
(7) Maximum allowed airflow pressure drop through the ventilation supply into the room and through the ventilation discharged from the radiator

A.7.9.1.1 Cleaning and purging of flammable gas piping systems should be in accordance with NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*.

A.7.9.1.2 To optimize the long-term storage of fuels for prime movers, the fuel tanks should be kept cool and dry, and the tank as full as possible. Tanks that are subject to temperature variations can experience accelerated fuel degradation, especially if the tanks are outside and above ground or close to an extreme heat source if stored inside a structure. The more constant and cooler the tank temperatures, the less likely temperature-related fuel degradation will occur. Tank ullage (air space) should be kept to a minimum. Excess air space allows for warm, humid air to enter the tank and condense moisture during the cool evening. Also, prolonged exposure to ambient air, which is 20 percent oxygen, can facilitate oxidative degradation of the fuel. Fuel storage tanks should be kept as dry as possible and have provisions for water drainage on a regular basis. The presence of water can lead to microbiological contamination and growth, which in turn can lead to general or pitting corrosion of steel tanks and components, possibly resulting in filter plugging, operational issues, or a hydrocarbon release to the environment. Regularly scheduled surveillance of the fuel allows the operator(s) to evaluate the condition of the fuel and make important decisions regarding the quality of the fuel dedicated to reliable operation of the prime mover. Fuel maintenance and testing should begin the day of installation and first fill in order to establish a benchmark guideline for future comparison. Laboratory testing services should always be sought from a qualified or certified petroleum laboratory.

A.7.9.3.1 Fuel lines containing copper, copper-containing alloys, and zinc (including galvanized piping or containers) should be avoided. Copper can promote fuel degradation and can produce mercaptide gels. Zinc coatings can react with water or organic acids in the fuel to form gels that rapidly plug filters.

A.7.9.6 See NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*; NFPA 54, *National Fuel Gas Code*; and NFPA 58, *Liquefied Petroleum Gas Code*.

A.7.9.7 Valving for natural gas–fueled prime movers should be configured so that the gas supply to the prime mover cannot be inadvertently or intentionally shut off by anyone other than qualified personnel such as the gas supplier. If valves are placed in an isolated area, a secure area or locking the valve(s) open is recommended.

A.7.10.3 Consideration should also be given to utilizing dampening supports where it is necessary to reduce exhaust noise vibration transmission.

A.7.11.2 If a fire suppression system is used in EPS rooms or separate buildings housing EPS equipment, consideration should be given to preaction-type suppression systems.

A.7.11.5 Consideration should be given to the location of the EPS equipment, both as it relates to the building structure and to the effects of an earthquake.

All emergency power equipment support or subsupport systems should be designed and constructed so that they can withstand static or anticipated seismic forces, or both, in any direction, with the minimum force value used being equal to the equipment weight.

Bolts, anchors, hangers, braces, and other restraining devices should be provided to limit earthquake-generated differential movements between the EPS nonstructural equipment and the building structure. However, the degree of isolation required for vibration and acoustical control of the EPS equipment and other equipment should be maintained.

Suspended items such as piping, conduit, ducts, and other auxiliary equipment related to the EPSS should be braced in two directions to resist swaying and excessive movement in earthquake risk areas.

Battery racks for EPS equipment and electrical items or related auxiliaries, or both, should be designed to resist internal damage and damage at the equipment supports resulting from earthquake-generated motion. Battery racks should be capable of withstanding seismic forces equal to the supported weight in any direction. Batteries should be restrained to their support to prevent vibration damage, and electrical interconnections should be provided with adequate slack to accommodate all relative deflections.

Transfer switch enclosures should be mounted so that their anchors and support structures can withstand static forces equal to the anticipated seismic shock in any direction.

Transfer switch components should be of the type that resists malfunction during dynamic excitation and should be designed to resist the anticipated seismic shock.

Where possible, EPS equipment and associated cooling systems and controls should be mounted on a single frame. The frame, in turn, should be rigidly attached to its foundation so that its anchorage can withstand static forces equal to the equipment weight in any direction. Where engine generator sets and associated cooling systems' controls cannot be mounted as an integral unit, each should be secured to meet the floating requirements previously described. Equipment not using the preferred rigid mounting should have vibration isolators with restraints capable of withstanding static forces equal to twice the weight of the supported equipment in any direction. In addition, interconnecting power, fuel, and cooling lines should be provided with adequate flexibility to allow maximum anticipated excursions without damage.

Appendages to the EPS equipment, such as day tanks, should be mounted to withstand static forces equal to the anticipated seismic shock in any direction.

A.7.11.6 Seismic shock should be simulated at the factory or in a testing laboratory on a prototype unit. Simulation should consist of a test(s) approximating actual time-history records of known seismic shocks applied to the equipment under test. Subassemblies of the total equipment could be tested separately where it is neither practical nor feasible to test the complete unit.

A.7.13.4.1.1 Cold start is typical standby condition under normal ambient conditions with coolant heaters functioning normally.

A.7.13.4.1.2 Cold start is typical standby condition under normal ambient conditions with coolant heaters functioning normally.

A.7.13.4.1.4(6) Verification of the engine start function can be accomplished by actual starting of the engine or by testing of the ATS start circuit.

A.7.13.4.3 Connection of the load bank (or a portable generator) is facilitated by providing permanently installed equipment or connection points such as spare circuit breakers or switches.

The generator set manufacturer should be consulted where the nameplate data do not indicate rating type. There is a difference between prime and standby ratings. For example, there are usually two kW nameplate ratings found on most engine-driven generators: "standby" and "prime." There can be a significant difference between the resulting kW figures when calculating 30 percent of nameplate — for example, a 100 kW standby generator is normally considered an 80 kW set for prime power: 100 kW × 30% = 30 kW, but 80 kW × 30% = 24 kW. A permanent record of the rating should be maintained and readily available.

A.7.13.4.3.1 The generator set manufacturer should be consulted where the nameplate data do not indicate rating type. There is a difference between prime and standby ratings. For example, there are usually two kW nameplate ratings found on most engine-driven generators: "standby" and "prime." There can be a significant difference between the resulting kW figures when calculating 30 percent of nameplate — for example, a 100 kW standby generator is normally considered an 80 kW set for prime power: 100 kW × 30% = 30 kW, but 80 kW × 30% = 24 kW. A permanent record of the rating should be maintained and readily available.

A.8.1 The continuing reliability and integrity of the EPSS are dependent on an established program of routine maintenance and operational testing. For more detailed information on electrical equipment maintenance, refer to NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*.

A.8.2 Where adequately secured from public access, it is desirable to locate an instruction manual, special tools and testing devices, and spare parts in the room in which the EPS is located. The articles should be mounted at a convenient location on a wall and should be enclosed in a metal or other suitable cabinet. The cabinet should accommodate the instruction manual on the inside of the door.

A.8.3.1 The suggested maintenance procedure and frequency should follow those recommended by the manufacturer. In the absence of such recommendations, Figure A.8.3.1(a) and Figure A.8.3.1(b) indicate alternate suggested procedures.

A.8.3.4 Where sealed devices are used, replacement of the complete device might be necessary. Maintenance should be performed according to manufacturer's recommendations. In the absence of such recommendations, the list given in 8.3.4 suggests minimal procedures.

Transfer switches should be subjected to an annual maintenance program including (one) major maintenance and (three) quarterly inspections. Programs should include all of the following operations. Note: Due to the critical nature of these devices, permission should be gained to perform these tasks since some of the following recommendations could cause disruption of power to the load. The following tasks should be carefully reviewed with facility management personnel to ensure agreement and plan for contingencies.

Major Maintenance

(1) Check connections.
   (a) A thermographic or temperature scan should be done prior to this visit, while the ATS is under normal (peak) load. This thermographic scan should be repeated during the EPSS load test. Results should be available to the maintenance provider so that suspect conditions can be addressed during this activity.

EPSS Maintenance Schedule

Component (as applicable)	Procedure X — Action R — Replace, if needed					Frequency W — Weekly, M — Monthly, Q — Quarterly S — Semiannually, A — Annually, Nos. indicate hours	
	Visual Inspection	Check	Change	Clean	Test	Level 1	Level 2
1. Fuel							
(a) Main supply tank level		X				W	M
(b) Day tank level	X	X				W	M
(c) Day tank float switch	X				X	W	Q
(d) Supply or transfer pump operation	X				X	W	Q
(e) Solenoid valve operation	X				X	W	Q
(f) Strainer, filter, dirt leg, or combination				X		Q	Q
(g) Water in system		X		X		W	Q
(h) Flexible hose and connectors	X		R			W	M
(i) Tank vents and overflow piping unobstructed		X			X	A	A
(j) Piping	X					A	A
(k) Gasoline in main tank (when used)			R			A	A
2. Lubrication System							
(a) Oil level	X	X				W	M
(b) Oil change			R			50 or A	50 or A
(c) Oil filter(s)			R			50 or A	50 or A
(d) Lube oil heater		X				W	M
(e) Crankcase breather	X		R	X		Q	S
3. Cooling System							
(a) Level	X	X				W	M
(b) Antifreeze protection level					X	S	A
(c) Antifreeze			R			A	A
(d) Adequate cooling water to heat exchanger		X				W	M
(e) Rod out heat exchanger				X		A	A
(f) Adequate fresh air through radiator		X				W	M
(g) Clean exterior of radiator				X		A	A
(h) Fan and alternator belt	X	X				M	Q
(i) Water pump(s)	X					W	Q
(j) Condition of flexible hoses and connection	X	X				W	M
(k) Jacket water heater		X				W	M
(l) Inspect duct work, clean louvers	X	X		X		A	A
(m) Louver motors and controls	X			X	X	A	A
4. Exhaust System							
(a) Leakage	X	X				W	M
(b) Drain condensate trap		X				W	M

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FIGURE A.8.3.1(a) Suggested Maintenance Schedule for Emergency Power Supply Systems (EPSSs).

EPSS Maintenance Schedule *(continued)*

Component (as applicable)	Procedure X — Action R — Replace, if needed					Frequency W — Weekly, M — Monthly, Q — Quarterly, S — Semiannually, A — Annually, Nos. indicate hours	
	Visual Inspection	Check	Change	Clean	Test	Level 1	Level 2
(c) Insulation and fire hazards	X					Q	Q
(d) Excessive backpressure					X	A	A
(e) Exhaust system hangers and supports	X					A	A
(f) Flexible exhaust section	X					S	S
5. Battery System							
(a) Electrolyte level		X				W	M
(b) Terminals clean and tight	X	X				Q	Q
(c) Remove corrosion, case exterior clean and dry	X			X		M	M
(d) Specific gravity or state of charge					X	M	M
(e) Charger and charge rate	X					M	M
(f) Equalize charge		X				M	M
6. Electrical System							
(a) General inspection	X					W	M
(b) Tighten control and power wiring connections		X				A	A
(c) Wire chafing where subject to movement	X	X				Q	S
(d) Operation of safeties and alarms		X			X	S	S
(e) Boxes, panels, and cabinets				X		S	S
(f) Circuit breakers, fuses Note: Do not break manufacturer's seals or perform internal inspection on these devices.	X	X	R	X	X	M	A
(g) Transfer switch main contacts	X			X		A	A
(h) Calibration of voltage-sensing relays/devices		X			X	A	A
(i) Wire insulation breakdown					X	5/500[a]	3/500[b]
7. Prime Mover							
(a) General inspection	X					W	M
(b) Service air cleaner			R	X		S	S
(c) Governor oil level and linkage	X	X				M	M
(d) Governor oil			R			A	A
(e) Ignition system — plugs, points, coil, cap, rotor, secondary wire insulation	X	X	R	X	X	A	A
(f) Choke setting and carburetor adjustment		X				S	S
(g) Injector pump and injectors for flow rate pressure and/or spray pattern					X	A	A
(h) EPS at minimum of 30% nameplate rating					X	3/4[c]	3/4[c]

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FIGURE A.8.3.1(a) ***Continued***

EPSS Maintenance Schedule *(continued)*

Component (as applicable)	Procedure (X — Action; R — Replace, if needed): Visual Inspection	Check	Change	Clean	Test	Frequency (W — Weekly; M — Monthly; Q — Quarterly; S — Semiannually; A — Annually; Nos. indicate hours): Level 1	Level 2
(i) Valve clearance					X	3/500[b]	3/500[b]
(j) Torque bolts					X	3/500[b]	3/500[b]
8. Generator							
(a) Brush length, appearance, free to move in holder	X	X		X		S	S
(b) Commutator and slip rings	X			X		A	A
(c) Rotor and stator	X			X		A	A
(d) Bearing(s)	X		R			A	A
(e) Bearing grease		X	R			A	A
(f) Exciter	X	X		X		A	A
(g) Voltage regulator	X	X		X		A	A
(h) Measure and record resistance readings of windings with insulation tester (Megger)					X	A	A
9. (a) General condition of EPSS, any unusual condition of vibration, leakage, noise, temperature, or deterioration	X			X		W	M
(b) Service room or housing house-keeping	X			X		W	M
10. Restore system to automatic operation condition	X					W	M

[a] Every 5 years or 500 hours
[b] Every 3 years or 500 hours
[c] Every 3 years for 4 hours

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FIGURE A.8.3.1(a) ***Continued***

(b) With power connected to the normal source, measure and record millivolt drop levels across each pole. Note: Any reading that is greater than 25 percent of the average of all poles should be carefully inspected when the ATS is de-energized.

(c) With power connected to the emergency source, measure and record millivolt drop levels across each pole. Note: Any reading that is greater than 25 percent of the average of all poles should be carefully inspected when the ATS is de-energized.

(d) If the ATS is equipped with a bypass isolation feature, operate the bypass to the connected source (emergency or normal) and repeat the steps in (a), (b), and (c). Levels should drop to approximately 50 percent of initial levels and be uniform relative to initial readings. This step verifies that the bypass feature is properly connected and that the connected load will not be affected when the automatic portion is isolated for maintenance.

(e) With power secured and both the emergency and normal sources properly locked out and tagged out, measure the micro-ohm resistance levels across the following connection points:

i. Emergency source cabling lug to bus
ii. Normal source cabling lug to bus
iii. Load cabling lug to bus
iv. Neutral cabling lug to bus
v. Load connected to normal across each pole
vi. Load connected to emergency across each pole

Note: If the ATS is equipped with an isolation bypass and the bypass remains energized, perform these tests on the isolated transfer switch unit only. DO NOT APPLY DIGITAL LOW RESISTANCE OHMMETER (DLRO) TO ENERGIZED CIRCUITS. Any value greater than 20 percent of the average value of all similar type connections requires further investigation.

EPSS Maintenance Log

Frequency
W — Weekly   S — Semiannually
M — Monthly   A — Annually
Q — Quarterly   Nos. indicate hours

	Service Frequency		Performed by											
			Date											
Component	**Level 1**	**Level 2**	**Fill in Appropriate Readings**											
1. Fuel														
(a) Main supply tank level	W	M												
(b) Day tank level	W	M												
(c) Day tank float switch	W	Q												
(d) Supply or transfer pump operation	W	Q												
(e) Solenoid valve operation	W	Q												
(f) Strainer, filter, dirt leg, or combination	Q	Q												
(g) Water in system	W	Q												
(h) Flexible hose and connectors	A	A												
(i) Tank vents and overflow piping unobstructed	A	A												
(j) Piping	A	A												
(k) Gasoline in main tank (when used)	A	A												
2. Lubrication System														
(a) Oil level	W	M												
(b) Oil change	50 or A	50 or A												
(c) Oil filter(s)	50 or A	50 or A												
(d) Lube oil heater	W	M												
(e) Crankcase breather	Q	S												
3. Cooling System														
(a) Level	W	M												
(b) Antifreeze protection level	S	A												
(c) Antifreeze	A	A												
(d) Adequate cooling water to heat exchanger	W	M												
(e) Rod out heat exchanger	A	A												
(f) Adequate fresh air through radiator	W	M												
(g) Clean exterior of radiator	A	A												
(h) Fan and alternator belt	M	Q												
(i) Water pump(s)	W	Q												
(j) Condition of flexible hoses and connection	W	M												
(k) Jacket water heater	W	M												
(l) Inspect duct work, clean louvers	A	A												
(m) Louver motors and controls	A	A												
4. Exhaust System														
(a) Leakage	W	M												
(b) Drain condensate trap	W	M												

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FIGURE A.8.3.1(b) Sample Maintenance Log — Routine Maintenance, Operation, and Testing (RMOT).

EPSS Maintenance Log *(continued)*

Frequency
W — Weekly S — Semiannually
M — Monthly A — Annually
Q — Quarterly Nos. indicate hours

Performed by

Date

Fill in Appropriate Readings

Component	Service Frequency Level 1	Service Frequency Level 2
(c) Insulation and fire hazards	Q	Q
(d) Excessive backpressure	A	A
(e) Exhaust system hangers and supports	A	A
(f) Flexible exhaust section	S	S
5. Battery System		
(a) Electrolyte level	W	M
(b) Terminals clean and tight	Q	Q
(c) Remove corrosion, case exterior clean and dry	M	M
(d) Specific gravity or state of charge	M	M
(e) Charger and charge rate	M	M
(f) Equalize charge	M	M
6. Electrical System		
(a) General inspection	W	M
(b) Tighten control and power wiring connections	A	A
(c) Wire chafing where subject to movement	Q	S
(d) Operation of safeties and alarms	S	S
(e) Boxes, panels, and cabinets	S	S
(f) Circuit breakers, fuses Note: Do not break manufacturer's seals or perform internal inspection on these devices.	2 or M	2 or A
(g) Transfer switch main contacts	A	A
(h) Calibration of voltage-sensing relays/devices	5 or A	5 or A
(i) Wire insulation breakdown	5/500[a]	3/500[b]
7. Prime Mover		
(a) General inspection	W	M
(b) Service air cleaner	S	S
(c) Governor oil level and linkage	M	M
(d) Governor oil	A	A
(e) Ignition system — plugs, points, coil, cap, rotor, secondary wire insulation	A	A
(f) Choke setting and carburetor adjustment	S	S
(g) Injector pump and injectors for flow rate pressure and/or spray pattern	A	A
(h) EPS at minimum of 30% nameplate rating	3/4[c]	3/4[c]

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FIGURE A.8.3.1(b) ***Continued***

EPSS Maintenance Log *(continued)*

Frequency
W — Weekly S — Semiannually
M — Monthly A — Annually
Q — Quarterly Nos. indicate hours

Component	Service Frequency Level 1	Service Frequency Level 2	Performed by / Date / Fill in Appropriate Readings											
(i) Valve clearance	3/500[b]	3/500[b]												
(j) Torque bolts	3/500[b]	3/500[b]												
8. Generator														
(a) Brush length, appearance, free to move in holder	W	M												
(b) Commutator and slip rings	S	S												
(c) Rotor and stator	A	A												
(d) Bearing(s)	A	A												
(e) Bearing grease	A	A												
(f) Exciter	A	A												
(g) Voltage regulator	A	A												
(h) Measure and record resistance readings of windings with insulation tester (Megger)	A	A												
9. (a) General condition of EPSS, any unusual condition of vibration, leakage, noise, temperature, or deterioration	W	M												
(b) Service room or housing housekeeping	W	M												
10. Restore system to automatic operation condition	W	M												

[a] Every 5 years or 500 hours
[b] Every 3 years or 500 hours
[c] Every 3 years for 4 hours

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FIGURE A.8.3.1(b) ***Continued***

(2) Inspect or test for evidence of overheating or excessive contact corrosion.

(a) With power from both sources secured and properly locked out and tagged out, remove all protective pole covers and arc chutes.

(b) Carefully inspect main contacts and other current-carrying parts for signs of corrosion or overheating. Note: Observation should correlate with previous results (i.e., thermographic or temperature evidence of higher than normal temperatures or heat migration, abnormal millivolt drop readings as previously noted, or abnormal micro-ohm (DLRO) readings as previously noted).

(c) Carefully inspect insulating materials or standoff insulators for signs of contamination (dirt, grime, oil, etc.). The combination of contaminants and possible introduction of high humidity or moisture could lead to insulation breakdown and subsequent destructive faults. Clean contaminated surfaces with a solvent approved for this purpose.

(d) Inspect control connection, plugs, and harnesses for signs of corrosion, heat, contamination, and so forth.

(e) Using a vacuum, remove all dust and debris from the ATS cabinet, transfer switch mechanism, bus, and so forth. Note: Never use compressed air to blow out dust. Doing so can blow dust and debris into controls and the transfer switch mechanism.

(f) Inspect cabinets for proper sealing. Open conduit knockouts or other penetrations should be properly sealed to prevent the introduction of dust, moisture, or other alien matter. Enclosures installed outside should be inspected for proper seal and appropriate gasketing. Ensure that enclosure door securing devices are intact and properly secured.

(g) Replace and secure all protective pole covers and chutes. Remove lockout devices and resupply normal power. If the ATS is of the bypass isolation type, reconnect the transfer switch mechanism. Observe proper manufacturer's procedures.

(3) Verify control and feature setpoints and operation.

(a) Measure and record the following data and setpoints:

i. Normal source voltage phase to phase, phase to ground, and phase to neutral
ii. Engine start time (from crank start to source available light or relay pickup)
iii. Emergency source voltage phase to phase, phase to ground, and phase to neutral
iv. Load current each phase
v. Momentary override normal deviation where provided
vi. Transfer time delay where provided
vii. Return to normal source time delay where provided
viii. Engine cooldown where provided

(b) If the connection is to a multiple-source EPS, verify the load priority of the ATS being tested and confirm this is correct given the criticality of the connected load.
(c) Verify proper operation of all indicator lights and meters and controls.
(d) Return ATS to normal service.

Quarterly Inspections

(1) Visually inspect the transfer switch control mechanism, control panel, harnesses, and cable connections for signs of moisture, corrosion, or heating.
(2) Measure and record the following data and setpoints:

(a) Normal source voltage phase to phase, phase to ground, and phase to neutral
(b) Engine start time (from crank start to source available light or relay pickup)
(c) Emergency source voltage phase to phase, phase to ground, and phase to neutral
(d) Load current each phase
(e) Momentary override normal deviation where provided
(f) Transfer time delay where provided
(g) Return to normal source time delay where provided
(h) Engine cooldown where provided

(3) If the connection is to a multiple-source EPS, verify the load priority of the ATS being tested and confirm this is correct given the criticality of the connected load.
(4) Verify proper operation of all indicator lights and meters and controls.
(5) Inspect cabinets for proper sealing. Open conduit knockouts or other penetrations should be properly sealed to prevent the introduction of dust, moisture, or other alien matter. Enclosures installed outside should be inspected for proper seal and appropriate gasketing. Ensure that enclosure door securing devices are intact and properly secured.
(6) Perform a load test using the test switch if permitted. Note: This will cause the emergency power source to start and the ATS to transfer. Be sure to gain permission from the facility management prior to performing this test.

A.8.3.5 Paralleling switchgear offers many advantages when testing and exercising. The system exercise period would be initiated by the automatic transfer switch (ATS) controls, and once operating, the system could be staged to establish appropriate loading of each EPS.

In addition, load-add, load-shed, load demand control, load optimization, and other operating and control features should be tested at appropriate intervals. Logic controls that contain load block information should be adjusted as necessary, and load priorities should be reviewed as ATS loads change.

A.8.3.6 A battery load test should be performed quarterly.

A.8.3.7 Limited fuel quality testing performed annually using appropriate ASTM standard test methods is recommended as a means to determine that existing fuel inventories are suitable for continued long-term storage. Special attention should be paid to sampling the bottom of the storage tank to verify that the stored fuel is as clean and dry as practicable and that water, sediment, or microbial growth on the tank bottom is minimized. ASTM D 975, *Standard Specification for Diesel Fuel Oils,* contains test methods for existing diesel fuel.

A.8.4.1 Weekly inspection does not require running of the EPS. Running unloaded generators as part of this weekly inspection can result in long-term problems such as wet stacking. See Figure A.8.4.1(a) and Figure A.8.4.1(b).

A.8.4.2 Light loading creates a condition termed *wet stacking,* indicating the presence of unburned fuel or carbon, or both, in the exhaust system. Its presence is readily indicated by the presence of continuous black smoke during engine-run operation. The testing requirements of 8.4.2 are intended to reduce the possibility of wet stacking. If equivalent loads are used for exercising, it is suggested that all essential loads be energized first, with the equivalent load used only to supplement the test. If the normal power were to fail during the exercise period, it would negate the urgency to automatically remove the equivalent load as described in 8.4.2.2.

The generator set manufacturer should be consulted where the nameplate data do not indicate rating type. There is a difference between prime and standby ratings. For example, there are usually two kW nameplate ratings found on most engine-driven generators: "standby" and "prime." There can be a significant difference between the resulting kW figures when calculating 30 percent of nameplate — for example, a 100 kW standby generator is normally considered an 80 kW set for prime power: 100 kW × 30% = 30 kW, but 80 kW × 30% = 24 kW. A permanent record of the rating should be maintained and readily available.

A.8.4.2.3 The generator set manufacturer should be consulted where the nameplate data do not indicate rating type. There is a difference between prime and standby ratings. For example, there are usually two kW nameplate ratings found on most engine-driven generators: "standby" and "prime." There can be a significant difference between the resulting kW figures when calculating 30 percent of nameplate — for example, a 100 kW standby generator is normally considered an 80 kW set for prime power: 100 kW × 30% = 30 kW, but 80 kW × 30% = 24 kW. A permanent record of the rating should be maintained and readily available.

EPSS Operation and Testing Log

	Performed by																		
	Date																		
Item*	**Fill in Appropriate Readings**																		
1. Maintenance schedule																			
2. RTM																			
3. Power fail																			
4. T/D start																			
5. Crank time																			
6. Transfer																			
7. (a) ac voltage																			
(b) Hz																			
(c) ac amperage																			
(d) ac kW																			
8. (a) Oil pressure																			
(b) dc amperage																			
9. (a) Oil pressure																			
(b) dc amperage																			
(c) W/A temp.																			
10. Restore normal																			
11. (a) Oil pressure																			
(b) dc amperage																			
(c) W/A temp.																			
(d) ac voltage																			
(e) Hz																			
(f) ac amperage																			
(g) ac kW																			
12. T/D retransfer																			
13. T/D stop																			
14. Auto mode																			

Comments

* See Suggested Operation and Testing Procedures for explanation of items.

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FIGURE A.8.4.1(a) Sample Operation and Testing Log for Rotating Equipment.

Suggested Operation and Testing Procedures

Item*	Procedure
1.	Perform maintenance per Maintenance Schedule
2.	Record running time meter (RTM) reading at start and end of test.
3.	Simulate normal power failure from a "cold start" by use of the test switch in automatic transfer switch or by opening normal power supply to EPSS.
4.	Observe and record time delay (T/D) on start.
5.	Record cranking time (terminates when engine starts).
6.	Transfer load to EPS.
7.	Record ac voltage, frequency, amperage, kW.
8.	Record initial oil pressure and battery-charging rate.
9.	Record oil pressure, battery-charging rate, and water or air temperature after 15 minutes running time.
10.	Return test switch to normal or reestablish normal power supply at such time to cause a minimum running time of 30 minutes under load.
11.	Record prime mover and ac instruments just prior to transfer.
12.	Record time delay on retransfer.
13.	Record time delay on shutdown for units so equipped.
14.	Place unit in automatic operation mode.

*See Operation and Testing Log.

FIGURE A.8.4.1(b) Operation and Testing Procedures Suggested for Rotating Equipment.

A.8.4.3.1 The intent is to verify the starting function from each ATS to the EPS by rotating the ATS that initiates the cold engine start of the monthly test. For example, if the facility has 37 ATSs, it can take more than 3 years to verify the starting function of the ATSs. Consideration should be given to ATS criticality. Once the testing cycle is completed, in subsequent years the testing order can be modified to reflect changes to the EPSS.

A.8.4.6.1 This requirement is to simulate a power outage without turning off normal power. This requirement allows selected ATSs to be transferred back to normal before the entire 30-minute test is complete when required for operational or safety considerations.

Selected ATSs can be electrically operated at a different time than the monthly operational test when required for operational or safety considerations, provided the monthly requirement of 8.4.6 is met.

A.8.4.7 Circuit breakers should be tested under simulated overload conditions every 2 years.

A.8.4.9 The intent of this requirement is to provide reasonable assurance that the EPSS with all of its auxiliary subsystems is capable of running for the duration of its assigned class with its running load. A full facility power outage is not intended for this test but is recommended where a total facility power outage has not occurred within the last 36 months. Supplemental load banks are not required. After the test, the fuel supply should be replenished if necessary.

A.8.4.9.5.1 The generator set manufacturer should be consulted where the nameplate data do not indicate rating type. There is a difference between prime and standby ratings. For example, there are usually two kW nameplate ratings found on most engine-driven generators: "standby" and "prime." There can be a significant difference between the resulting kW figures when calculating 30 percent of nameplate — for example, a 100 kW standby generator is normally considered an 80 kW set for prime power: 100 kW × 30% = 30 kW, but 80 kW × 30% = 24 kW. A permanent record of the rating should be maintained and readily available.

A.8.4.9.7 The generator set manufacturer should be consulted where the nameplate data do not indicate rating type. There is a difference between prime and standby ratings. For example, there are usually two kW nameplate ratings found on most engine-driven generators: "standby" and "prime." There can be a significant difference between the resulting kW figures when calculating 30 percent of nameplate — for example, a 100 kW standby generator is normally considered an 80 kW set for prime power: 100 kW × 30% = 30 kW, but 80 kW × 30% = 24 kW. A permanent record of the rating should be maintained and readily available.

Annex B Diagrams of Typical Systems

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Typical Power Supply Systems. See Figure B.1(a) through Figure B.1(e) for examples.

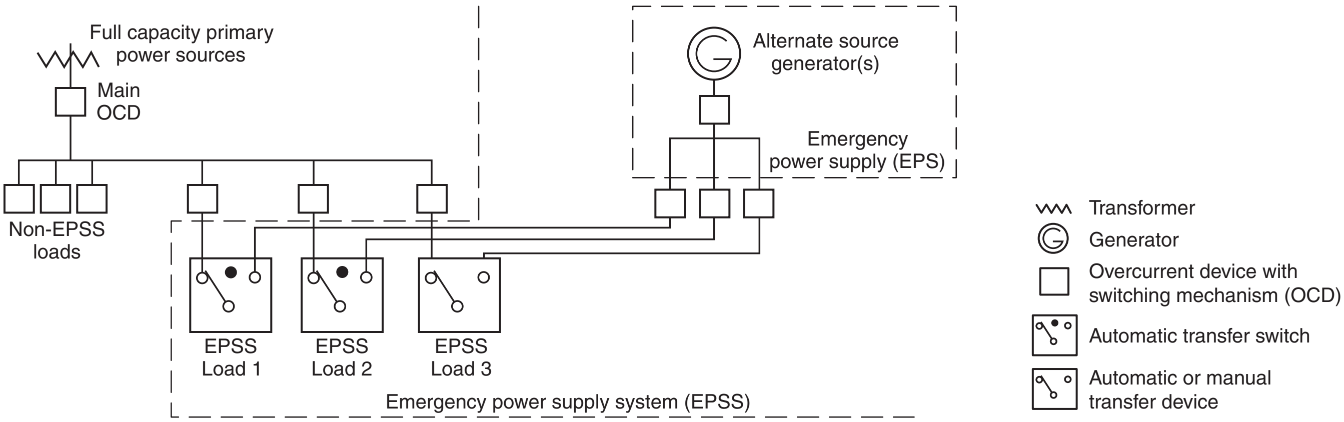
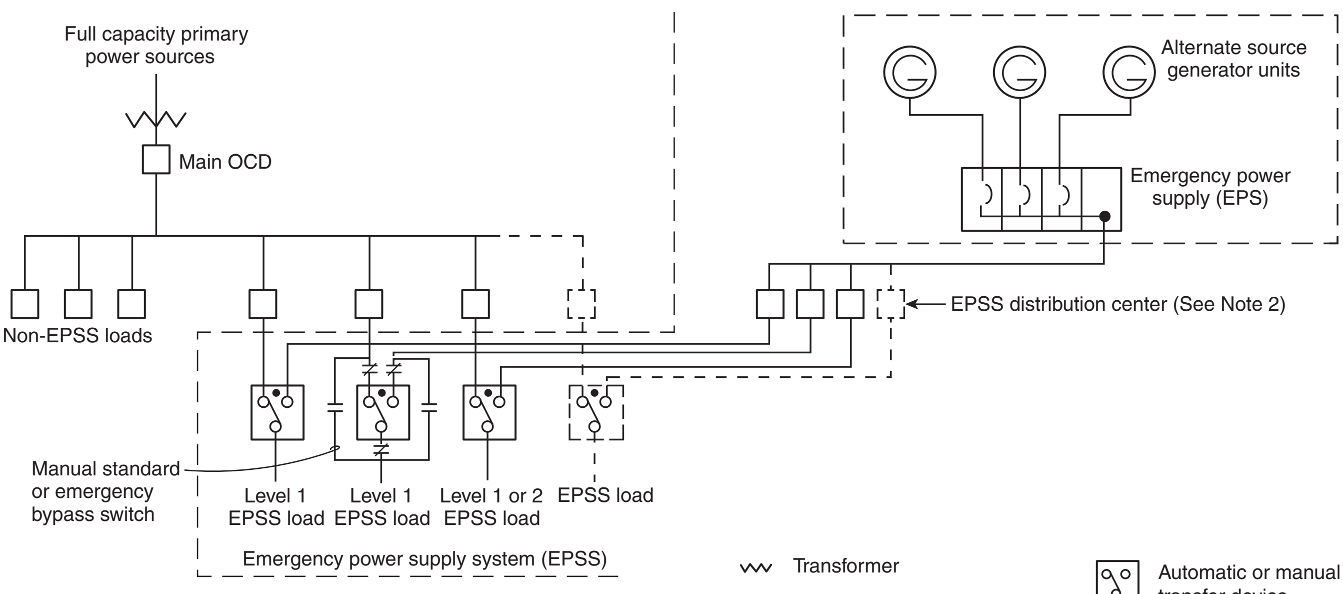


FIGURE B.1(a) Typical Rotating Emergency Power Supply System.



Notes:
1. One alternate source generator unit of the paralleling system to have sufficient capacity to carry all required Level 1 loads.
2. The EPSS distribution center can be installed in additional cubicles as part of the paralleling board setup.

FIGURE B.1(b) Typical Multiple-Unit Emergency Power Supply System.

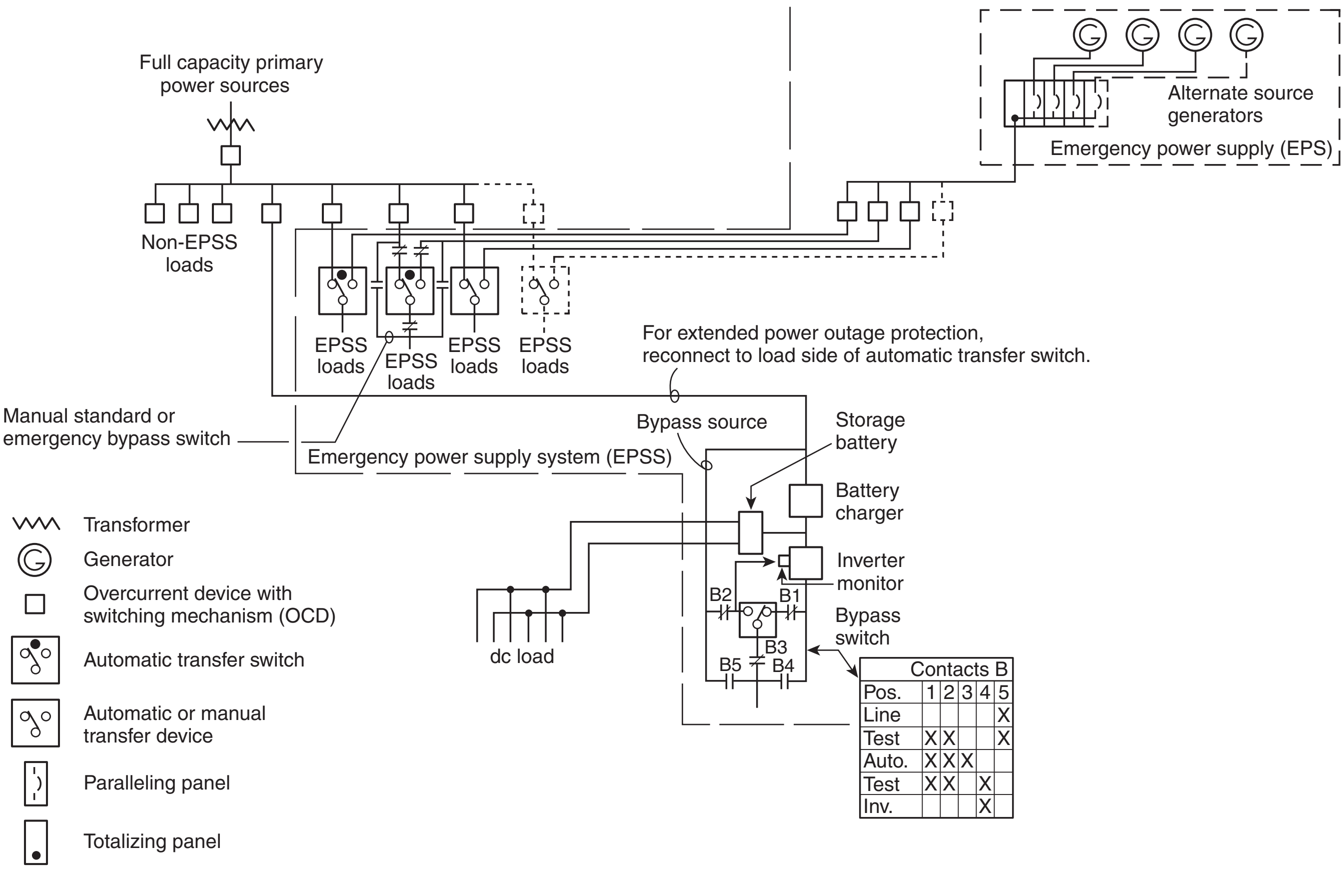


FIGURE B.1(c) Typical Composite Emergency Power Supply System.

Annex C Informational References

C.1 Referenced Publications. *The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.*

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2013 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2014 edition.

NFPA 54, *National Fuel Gas Code*, 2015 edition.

NFPA 56, *Standard for Fire and Explosion Prevention During Cleaning and Purging of Flammable Gas Piping Systems*, 2014 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA 70®, *National Electrical Code*®, 2014 edition.

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2013 edition.

NFPA 99, *Health Care Facilities Code*, 2015 edition.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems*, 2016 edition.

C.1.2 Other Publications.

C.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI C 84.1, *Standard for Electric Power Systems and Equipment — Voltage Ratings (60 hertz)*, 2006.

C.1.2.2 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191.

ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures*, 2010.

C.1.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshocken, PA 19428-2959.

ASTM D 975, *Standard Specification for Diesel Fuel Oils,* 2011b.

ASTM D 1835, *Standard Specification for Liquefied Petroleum (LP) Gases,* 2011.

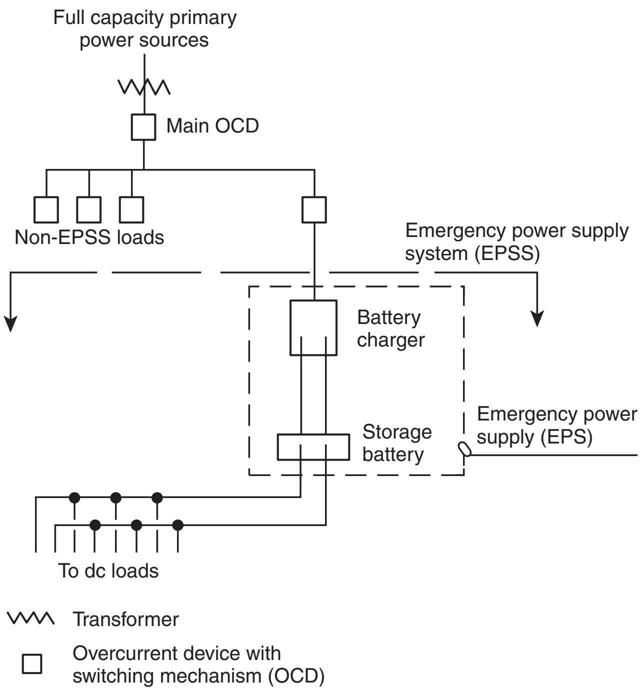


FIGURE B.1(d) Typical Uninterruptible Power Supply (UPS) System.

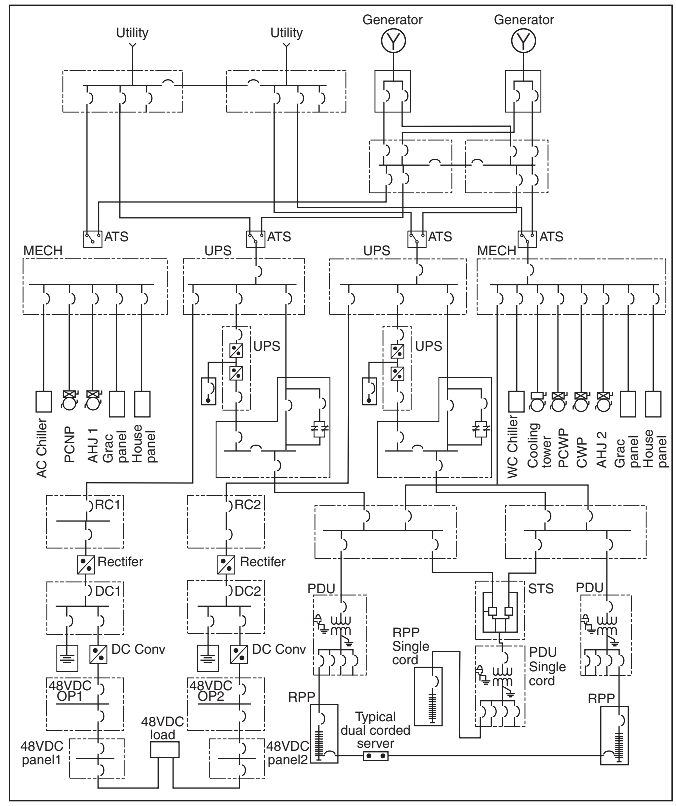


FIGURE B.1(e) Typical 911 Call Center in Designated Critical Operations Area.

C.1.2.4 IEEE Publications. IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

ANSI/IEEE 493, *Recommended Practice for the Design of Reliable Industrial and Commercial Power Systems,* 2007.

C.1.2.5 NEMA Publications. National Electrical Manufacturers Association, 1300 North 17th Street, Suite, 1847, Rosslyn, VA 22209.

ANSI/NEMA MG 1, *Standard for Motors and Generators*, 2009.

ANSI/NEMA MG 2, *Safety Standard and Guide for Selection, Installation and Use of Electric Motors and Generators*, 2001, Revision 1, 2007.

C.1.2.6 NHC Publications. National Hurricane Center, 11691 SW 17th Street, Miami, FL 33165-2149.

SLOSH (Sea, Lake and Overland Surges from Hurricanes) Model.

C.1.2.7 U.S. Government Publications. FEMA 543, *Design Guide for Improving Critical Facility Safety from Flooding and High Winds*, 2007.

FEMA 577, *Design Guide for Improving Hospital Safety in Earthquakes, Floods, and High Winds*, 2007.

C.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

C.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

C.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 111

Standard on

Stored Electrical Energy Emergency and Standby Power Systems

2016 Edition

This edition of NFPA 111, *Standard on Stored Electrical Energy Emergency and Standby Power Systems,* was prepared by the Technical Committee on Emergency Power Supplies and released by the Correlating Committee on National Electrical Code®. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

A Tentative Interim Amendment (TIA) to Table 4.2.2 was issued on August 18, 2015. For further information on tentative iterim amendments, see Section 5 of the Regulations Governing the Development of NFPA Standards, available at: http://www.nfpa.org/regs.

This edition of NFPA 111 was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 111

The Technical Committee on Emergency Power Supplies was organized in 1976 by NFPA in recognition of the demand for guidelines on the assembly, installation, and performance of electrical power systems to supply critical and essential needs during outages of the normal power source. During the development of a base standard (NFPA 110, *Standard for Emergency and Standby Power Systems*), it was determined that several power sources were available for emergency and standby power systems. The committee determined that sufficient differences existed between these sources to justify separate documents providing clearly defined specifics. Each document would follow the basic format of NFPA 110 to provide a consistent basis for comparison and usage and would remain under the jurisdiction of the Technical Committee on Emergency Power Supplies.

Because of the unique knowledge necessary to provide an authoritative document, the technical committee authorized a subcommittee in 1982 to prepare a draft document on systems using stored energy sources. In 1986, a document tentatively titled NFPA 110A, *Stored Energy Emergency and Standby Power Systems,* was submitted for adoption at the 1989 NFPA Annual Meeting.

Formally designated as NFPA 111, this document addressed the performance of stored energy systems with appropriate equipment detail. The requirements of the standard were considered necessary to obtain the minimum level of reliability and performance and to achieve an on-site stored energy auxiliary electrical power source suitable to the needs of the applicable requirements. If followed, its use would result in a system suitable for various situations as required by other codes and standards.

The second edition in 1993 contained only minor changes.

For the 1996 edition, a section was added to cover the acceptability of systems, methods, and devices other than those listed in the document.

The 2001 edition contained two changes: informational text was moved to the appendix and the operational testing requirements were expanded.

The 2005 edition underwent a complete rewrite in accordance with the *Manual of Style* for NFPA Technical Committee Documents. Along with the rewrite, some of the definitions were revised and located in Chapter 3. Other data in the document were transferred to the table format for better usability.

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The 2010 edition revised the document scope to clarify that an uninterruptible power supply (UPS) supplied through an emergency power supply (EPS) is not a stored emergency power supply system (SEPSS). The definitions of automatic transfer switch and nonautomatic transfer switch were revised to correlate with NFPA 110. New definitions covered battery cell types, bridging systems, and electrochemical energy storage devices. Energy sources, convertors, inverters, and accessories were covered by Chapter 5 revisions that clarified existing requirements, recognized new battery types, and provided requirements covering stored energy sources other than batteries. Revisions to area ventilation requirements acknowledged that there might be flammable gases other than hydrogen associated with energy sources that are not batteries. Annex diagrams were added to illustrate flywheel and rotating EPS systems, different UPS systems, and basic switching points of an SEPSS.

A rectifier plant, which is often used in the telecommunications industry, was added in 2013 as a potential stored emergency power supply system (SEPSS). These rectifier plants were also included as a suitable bridging system. The location of SEPSS equipment serving Level 1 EPSS loads was revised to correlate with the requirements of NFPA 110.

Throughout the 2016 edition, references to a stored emergency power supply system have been revised to a stored-energy emergency power supply system to more appropriately describe the type of system. Requirements for baseline measurements have been revised to provide more accurate data. The load test has been revised to correlate with the IEEE 450 rate-adjusted and time-adjusted capacity tests.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on minimizing the risk of electricity as a source of electric shock and as a potential ignition source of fires and explosions. It shall also be responsible for text to minimize the propagation of fire and explosions due to electrical installations.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on performance criteria for the selection and assembly of the components for emergency and standby power systems in buildings and facilities, including categories of power supplies, transfer equipment, controls, supervisory equipment, and all related electrical and mechanical auxiliary or accessory equipment needed to supply emergency or standby power to the utilization equipment. The Committee also shall be responsible for criteria on the maintenance and testing of the system. This Committee does not cover requirements for the application of emergency power systems, self-contained emergency lighting units, and electrical wiring, except that wiring that is an integral part of the system up to the load side of the transfer switch(es). This Committee shall report to Technical Correlating Committee of the National Electrical Code.

NFPA 111

Standard on

Stored Electrical Energy Emergency and Standby Power Systems

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall cover performance requirements for stored electrical energy systems providing an alternate source of electrical power in buildings and facilities in the event that the normal electrical power source fails.

1.1.2 Systems covered in this standard shall include power sources, transfer equipment, controls, supervisory equipment, and accessory equipment, including integral accessory equipment, needed to supply electrical power to the selected circuits.

1.1.3 This standard shall cover installation, maintenance, operation, and testing requirements as they pertain to the performance of the stored-energy emergency power supply system (SEPSS).

1.1.4 Exclusions.

1.1.4.1* This standard shall not cover the following:

(1) Application of the SEPSS
(2) Distribution wiring
(3) Systems having total outputs less than 500 VA or less than 24 V or systems less than Class 0.033
(4) Unit equipment
(5) Nuclear sources, solar systems, and wind stored-energy systems
(6) Uninterruptible power systems (UPS) supplied by an emergency power supply system (EPSS) or a UPS supplied by a SEPSS
(7) Optional standby systems

1.1.4.2 The following shall not be within the scope of this standard:

(1) Specific buildings or facilities, or both, requiring an SEPSS
(2) Specific loads to be served by the SEPSS
(3) Type, class, or level to be assigned to any specific load *(See Section 4.1.)*

1.2 Purpose.

1.2.1 This standard shall provide performance requirements for SEPSS and also shall be used in conjunction with other standards.

1.2.2 It shall be the role of other NFPA standards to specify which occupancies require an SEPSS and the applicable level, type, and class.

1.2.3 This standard shall not specify where an SEPSS is required. *(See 1.1.4.2.)*

1.2.4 This standard shall provide guidance for inspectors, designers, installers, manufacturers, and users of an SEPSS and shall serve as a basis for communication between the parties involved.

1.2.5 This standard shall not be considered a design manual.

1.2.6 Compliance with this standard shall not absolve the parties involved of their respective responsibilities for the design, installation, maintenance, performance, or compliance with other applicable standards and codes.

1.2.7 The installation of a stored-energy system(s) conforming to this standard shall ensure that alternate power is available to minimize life safety hazards resulting from power loss to certain continuous chemical or industrial processes, computer controlled systems, emergency lighting, and the like.

1.3 Application.

1.3.1 This document shall apply to new installations of SEPSS.

1.3.2 Existing systems shall not be required to be modified to conform except where the authority having jurisdiction determines that nonconformity presents a distinct hazard to life.

1.4 Equivalency. Nothing in this standard shall be intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety to those prescribed by this document, provided the requirements of 1.4.1 and 1.4.2 are met.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5 Function.

1.5.1 SEPSS shall provide a source of electrical power of required capacity, reliability, and quality to loads for a given length of time within a specified time after loss, failure, or disruption of the normal power supply.

1.5.2 An SEPSS shall include a means to recharge the stored-energy system.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code,* 2015 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.

2.3 Other Publications.

2.3.1 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE/SEI 7, *Minimum Design Loads for Buildings and Other Structures,* 2010.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code,* 2015 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems,* 2016 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Battery. Two or more cells connected together electrically in series or parallel, or both, to provide the required operating voltage and current levels.

3.3.1.1* ***Lead-Acid (LA) Cell.*** A secondary cell in which the active material of the positive electrode is lead dioxide, the active material of the negative electrode is lead, and the electrolyte is dilute sulfuric acid.

3.3.1.1.1* ***Valve-Regulated (VRLA).*** A lead-acid battery consisting of sealed cells furnished with a valve that opens to vent the battery whenever the internal pressure of the battery exceeds the ambient pressure by a set amount. [**1,** 2015]

3.3.1.1.2* ***Vented (Flooded).*** A lead-acid battery consisting of cells that have electrodes immersed in liquid electrolyte. [**1,** 2015]

3.3.1.2 ***Nickel-Cadmium (NiCd) Cell.*** A secondary cell in which the active material of the positive electrode is nickel oxyhydroxide, the active material of the negative electrode is cadmium, and the electrolyte is dilute potassium hydroxide.

3.3.1.3 ***Nickel-Metal Hydride (NiMH) Cell.*** A secondary cell in which the active material of the negative electrode is a hydrogen-absorbing alloy and the positive electrode is nickel.

3.3.2* Bridging System. A type of energy conversion equipment (ECE) intended to temporarily support the critical load with stored energy until an alternate energy source can assume the load.

3.3.3* Electrochemical Energy Storage Device. A device based on the interrelated transformations of chemical and electric energy, usually consisting of an anode, a cathode, and an electrolyte plus such connections (electrical and mechanical) as needed to allow the cell to deliver or receive electric energy.

3.3.4 Emergency Power Supply. See 3.3.8.1.

3.3.5 Emergency Power Supply System (EPSS). A complete functioning EPS system coupled to a system of conductors, disconnecting means and overcurrent protective devices, transfer switches, and all control, supervisory, and support devices up to and including the load terminals of the transfer equipment needed for the system to operate as a safe and reliable source of electric power. [**110,** 2016]

3.3.5.1 ***Stored-Energy Emergency Power Supply System (SEPSS).*** A system consisting of a UPS, a rectifier plant, or a motor generator powered by a stored electrical energy source; a transfer switch designed to monitor preferred and alternate load power source and provide desired switching of the load; and all necessary control equipment to make the system functional.

3.3.6 Energy Conversion Equipment (ECE). A system of either a UPS, a battery bank and battery charger (central battery system), or a rotating motor generator (with or without inertia flywheel), often supplied by a central battery system power source.

3.3.7 Internal Ohmic Measurement. A measurement of the electronic and ionic conduction path within a cell or unit, using techniques commonly known as impedance, conductance, or resistance tests.

3.3.8 Power Supply.

3.3.8.1* ***Emergency Power Supply (EPS).*** The source of electric power of the required capacity and quality for an emergency power supply system (EPSS). [**110,** 2016]

3.3.8.2* ***Uninterruptible Power Supply (UPS).*** A device or system that provides quality and continuity of ac power through the use of a stored-energy device as the backup power source during any period when the normal power supply is incapable of performing acceptably.

3.3.9 Transfer Switch.

3.3.9.1 ***Automatic Transfer Switch (ATS).*** Self-acting equipment for transferring the connected load from one power source to another power source. [**110,** 2016]

3.3.9.2 ***Nonautomatic Transfer Switch.*** A device, operated manually by a physical action or electrically by either a local or remote control, for transferring a common load between a normal and alternate supply. [**110,** 2016]

Chapter 4 Classification of Stored-Energy Emergency Power Supply Systems (SEPSS)

4.1* General. Stored-energy emergency power supply systems (SEPSS) shall be classified as detailed in Sections 4.2 through 4.5.

4.2 Type.

4.2.1 The type shall determine the maximum time, in seconds, that the SEPSS will permit the load terminals of the transfer switch to be without acceptable electrical power.

4.2.2* The interruption times of the SEPSS types covered by this standard shall be as provided in Table 4.2.2.

Table 4.2.2 was revised by a tentative interim amendment (TIA). See page 1.

Table 4.2.2 Types of SEPSS

Type	Interruption Time
Type O	No interruptions — UPS carrying load, 0.0 sec
Type U	UPS system with utility as preferred source
Type A	0.25 cycle: 0.0042 sec
Type B	1.0 cycle: 0.0167 sec
Type 10	10 sec
Type M	Manual stationary or nonautomatic — no time limit

4.3* Class. The class shall determine the minimum time, in hours, for which the SEPSS is designed to operate at its rated load without being refueled or recharged as shown in Table 4.3.

Table 4.3 Classes of SEPSS

Class	Reserve Time
Class 0.033	0.033 hr (2 min)
Class 0.083	0.083 hr (5 min)
Class 0.25	0.25 hr (15 min)
Class 1.5	1.5 hr (90 min)
Class X	Other time, in hours, as required by the application, code, or user

4.4 Category. This standard shall regulate stored-energy devices into the following two categories:

(1) Category A includes stored-energy devices receiving their energy solely from the normal supply under conditions of normal operation.
(2) Category B includes all devices not included in Category A and not specifically excluded elsewhere in this standard.

4.5* Level. The level of equipment installation, performance, and maintenance shall be as specified in 4.5.1 through 4.5.5.

4.5.1* Level 1 systems shall be installed where failure of the equipment to perform could result in loss of human life or serious injuries.

4.5.2* Level 2 systems shall be installed where failure of the EPSS to perform is less critical to human life and safety.

4.5.3 All equipment shall be permanently installed.

4.5.4* Level 1 and Level 2 SEPSS shall supply alternate power of a quality that ensures reliable operation of the load, within the time determined by the type and for a duration determined by the class.

4.5.5* Other equipment and applications, including optional standby systems, not defined in Levels 1 and 2 are beyond the scope of this document.

Chapter 5 Emergency Power Supply: Energy Sources, Convertors, Inverters, and Accessories

5.1 Energy Sources. The energy sources listed in this section shall be permitted for use for the emergency power supply (EPS).

5.1.1 Battery Systems.

5.1.1.1* Battery Types. Electrical storage batteries having a construction and chemical composition suitable for standby, float service operation shall consist of one of the following:

(1) Lead-acid batteries (LA)
(2) Nickel-cadmium batteries (NiCd)
(3) Nickel-metal hydride batteries (NiMH)
(4) Lithium ion (LI) batteries

5.1.1.2 Battery System Electrolyte. The following batteries shall be permitted with either free-flowing or immobilized electrolyte:

(1) LA
(2) NiCd
(3) NiMH

5.1.1.3 Battery Installation. Battery installations shall comply with the following:

(1) Vented batteries (LA, NiCd, NiMH) shall be installed in a room(s) dedicated to the batteries and associated equipment with approved ventilation.
(2) Vented batteries shall be mounted on open racks.
(3) Sealed and valve-regulated batteries (VRLA, NiMH, LI) shall be permitted in dedicated battery rooms. Batteries shall be mounted in either of the following ways:
    (a) On open racks
    (b) In listed battery cabinets
(4) Distributed sealed and valve-regulated batteries (VRLA, NiMH, LI) shall be permitted in occupied spaces and shall be mounted in one of the following ways:
    (a) In listed battery cabinets with restricted access (tool or key required)
    (b) In listed console or package style
    (c) In a combination of (a) and (b)

5.1.2* Mechanical Inertia Systems. Flywheel systems shall be installed in dedicated equipment rooms with restricted access or in enclosures with restricted access.

5.2 Energy Conversion Equipment (ECE) — General. ECE covered by this standard shall pertain to systems utilizing electrochemical devices, mechanical inertia devices, or both, with related control, conversion, and accessory items.

5.2.1* Bridging Systems. Bridging systems shall be capable of supporting the load for a finite period of time until the emergency or standby power source is able to assume the load.

5.2.1.1* The following electrochemical bridging systems shall be permitted:

(1) Solid state (static) UPS systems of the following types:
    (a) On-line UPS capable of assuming the load without interruption upon loss of the primary input source
    (b) Standby and off-line (UPS) capable of assuming the load within a specified time frame and without interruption of the load operation upon loss of the primary input source
(2) Ultracapacitor systems integrated into the following types of systems:
    (a) UPS systems capable of sustaining the load without interruption upon momentary loss or degradation of the primary input source with or without battery
    (b) Fuel cell systems capable of sustaining the load without interruption upon loss of input power until the fuel cell assumes the load
(3) Solid state (static) rectifier plants capable of providing continuous power to the dc load(s) without interruption or disturbance upon loss of the primary input source

5.2.2 Mechanical Inertia Systems. Flywheel systems shall sustain the load without interruption upon momentary loss or degradation of input power until power is restored or an emergency or standby power source assumes the load.

5.2.3 Level. The ECE for each level shall be of proven design and components whose performance and reliability have been documented.

5.2.4 Class. The ECE shall be identified by the manufacturer for the specified class.

5.2.5 Output. The output of an ECE shall be of the voltages, waveform, and frequency rated for the load.

5.2.6 Temperature. ECEs shall be designed to operate over the following expected environmental temperature ranges:

(1) Indoor: 10°C to 40°C (50°F to 104°F)
(2) Outdoor: −34°C to 50°C (−30°F to 122°F)

5.2.7* Humidity. The ECE shall be designed to function in an atmosphere having a relative humidity that can vary from 5 percent to 95 percent, noncondensing.

5.2.8 Capacity.

5.2.8.1 Class. The ECE shall have the capacity to supply power for the class for which it is rated.

5.2.8.2 Stored-Energy Recovery. Following a power outage for the full duration of the assigned class, the ECE shall be capable of automatically resupplying the full rated load and duration within the time appropriate for the technology as follows:

(1) Battery-based systems with a charger identified for the battery type and capable of recharging as follows:
    (a) 80 percent within 12 times the discharge period
    (b) 100 percent within 48 hours
(2) Ultracapacitor-based systems: 100 percent within 1 hour
(3) Mechanical inertia–based systems: 100 percent within 1 hour

5.3 Instrumentation.

5.3.1 Instruments. The SEPSS shall be provided with instruments or other approved display means, including remote annunciation capability, to indicate the requirements shown in Table 5.3.1, where applicable to the technology.

Table 5.3.1 Instrumentation Display Indicator

Device	Level 1	Level 2
Battery voltage	X	X
System output voltage, each leg	X	X
System output current, each leg	X	X
System output frequency (ac output systems only)	X	X

X = Required.

5.3.2 Indicators. Individual visual indicators and a common audible annunciator shall be provided for the requirements shown in Table 5.3.2.

Table 5.3.2 Visual Indicator Display Indicator

Device	Level 1	Level 2
Load on normal power	X	X
Load on emergency power	X	X
Output circuit breaker open	X	O
Output overload/overcurrent	X	X
High temperature	X	X
ECE in bypass mode	X	X
Low battery (if present)	X	X
Major alarm condition	X	X
Minor alarm condition	X	X

X = Required. O = Not Required.

5.3.3* Annunciation.

5.3.3.1 The following monitoring shall be provided at a minimum:

(1) For Level 1 SEPSS, local annunciation and facility remote annunciation, or local annunciation and network remote annunciation
(2) For Level 2 SEPSS, local annunciation

5.3.3.2 For the purposes of this section, the following shall be permitted:

(1) Local annunciation located on the equipment itself or within the same equipment room.
(2) Facility remote annunciation located on site but not within the room where the equipment is located.
(3) Network remote annunciation located off site.

Chapter 6 Transfer Switches and Protection

6.1 General.

6.1.1* Switching, as used in this chapter, shall refer to any electrical or electronic equipment that is used as follows:

(1) To transfer an electrical load from one power source to another
(2) To perform load-switching or load-shedding functions on any electrical load
(3) To bypass, isolate, and test any transfer or isolation switch in the static system
(4) To isolate any faulted component inside the static system so that it ceases to be connected to the output load terminals
(5) To bypass the energy conversion equipment (ECE)

6.1.2 Protection, as used in this chapter, shall reference electronic-sensing or inherent overload protective devices, such as fuses, automatic breakers, or both, that are used to protect the static system against damage caused by faults or overloads on either the output of the static system in its loads or conductors, or on internal faults in the static system.

6.1.3* Equipment used with batteries or other dc sources shall be identified and rated for the dc voltage and current.

6.2 Transfer Switches.

6.2.1 General. Transfer switches shall be rated for transferring the connected loads between the energy converter and the building electrical service.

6.2.1.1 Transfer switches shall be permitted to be electrical or electronic or a hybrid of both.

6.2.1.2 Any transfer switch shall be rated for transferring all connected electrical loads from one power source to another.

6.2.1.3 Transfer switch characteristics shall be sized for the connected electrical load.

6.2.1.4 Transfer switches shall provide rated isolation between the electrical load and the alternate source(s).

6.2.1.5 Transfer switches shall be permitted to be separate devices within their own enclosures or an integral part of the ECE.

6.2.1.6 The capacity and endurance rating of transfer switches shall be sized for all classes of loads to be served.

6.2.1.7 The method of operation of transfer switches shall ensure that the most likely causes of switch failure result in the loads being connected to the building service.

6.2.1.8 Means shall be provided to check the operation of the transfer switch.

6.2.2* Switch Capacity.

6.2.2.1 The capacity of the transfer switch, electronic or electromechanical, shall be rated for all classes of loads to be served.

6.2.2.2 The transfer switch, including all load current–carrying components, shall be rated to withstand the effects of available fault currents.

6.2.3 Transfer Switch Classification.

6.2.3.1 Each transfer switch shall be listed for emergency service as a completely factory-assembled and factory-tested apparatus unless under the conditions of 6.2.3.2.

6.2.3.2 Electronic or electromechanical switches that constitute an integral part of the ECE shall be permitted, provided they form part of a listed equipment.

6.2.4 Automatic Transfer Switch (ATS) Features.

6.2.4.1 General. Automatic transfer switches shall be electrically or electronically operated.

6.2.4.1.1 The transfer of the load from one source to another source shall be permitted to be automatic.

6.2.4.1.2 The retransfer shall be permitted to be automatically or manually initiated.

6.2.4.2 Source Monitoring. The preferred source shall be monitored for undervoltage and overvoltage on all its ungrounded input lines.

6.2.4.2.1 The ECE and the utility shall be monitored for unacceptable conditions.

6.2.4.2.2 If a condition that is out of tolerance is sensed, the transfer switch shall automatically switch to the alternate source(s) of power, provided that the alternate source(s) of power itself is within tolerance.

6.2.4.2.3 When the preferred source of power returns to levels of output within equipment tolerance in its sensed parameters as described in 6.2.4.2, the transfer switch shall be capable of initiating an automatic transfer to the preferred source.

6.2.4.2.4 An adjustable time delay shall be allowed to ensure that the preferred source is within its steady-state specification limits before such retransfer is performed.

6.2.4.2.5 Provision for retransfer to the preferred source also shall be available under manual command, provided the preferred source is within tolerance.

6.2.4.2.6 Retransfer shall be permitted to be sequenced if desired to pick up heavy loads without introducing further disturbances.

6.2.4.3 Interlocking.

6.2.4.3.1 Interlocking shall be provided to prevent inadvertent interconnection of the preferred and alternate power sources unless under the conditions of 6.2.4.3.2.

6.2.4.3.2 Where interconnection is inherent in the system design, the preferred and alternate sources of power shall not be connected together longer than is necessary to transfer the preferred sources of power, without disturbance to the electrical loads connected to it, provided that such interconnection can be sustained by the two connected sources of incoming power without causing internal current protection features to be initiated.

6.2.4.4* Manual Operation. Instruction and equipment shall be provided for the manual nonelectric transfer or bypass in the event the automatic transfer switch malfunctions.

6.2.4.5* Time Delay on Retransfer to Preferred Source.

6.2.4.5.1 An adjustable time delay device with automatic bypass shall be provided to delay retransfer from the alternate source to the preferred source of power.

6.2.4.5.2 The time delay shall be automatically bypassed if the ECE or EPS fails.

6.2.4.6 Test Switch.

6.2.4.6.1 A test switch shall be provided on each automatic transfer switch that simulates failure of the preferred power source.

6.2.4.6.2 The automatic transfer switch shall perform its intended function when the test switch is activated.

6.2.5 Nonautomatic Transfer Switch Features.

6.2.5.1 General. Manual control of switching devices shall be permitted to be either local or remote.

6.2.5.1.1 When initiated, a device shall switch to its alternate state and shall remain in that state.

6.2.5.1.2 Upon cessation of the initiating control action, the device shall return to its preferred state.

6.2.5.2 Interlocking. Reliable mechanical interlocking, or an approved alternate method, shall prevent the inadvertent interconnection of the preferred and alternate power sources or of any two separate sources of power.

6.2.5.3 Indication of Switch Position. Two pilot lights with identification nameplates, or other approved position indicators, shall be provided to indicate the switch position.

6.3 Load Switching (Load Shedding).

6.3.1 General. When the connected load exceeds the capacity of the ECE, system controls shall automatically do one of the following:

(1) Disconnect pre-identified noncritical loads
(2) Transfer the loads to bypass

6.3.2 Transfer Switch Rating.

6.3.2.1 Each transfer switch shall have a continuous current rating and interrupting rating for all classes of loads to be served.

6.3.2.2 The transfer switch shall be capable of withstanding the available fault current at the point of installation.

6.3.3 Operation. First priority loads shall be switched to the emergency bus (if not already on that bus) when the emergency source is made available to their switching devices.

6.3.3.1 The remaining lower priority loads shall be switched to the emergency bus thereafter, provided the emergency bus is not overloaded by such switching, until all such emergency loads of lower priority are on the emergency bus.

6.3.3.2 The total loading on the emergency bus also shall be reduced by switching off the loads in inverse priority order, in proportion to the lost power capacity of the isolated module, when both of the following conditions exist:

(1) Any static power module connected to the emergency bus is isolated from that bus due to internal failure.
(2) The remaining connected power modules cannot serve the total connected load because they are overloaded.

6.3.3.3 Disconnecting the lower priority loads (load shedding) shall cease when the load demand matches the connected capacity of the remaining modules.

6.4 Bypass Switches.

6.4.1* Isolation. Bypass switches, with or without isolation, shall be permitted for bypassing or for bypassing and isolating the transfer switch, and if installed, bypass switches shall be in accordance with 6.4.2 and 6.4.3.

6.4.2 Bypass Switch Rating. The bypass switch shall have a continuous current rating and shall withstand a current rating compatible with that of the associated transfer switch.

Exception: UPS static bypass transfer switches shall be permitted to have a current rating and interrupting rating for all classes of loads to be served sufficient to support all connected loads from either source.

6.4.3 Bypass Switch Classification. Each bypass switch shall be designed for emergency electrical service as a completely factory-assembled and factory-tested apparatus.

6.5 Protection.

6.5.1* General.

6.5.1.1 The overcurrent protective devices in the SEPSS shall be coordinated to ensure selective tripping of the circuit overcurrent protective devices when a short-circuit current occurs.

6.5.1.2 The maximum available short-circuit current from both the utility source and the emergency energy source shall be evaluated to verify compliance with this coordination.

6.5.2 Overcurrent Protective Device Rating.

6.5.2.1 The rating of integral devices (e.g., fuses or breakers) shall be coordinated with the rating of downstream protective devices, taking into account the prospective short-circuit current available from the connected upstream power sources, such that the downstream devices operate first to eliminate the least critical portion of the connected electrical load.

6.5.2.2 In those cases where electronic protection is incorporated via feedback to limit the current output of the ECE, the internal transfer switch(es) shall operate to switch the connected electrical load to the alternate source.

6.5.3 Accessibility. Overcurrent devices in EPSS circuits shall be accessible to authorized persons only.

Chapter 7 Installation and Environmental Considerations

7.1 General.

7.1.1 This chapter shall provide the minimum requirements and considerations for an SEPSS relative to the installation and environmental conditions that could adversely affect its performance.

7.1.2 When the location of the SEPSS is evaluated, consideration shall be given to the geographic location, building type, classification of occupancy, and hazardous nature of the area.

7.1.3 The SEPSS equipment shall be installed in a manner and location recommended by the manufacturer and acceptable to the authority having jurisdiction.

7.1.4 Where normal power is available, the EPS shall serve Level 1 and Level 2 system loads and shall be permitted to serve additional loads, provided that, on failure of the normal power, the additional loads are automatically dropped to ensure that the EPS has sufficient capacity to serve the Level 1 and Level 2 loads.

7.2 Location.

7.2.1* The SEPSS shall be located in a room(s) in accordance with the manufacturer's environmental specifications.

7.2.1.1 The location of SEPSS equipment serving Level 1 EPSS loads shall not be installed in the same room with the normal supply equipment, where the supply equipment is rated over 150 volts to ground and equal to or greater than 1000 amperes.

7.2.2 The rooms or buildings housing the SEPSS shall be located to minimize the possibility of damage from flooding, including flooding resulting from fire fighting, sewer water backup, and similar disasters or occurrences.

7.2.3 SEPSS Equipment.

7.2.3.1 The SEPSS equipment shall be installed in a location that allows for equipment accessibility and working space clearance for the inspection, repair, maintenance, cleaning, or replacement of the unit per Table 110.26(A)(1) of *NFPA 70 (NEC)*.

7.2.3.2 A separate unit emergency lighting system shall be provided at the SEPSS location if no other emergency lighting is present.

7.3 Heating, Cooling, Ventilating, and Humidity Control.

7.3.1 The SEPSS shall be located in an area provided with heating and cooling capable of ensuring, both during the time that normal power is available and during an emergency, that the equipment is operated within the manufacturer's ambient temperature specifications. *(See also 5.2.6.)*

7.3.2 Provisions shall be made for sufficient diffusion and ventilation of the flammable gases from the battery or other electrochemical energy storage devices to limit the concentration of flammable gas in accordance with NFPA 1 or other applicable codes.

7.3.3 Ventilation.

7.3.3.1* For SEPSS equipment using free-flowing liquid electrolyte (a.k.a. vented or flooded) batteries in which vents allow the continuous evolution and release of gases into the battery space, ventilation openings or airflow shall be situated to limit the possibility of the buildup of gas pockets in accordance with NFPA 1.

7.3.3.2 Where needed, fans used to circulate and exhaust air shall use motors designed for the application. *(See Article 480, NFPA 70.)*

7.4 Protection.

7.4.1 The room in which the EPS equipment is located shall not be used for storage purposes.

7.4.2 Where SEPSS equipment rooms or separate buildings are equipped with fire suppression, one of the following systems that is compatible with the battery or other electrochemical type shall be used:

(1) Clean agent gaseous systems
(2) Pre-action systems
(3) Other suppression systems approved by the AHJ

7.4.3 Where SEPSS equipment rooms are equipped with fire detection systems, the installation of the fire detection system shall be in accordance with applicable standards. *(See NFPA 72.)*

7.4.4 The SEPSS equipment shall be protected from voltage transients due to lightning.

7.4.5* Seismic Risk.

7.4.5.1 In seismic design categories C, D, E, and F, as determined in accordance with ASCE 7/SEI 7, *Minimum Design Loads for Buildings and Other Structures,* the equipment shall be designed to reduce the risk of failure caused by the anticipated seismic ground motion.

7.4.5.2 Components of an SEPSS shall be assigned a component importance factor of 1.5, per ASCE 7/SEI 7, *Minimum Design Loads for Buildings and Other Structures.*

7.4.5.3 The batteries shall be restrained in position, to limit the chance of spillage or breakage due to the anticipated seismic ground movement.

7.4.5.4 Outgoing bus bars and cables on battery systems shall be braced in such a manner as to limit the chance of post rupture where seismic ground movement is anticipated.

7.5 Distribution.

7.5.1 The grounding, distribution, and wiring systems within the EPS shall be installed in accordance with applicable standards. *(See NFPA 70.)*

7.5.2 The electrical distribution system within the SEPSS shall be complete with overcurrent and fault current protective equipment designed and sized for the system.

7.5.3 Overcurrent protective devices for batteries or other dc sources shall be located as close as practical to the stored-energy source to minimize possibility of fault.

7.5.4 Storage batteries used to power the SEPSS shall be located as close to the SEPSS as practicable and shall be connected using cable that is sized to limit the voltage drop to levels within the SEPSS manufacturer's specifications.

7.6 Installation Acceptance.

7.6.1 Upon completion of the installation of the SEPSS, the system shall be tested to ensure conformity with the requirements of this standard with respect to both power output and function.

7.6.2 An on-site acceptance test shall be conducted to determine final approval for all SEPSS.

7.6.2.1 For battery-based systems, the on-site test shall be conducted in the following manner:

(1) With the batteries fully charged and with a connected load bank at rated value, a normal power failure shall be initiated by opening all switches or breakers supplying the normal power to that load.
(2) All emergency loads, including those not normally energized, shall be included in the on-site test.
(3) The time delay between initiation of the power failure and the assumption of the load by the EPS shall be observed and recorded.
(4) The voltage and current supplied to the emergency load and, where applicable, the frequency, waveform, and transients shall be recorded.
(5) The load test shall be continued for 15 minutes or the rated time (class), whichever is shorter, and the following shall be observed and recorded:
    (a) Voltage and current to the load
    (b) Voltage and current of the battery bank
    (c) Where applicable, the frequency
(6) The normal power shall be restored to the monitored circuit.
(7) The transfer time shall be observed.

7.6.2.2 Immediately following the test specified in 7.6.2.1, the SEPSS shall be connected to the normal power for 24 hours. *(See 5.2.8.2.)*

7.6.2.3 System Load Test. A system load test shall be initiated following the recharge period required in 7.6.2.2.

7.6.2.3.1 The system load test shall be permitted to be performed on the site-connected load; however, a load bank shall be permitted to be used to augment the site-connected load, provided that it is sized to be equal to the ECE rating.

7.6.2.3.2 The unity power factor for an ac SEPSS shall be permitted, provided that rated load tests at the rated power factor are within the design parameters stated by the manufacturer of the SEPSS.

7.6.2.3.3 The duration of the load test shall be 100 percent of the class for which the SEPSS is rated.

7.6.2.3.4 The following procedure shall be utilized:

(1) A normal power failure shall be initiated by opening all switches or breakers supplying the normal power to that load.
(2) All emergency loads, including those not normally energized, shall be included in the on-site test.
(3) The time delay between initiation of the power failure and the assumption of the load by the EPS shall be observed and recorded.
(4) The voltage and current supplied to the emergency load and, where applicable, the frequency, waveform, and transients shall be recorded.
(5) The load test shall be continued for 15 minutes or the rated time (class), whichever is shorter, and the following shall be observed and recorded:
    (a) Voltage and current to the load
    (b) Voltage and current of the battery bank
    (c) Where applicable, the frequency
(6) The normal power shall be restored to the monitored circuit.
(7) The transfer time shall be observed.

7.6.3* Any battery cells or multicell units, transfer switches, or other system components that have failed shall be replaced and so noted on test reports or records, after which the system shall be retested.

7.6.4 The following shall be made available to the authority having jurisdiction at the time of the acceptance test:

(1) Factory test data on the completed system
(2) Battery specifications
(3) Vendor's certificate of compliance to the specification

7.6.5 Baseline Measurement. A permanently installed method of monitoring lead-acid batteries shall be permitted based on ohmic measurements.

7.6.5.1* Ohmic measurements shall be taken of every cell within the battery system after approximately 6 months of operation following the full load test described in 7.6.2.3, or 2 weeks following the most recent discharge thereafter.

7.6.5.1.1 Measurements shall be taken on a fully charged battery while float charging.

7.6.5.1.2 The data shall be recorded to establish a baseline against which all future measurements will be compared.

Chapter 8 Routine Maintenance and Operational Testing

8.1 General. The SEPSS shall have routine maintenance and operational testing based on the manufacturer's recommendations, instruction manuals, and the minimum requirements of this chapter and subject to the approval of the authority having jurisdiction.

8.2 Manuals, Special Tools, and Spare Parts.

8.2.1 At least two sets of instruction manuals for the SEPSS shall be supplied by the manufacturer of the SEPSS and shall contain the following:

(1) A detailed explanation of the operation of the system
(2) A schematic wiring diagram
(3) A function block diagram
(4) The energy storage device's specification, installation instructions, maintenance information, and wiring diagrams

(5) Instructions for routine maintenance
(6) Recommended spare parts list with part numbers and part sources
(7) Routine troubleshooting procedures

8.2.2 For Level 1, one set of the instructions shall be kept with the equipment, and the other set shall be kept in another secure location.

8.2.3 Special tools and testing devices required for routine maintenance shall be available for use when needed.

8.3 Maintenance and Operational Testing.

8.3.1 The SEPSS shall be maintained so that the system is capable of supplying the service quality within the time specified for the type and for the time duration specified for the class.

8.3.2* A routine maintenance and operational testing program shall be initiated immediately following the acceptance test or any repair or component replacement, including battery replacement. *(See Table A.8.3.2 and Figure A.8.4.2 for guidance.)*

8.3.3 Reproducible Records.

8.3.3.1 A reproducible record of inspection, tests, and repairs shall be maintained on the premises. *(See Table A.8.3.2.)*

8.3.3.2 The record shall include the following:

(1) Completion of a log
(2) Notification of any unsatisfactory condition and the corrective actions taken, including parts replaced
(3) Identification of the servicing personnel
(4) Documentation of a completed test of the SEPSS, according to 8.4.1, immediately following any repair or battery replacement

8.4 Operational Inspection and Testing.

8.4.1* Level 1 equipment shall be inspected monthly and tested in accordance with the manufacturer's recommendations. *(See Figure A.8.4.2.)*

8.4.2* Inspection of the equipment shall include the following:

(1) The battery and associated charger/control equipment shall be checked to verify that they are in a clean and satisfactory condition and that no exceptional environmental or other conditions exist that could damage or affect performance.
(2) Battery electrolyte levels shall be checked, where applicable, and refilled as necessary.
(3) Terminals and intercell connectors shall be cleaned and regreased, if necessary, and cell tops shall be cleaned.
(4) Individual cell voltages shall be checked and recorded where practical.
(5) The specific gravity of pilot cells shall be checked and recorded, where applicable.
(6) The conditions of the plates and sediment of free-electrolyte, LA batteries in transparent containers shall be noted.
(7) All indicator lamps, meters, and controls shall be checked to verify that they are operating correctly.
(8) The load value shall be checked to ensure that it is within the equipment rating.

8.4.3 Load Testing.

8.4.3.1 A load test shall be performed as required by 8.4.1. The output voltage, battery voltage, and duration of the test shall be recorded at the beginning and at the end of the test for each battery set.

8.4.3.2 When a method of ohmic measurements is used to monitor LA batteries, the results shall be maintained and checked for deviance from the baseline established in 7.6.5.

8.4.3.2.1 If data indicate deviation outside an acceptable range, the battery shall be load tested for the full duration for its class.

8.4.3.2.2 A fully rated load bank shall be used in lieu of an actual load, provided it is sized to be equal to the ECE rating.

8.4.4 The SEPSS shall be tested annually by one of the following methods:

(1) At 100 percent of its rated load for 60 percent duration of its rated class
(2) At 60 percent of its rated load for 100 percent duration of its class

8.4.5 A written record of all checks and tests in 8.4.2 shall be maintained and shall be accessible to the authority having jurisdiction. *(See Figure A.8.4.2.)*

8.4.6 The routine maintenance and operational testing program shall be performed by qualified personnel.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 This document applies to stored-energy power systems that are used in lieu of the systems defined in NFPA 110. For emergency power systems supplied by emergency generators, see NFPA 110. Such systems are regulated in Articles 700 and 701 of *NFPA 70 (NEC)*.

A.1.1.4.1 Optional standby systems are described in Article 702 of *NFPA 70 (NEC)*.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1.1 Lead-Acid (LA) Cell. Multiple cells make up an LA battery. LA cells are often further identified by the type of lead alloy. Most common is "lead-calcium." "Lead antimony" and "lead selenium" are also used.

A.3.3.1.1.1 Valve-Regulated (VRLA). In VRLA batteries, the liquid electrolyte in the cells is immobilized in an absorptive glass mat (AGM cells or batteries) or by the addition of a gelling agent (gel cells or gelled batteries).

A.3.3.1.1.2 Vented (Flooded). Flooded lead-acid batteries have a provision for the user to add water to the cell and are equipped with a flame-arresting vent that permits the escape of hydrogen and oxygen gas from the cell in a diffused manner such that a spark, or other ignition source, outside the cell will not ignite the gases inside the cell. [**1,** 2015]

A.3.3.2 Bridging System. A bridging system is an electrical system used to support the load only long enough to allow transfer to an alternate energy source (such as an emergency or standby generator, fuel cells, or an alternate utility source). Common bridging systems are rotary, static, or hybrid UPS systems.

A.3.3.3 Electrochemical Energy Storage Device. Examples of electrochemical energy storage devices include batteries and ultracapacitors.

A.3.3.8.1 Emergency Power Supply (EPS). The supply includes all the related electrical and mechanical components of the proper size and/or capacity required for the generation of the required electrical power at the EPS output terminals.

For rotary energy converters, components of an EPS include the following:

(1) Prime mover
(2) Cooling system
(3) Generator
(4) Excitation system
(5) Starting system
(6) Control system
(7) Fuel system
(8) Lube system (if required)

For stationary fuel cell systems, components of an EPS include the following:

(1) Fuel cell stack
(2) Cooling system
(3) Fuel system (pure H_2, reformer system or natural gas)
(4) Air supply
(5) Exhaust system (cathode, purge)
(6) Starting system (batteries, ultracapacitors)
(7) Control system
(8) Power conversion system

Chemically derived stored-energy emergency supplies include, but are not limited to, batteries and fuel cells.

A.3.3.8.2 Uninterruptible Power Supply (UPS). The UPS usually monitors and tracks the voltage and frequency of the normal source. It could be the preferred or alternate source of power to the load.

A.4.1 The terms *emergency power supply systems (EPSS)* and *standby power supply systems,* as used in this standard, include such other terms as *alternate power systems, standby power systems, legally required standby systems, alternate power sources,* and other similar terms. Because this standard specifies the installation, performance, maintenance, and test requirements in terms of types, classes, categories, and levels, any one of the terms listed might be appropriate to describe the application or use, depending on the need and the preference of the parties involved.

For optional standby systems, see Article 702 of *NFPA 70 (NEC).*

A.4.2.2 Table 4.2.2 includes two types of uninterruptible power supply (UPS). UPS systems are available today that are capable of operation in more than one normal mode of operation. Typically, each normal mode will have a different input dependency characteristic, depending on whether the UPS output creates a new source of voltage and frequency or passes through to the load the same voltage and/or frequency characteristics of the input when not operating from its stored-energy source (e.g., battery). Some UPS have a single mode of operation, whereas other UPS can allow the user to select from among multiple modes of operation. The U.S. Environmental Protection Agency (EPA) has adopted the terminology of IEC 62040-3, *Uninterruptible Power Systems (UPS)-Part 3: Method of Specifying the Performance and Test Requirements*, which identifies the following modes of operation:

Voltage and Frequency Dependent (VFD) — Typical of an off-line UPS. Loads are supported by straight utility power until the source goes out of tolerance, at which time the UPS switches to its stored energy and inverter. VFD types typically have the best efficiency but lowest power quality. This is an example of a interruption Type U.

Voltage Independent (VI) — Typical of a line-interactive UPS, in which there could be voltage regulation, transient protection, or both, but frequency tracks the input source. VI types typically have moderate efficiency and moderate power quality. This is an example of a interruption Type U.

Voltage and Frequency Independent (VFI) — Typical of a double conversion UPS, in which both voltage and frequency are independently created by the UPS inverter. VFI types typically have somewhat lower efficiency but offer the highest power quality. This is an example of a interruption Type O.

Some UPS are able to sense a power abnormality and switch from one operating mode to another, with a time delay typically ranging from ½ to 1½ cycles. Continued operation (availability) of the load depends on the ability of its internal stored energy (e.g., capacitors) to hold it up during transfer. Only full double conversion meets Type O — all others will have some degree of transfer time that will vary depending on conditions.

A.4.3 Selection of the EPS class should take into account past outage records and fuel delivery problems due to weather and other geographic/environmental conditions. For SEPSS with batteries, the values shown in Table 4.3 assume capacity at the end of life. The end of life for lead-acid batteries is typically defined as the point at which a battery can no longer deliver 80 percent or more of its rated capacity. The end of life can vary for different types of batteries.

A.4.5 It is recognized that an SEPSS is utilized in many different locations and for many different purposes. The requirement for one application might not be appropriate for another application.

A.4.5.1 Typically, Level 1 systems are intended to automatically supply illumination, power, or both, to critical areas and equipment in the event of failure of the normal supply or in the event of damage to elements of a system intended to supply, distribute, and control power and illumination essential for safety to human life.

Level 1 systems generally are installed in places of assembly where artificial illumination is necessary for safe exiting and for panic control in buildings subject to occupancy by large numbers of people. Level 1 systems correspond to Article 700 of *NFPA 70 (NEC)* for emergency systems.

Emergency systems also can provide power for such functions as uninterruptible power supplies, ventilation where essential to maintain life, fire detection and alarm systems, public safety communications systems, industrial processes where current interruption would produce serious life safety or health hazards, and similar functions. *(See NFPA 101 and Chapter 6 of NFPA 99.)*

A.4.5.2 Typically, Level 2 systems are intended to supply power automatically to selected loads (other than those classed as emergency systems) in the event of failure of the normal source.

Level 2 systems typically are installed to serve loads such as heating and refrigeration systems, communication systems, ventilation and smoke removal systems, sewage disposal, lighting, and industrial processes that, when stopped due to any interruption of the normal electrical supply, could create hazards or hamper rescue or fire-fighting operations. Level 2 systems correspond to Article 701 of *NFPA 70 (NEC)* for legally required standby systems.

A.4.5.4 It is important to recognize that an SEPSS can react in a manner substantially different from commercial power during transient and short-circuit conditions because of the relatively small capacities of the SEPSS as compared to a commercial power source.

See ANSI C84.1, *American National Standard for Electric Power Systems and Equipment — Voltage Ratings (60 Hertz).*

A.4.5.5 A UPS has stored energy (e.g., batteries) and could function as a bridging system in an EPSS. The UPS would be classified as an optional standby system, even though it is part of the greater EPSS.

A.5.1.1.1 Other emerging battery types have potential for use in SEPSS but have yet to become widely accepted in the industry. These include, but are not limited to, sodium metal-halide, sodium sulfur, vanadium redox, polysulphide bromide, and zinc bromine.

A.5.1.2 See Figure A.5.1.2(a) and Figure A.5.1.2(b) for examples of typical flywheel and rotating EPS systems.

A.5.2.1 Bridging systems can be used where Article 700 of *NFPA 70 (NEC)* requires an auxiliary power supply.

A.5.2.1.1 The requirements of 5.2.1.1 apply specifically to those solid state (static) UPS systems intended to supply power to the emergency loads during an interruption of the main power source (usually utility power) until an alternate source of power is available (such as a standby or emergency generator per NFPA 110). The intent is to cover electronic types of stored-energy systems in which power must be restored automatically and electrically when electrical power is restored to the ECE from a stable source. Mechanical inertia systems are specifically not included in the section.

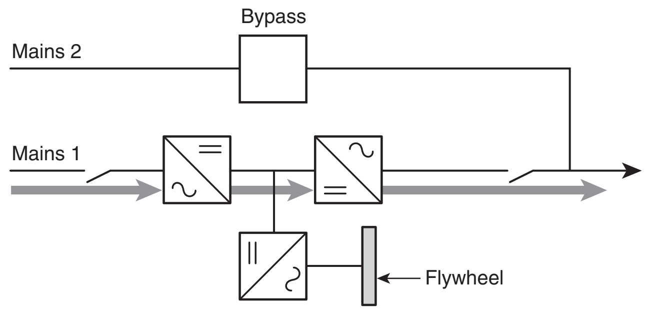

FIGURE A.5.1.2(a) UPS Using Flywheel as Energy Storage.

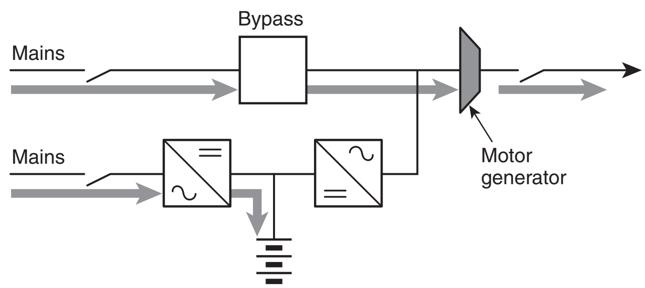

FIGURE A.5.1.2(b) Motor-Generator High Impedance Line Interactive Topology.

A.5.2.7 If the ambient temperature in the location falls below 20°C (68°F), anticondensation measures should be considered.

A.5.3.3 The minimum "remote alarm annunciation" is to alert personnel at a constantly attended station somewhere on the site when the facility is in use as a Level 1 system. If the site is not continuously occupied, "network remote" should allow people at another site to know the operating status of the equipment.

The preferred method of remote annunciation is to notify personnel both somewhere on the site and at other locations via a network such as LAN, WAN, or internet, including the ability to initiate auto-dial and send predefined text messages.

A.6.1.1 It is the intent of 6.1.1 to apply to any point in the system at which power is transferred from one point to another, such as shown in Figure A.6.1.1.

A.6.1.3 AC ratings are not suitable for dc applications. Not all overcurrent protective devices (OCPDs) are suitable for dc. Circuit breakers and/or fuses should be listed and labeled for their dc rating.

A.6.2.2 See ANSI/UL 1008, *Standard for Safety Transfer Switch Equipment.*

A.6.2.4.4 Authorized, trained personnel should be available and familiar with manual operation of the transfer switch and

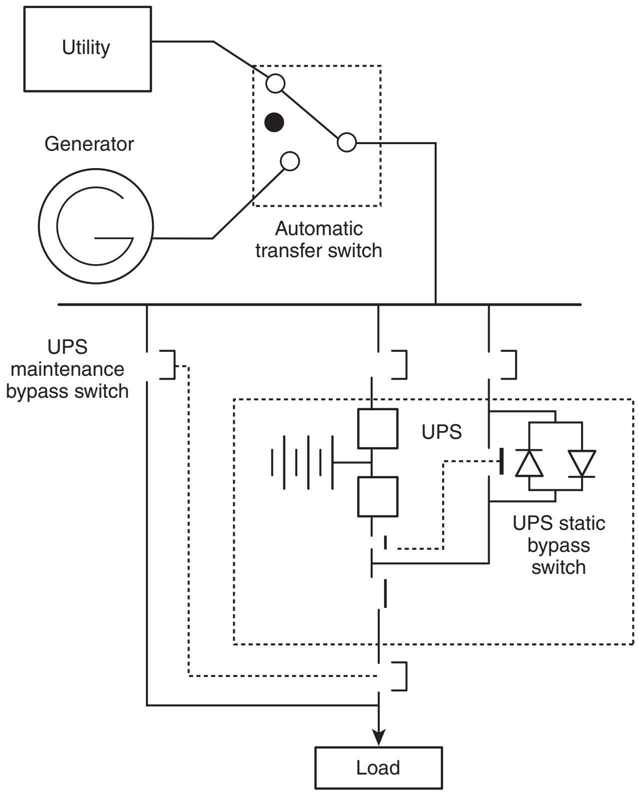

FIGURE A.6.1.1 Simplified One-Line SEPSS Switching Points.

should be capable of determining the adequacy of the alternate source of power prior to manual transfer.

A.6.2.4.5 The timer is intended to allow the preferred source of power to stabilize before retransfer of the load.

A.6.4.1 Consideration should be given to the effect that load interruption could have on the load during maintenance and service of the transfer switch.

A.6.5.1 It is extremely important that the various overcurrent devices be coordinated to protect against cascading operation on short-circuit faults. Primary consideration also should be given to prevent overloading of equipment by limiting the possibilities of large current inrushes due to instantaneous reestablishment of connections to heavy loads.

A.7.2.1 Separate rooms might be necessary for battery banks for the following reasons:

(1) Possibility of corrosion
(2) Ventilation for hazardous gas accumulation
(3) Service requirements

A.7.3.3.1 Battery rooms frequently house vented lead-acid (VLA) or nickel-cadmium (NiCd) batteries that evaporate electrolyte gas into the battery space, thereby requiring periodic water replenishment. Valve regulated lead-acid (VRLA) batteries, by contrast, vent immeasurable amounts of flammable gas under normal conditions, but they can also vent significant amounts of gas under certain failure modes such as thermal runaway. Battery manufacturers can provide guidance on the rate of gassing. All batteries require some ventilation.

A.7.4.5 Consideration should be given to the location of the emergency conversion equipment (ECE), both as it relates to the building structure and to the effects of an earthquake.

All emergency power equipment support or subsupport systems should be designed and constructed so that they can withstand anticipated static or dynamic seismic forces, or both, in any direction, with the minimum force value used being equal to the equipment weight.

Bolts, anchors, hangers, braces, and other restraining devices should be provided to limit earthquake-generated differential movements between the ECE nonstructural equipment and the building structure. However, the degree of isolation necessary for vibration and acoustical control of the ECE and other equipment should be maintained.

Suspended items such as piping, conduit, ducts, and other auxiliary equipment related to the emergency power supply system (EPSS) should be braced in two directions to resist swaying and excessive movement resulting from seismic ground motion.

Battery racks for ECE and electrical items or related auxiliaries, or both, should be designed to resist internal damage and damage at the equipment supports resulting from seismic ground motion.

Battery racks should be capable of withstanding seismic forces in any direction equal to the supported weight. Batteries should be restrained to their support to prevent vibration damage, and electrical interconnections should be provided with adequate slack to accommodate all relative deflections.

A.7.6.3 Any component of an SEPSS that has failed — not just battery components — should be replaced. If elements of the system have failed and been replaced, the SEPSS should be retested to ensure proper performance before being put into service. If battery cells or units have been replaced, the replacement cells should be torqued, charged, and balanced in accordance with the manufacturer's recommendations.

A.7.6.5.1 Case studies show that battery units are too unstable to get meaningful ohmic data when they are first installed. After a battery has been installed for some period of time (typically 6 months or longer), reliable baseline data can be taken. The actual stabilization time can vary depending upon a number of variables, including the number of discharge/recharge cycles that occur.

A.8.3.2 Maintenance procedures and frequency should follow those recommended by the manufacturer. In the absence of such recommendations, Table A.8.3.2 indicates suggested procedures.

A.8.4.1 The following standards should be consulted for recommendations on battery inspection, testing, and maintenance:

(1) IEEE 450, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*
(2) IEEE 1106, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*
(3) IEEE 1188, *Recommended Practice for Maintenance, Testing and Replacement of Valve-Regulated Lead-Acid Batteries for Stationary Applications*

For other battery chemistries, refer to the manufacturer's recommendations.

A.8.4.2 Figure A.8.4.2 provides guidance for operation and testing.

Table A.8.3.2 Suggested Maintenance Schedule for Solid-State Emergency Power Supply Systems

Item Component (as Applicable)	Procedure: Visual Inspection	Check	Change	Clean	Test	Frequency
Battery						
Float voltage		X				M
Cable connections		X				S
Terminals				X		Q
Electrolyte gravity					X	Q
Electrolyte level	X					M
Replace cell or battery			X			See manufacturer's instructions
ECE						
Power supply voltage		X				M
Terminals		X				S
Panel meters	X					M
Panel lamps	X					M
Circuit breakers, fuses	X	X	X	X		Every 2 years
Battery charger						
Output terminal volts		X				M
Fuses	X	X	X	X		Every 2 years
Charge current		X			X	Q
Equalize voltage		X				Q
Panel meters	X					M
Panel lamps	X					M
Load						
Load current		X				Q
Panel meters	X					M
Transfer switch						
Contacts	X					A
Test switch					X	S
Fuel cell						
Check fuel supply (pressure/quantity)	X					Q
Start up system	X					Q
Exercise load until system heats up					X	Q
Fuel supply piping	X					A
Exhaust piping	X					A
Air supply piping	X					A
Cooling system	X					A
Connectors				X		A
Fuel system pressure/leakage					X	A
Full load test					X	A
Calibrate H_2 detector		X				A

A: Annually. M: Monthly. Q: Quarterly. S: Semiannually. X: Actions.

SEPSS MAINTENANCE SCHEDULE CHECKLIST

Component Description	Frequency	Action Performed Yes	No	N/A	Date Completed
Battery					
Check float voltage	M	❑	❑	❑	______
Check cable connections	S	❑	❑	❑	______
Clean terminals	Q	❑	❑	❑	______
Test electrolyte gravity	Q	❑	❑	❑	______
Visually inspect electrolyte level	M	❑	❑	❑	______
Visually inspect and replace cell or battery	Manufacturer's instructions	❑	❑	❑	______
ECE					
Check power supply voltage	M	❑	❑	❑	______
Check terminals	S	❑	❑	❑	______
Visually inspect panel meters	M	❑	❑	❑	______
Visually inspect panel lamps	M	❑	❑	❑	______
Visually inspect circuit breakers/ fuses, check, replace, or clean	Every 2 years	❑	❑	❑	______
Battery Charger					
Check output terminal voltage	M	❑	❑	❑	______
Visually inspect, check, replace, and clean fuses	Every 2 years	❑	❑	❑	______
Test charge current	Q	❑	❑	❑	______
Check/equalize voltage	Q	❑	❑	❑	______
Visually inspect panel meters	M	❑	❑	❑	______
Check panel lamps	M	❑	❑	❑	______
Load					
Check load current	Q	❑	❑	❑	______
Check panel meters	M	❑	❑	❑	______
Transfer Switch					
Visually inspect contacts	A	❑	❑	❑	______
Verify test switch	S	❑	❑	❑	______

Measure and Record Values:

	Date
Output AC Volts	
Frequency in Hz	______
Load in amperes	______
DC Voltage	
Prior to ac failure	______
1 minute after ac failure	______
5 minutes after restoring ac input	______
Battery Wet Lead-Acid	
For each battery	______
Measure gravity	______
Check electrolyte level	______

	Date
Charge Current	
Prior to ac failure	______
5 minutes after failure	______
Meters	______
Panel lamps	______
Load circuit breakers	______
Bus bars/cables of battery systems	______

M: Monthly. Q: Quarterly. S: Semiannually. A: Annually.

Test performed by: ______________________ Date: _____ /_____ /______

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FIGURE A.8.4.2 Stored-Energy Emergency Power Supply System Operation and Suggested Testing Log.

Annex B Diagram of SEPSS Versus EPSS Use of Stored-Energy System

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Figure B.1(a) through Figure B.1(d) show an uninterruptable power supply (UPS) being used in different functions.

Figure B.1(a) distinguishes the use of a stored-energy system as an SEPSS from a stored-energy system being supplied from an EPSS.

Figure B.1(b) shows a UPS being used as a stored-energy emergency power supply system (SEPSS), which is fully within the scope of this standard.

Figure B.1(c) shows a UPS being used as a bridge (also known as an auxiliary power unit) in combination with a generator emergency power supply (EPS), which is within the scope of NFPA 110. A bridge UPS is optional within NFPA 111, unless it is required for an emergency power supply that takes longer than ten seconds to start. A bridge's stored energy (e.g., battery) does not have the same reserve time as the EPS that it supports. However, because it is a component in an emergency power supply system, it is inspected and tested as part of the EPSS.

Figure B.1(d) shows a UPS being used as an optional standby power system where life safety does not depend on the performance of the system. As such, it is outside the scope of this standard.

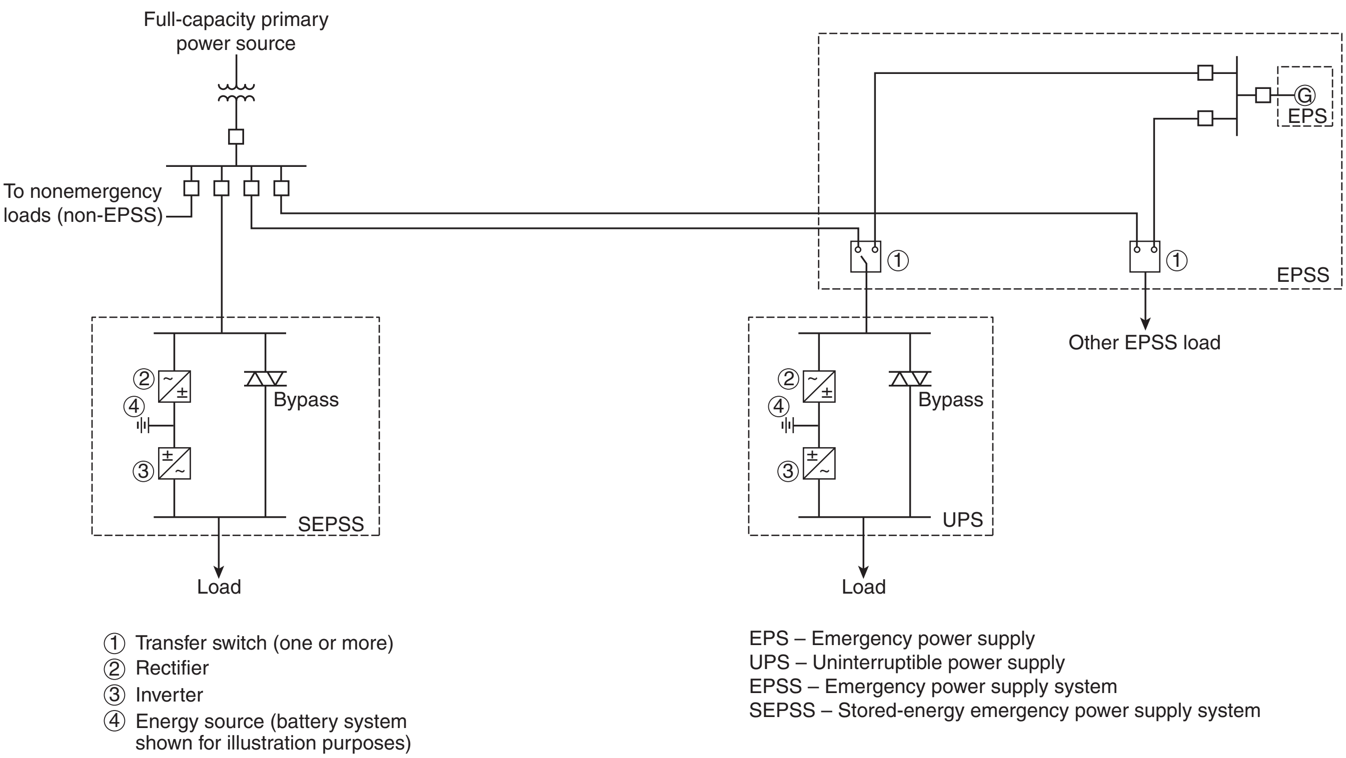

FIGURE B.1(a) Stored-Energy System Serving as SEPSS (Shown on Left) and as Equipment Supplied Through an EPSS (Shown on Right).

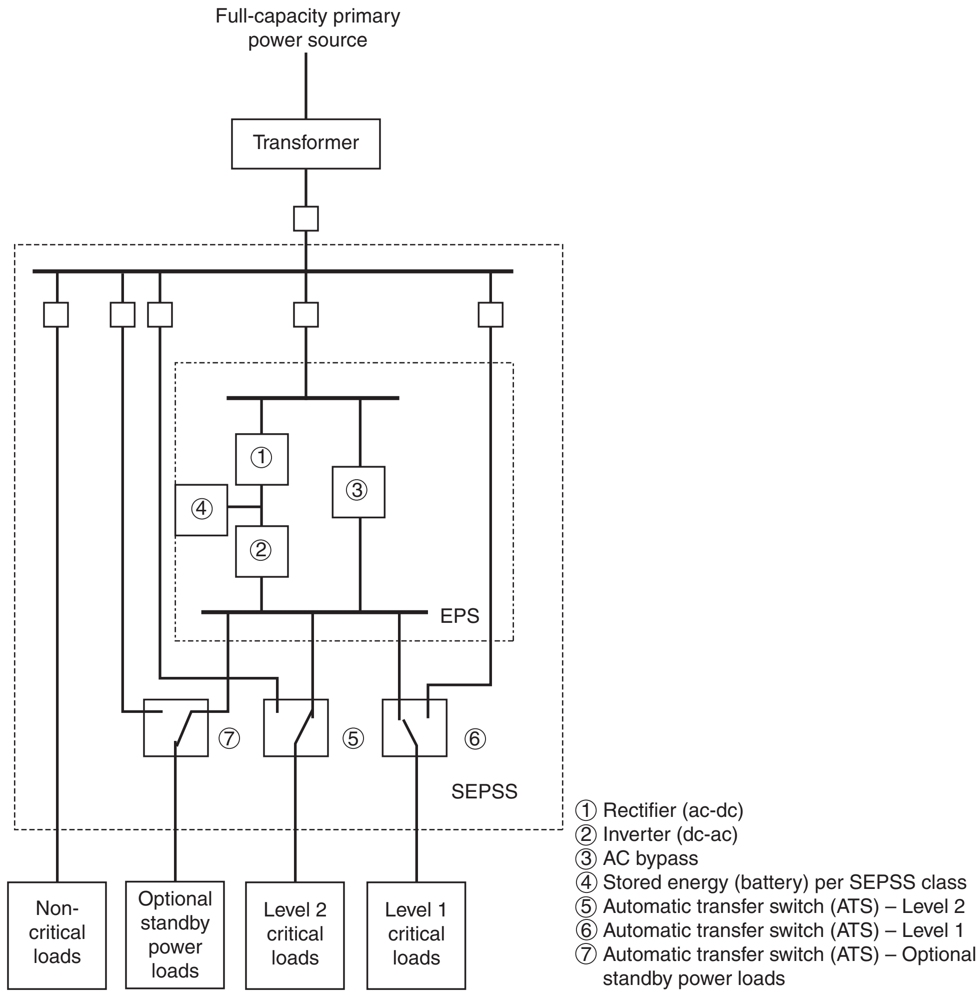

FIGURE B.1(b) Simplified Diagram Showing a Stored-Energy Emergency Power Supply System (SEPSS).

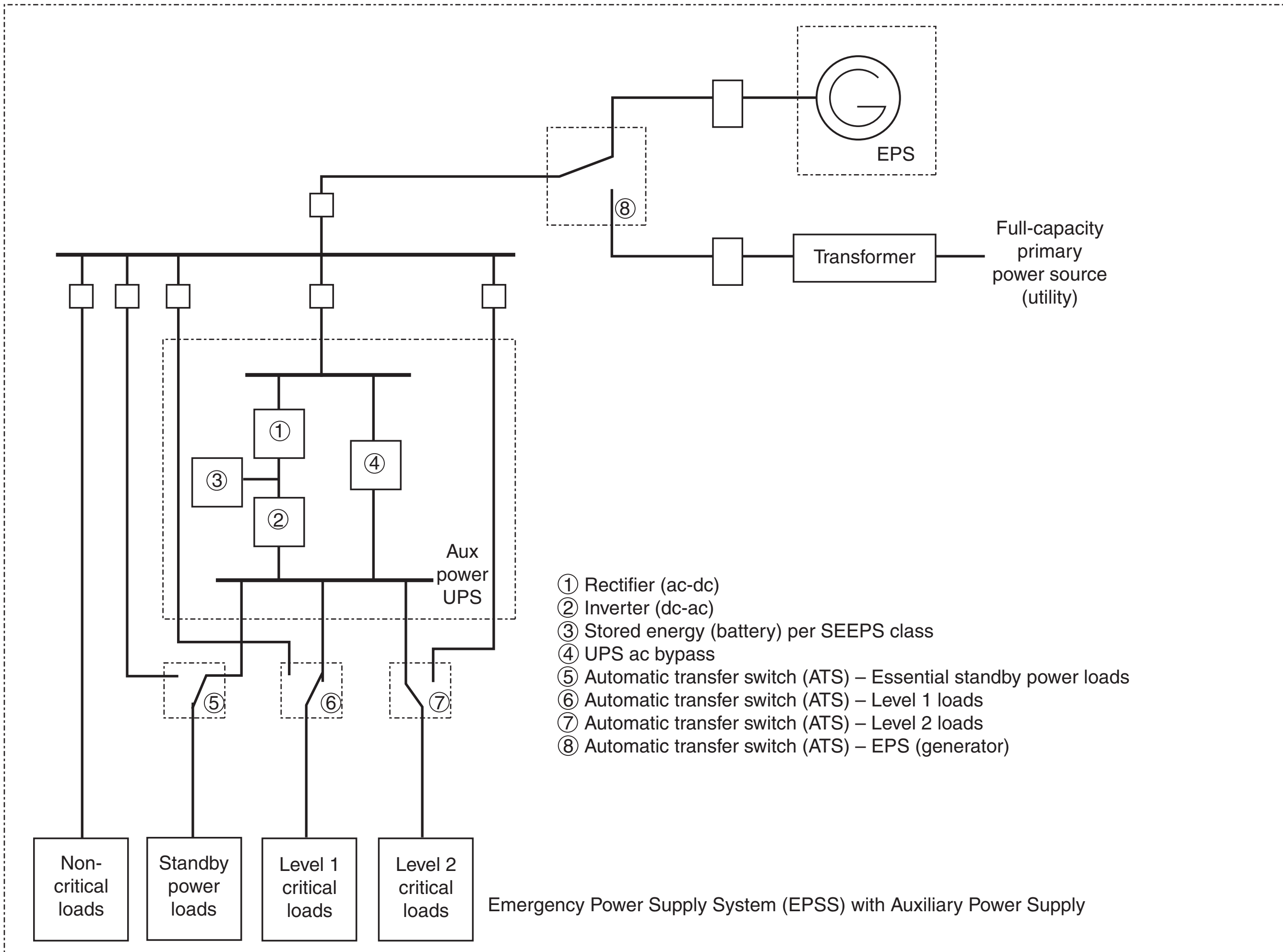

FIGURE B.1(c) Simplified Diagram Showing a UPS Used as a Bridge (a.k.a. an Auxiliary Power Unit) within an Emergency Power Supply System (EPSS).

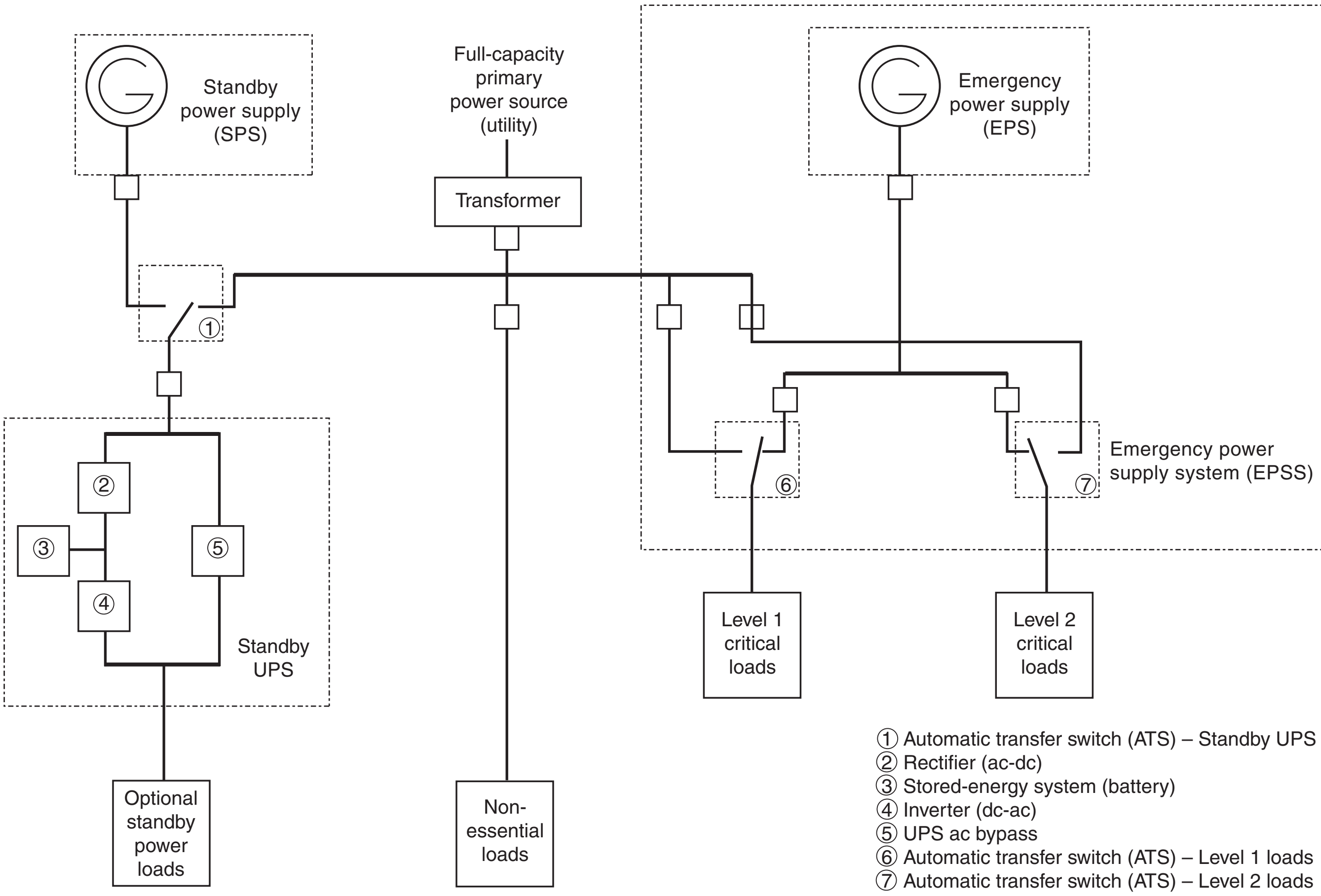

FIGURE B.1(d) Simplified Diagram for an Emergency Power Supply System (EPSS) and a Standby UPS.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70®, *National Electrical Code*®, 2014 edition.

NFPA 99, *Health Care Facilities Code*, 2015 edition.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems*, 2016 edition.

C.1.2 Other Publications.

C.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI C84.1, *American National Standard for Electric Power Systems and Equipment — Voltage Ratings (60 Hertz)*, 2011.

C.1.2.2 IEC Publications. International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 62040-3, *Uninterruptible Power Systems (UPS)-Part 3: Method of Specifying the Performance and Test Requirements*, 2011.

C.1.2.3 IEEE Publications. IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE 450, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Lead-Acid Batteries for Stationary Applications*, 2010.

IEEE 1106, *Recommended Practice for Maintenance, Testing, and Replacement of Vented Nickel-Cadmium Batteries for Stationary Applications*, 2005.

IEEE 1188, *Recommended Practice for Maintenance, Testing and Replacement of Valve-Regulated Lead-Acid Batteries for Stationary Applications*, 2005.

C.1.2.4 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 1008, *Standard for Safety Transfer Switch Equipment*, 2012.

C.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

C.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 70B, *Recommended Practice for Electrical Equipment Maintenance*, 2013 edition.

C.2.2 IEEE Publications. IEEE, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

ANSI/IEEE 446, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*, 2002.

ANSI/IEEE 484, *Recommended Practice for Installation Design and Installation of Vented Lead-Acid Batteries for Stationary Applications*, 2008.

IEEE 485, *Recommended Practice for Sizing Lead-Acid Batteries for Stationary Applications*, 2010.

ANSI/IEEE 944, *Recommended Practice for the Application and Testing of Uninterruptible Power Supplies for Power Generating Systems*, 1996.

C.3 References for Extracts in Informational Sections.

NFPA 1, *Fire Code*, 2015 edition.

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NFPA® 115

Standard for

Laser Fire Protection

2016 Edition

This edition of NFPA 115, *Standard for Laser Fire Protection*, was prepared by the Technical Committee on Laser Fire Protection. It was issued by the Standards Council on January 28, 2015, with an effective date of February 17, 2015, and supersedes all previous editions.

This edition of NFPA 115 was approved as an American National Standard on February 17, 2015.

Origin and Development of NFPA 115

In September 1988, a request was received by the NFPA Standards Council to establish a project on laser fire protection. At that time, NFPA documents did not address the fire hazards of lasers. Existing non-NFPA standards addressed other laser hazards (primarily health hazards) but did not adequately address the fire hazards involved. In October 1988, the Council published a request for comments on the need for such a project. After reviewing comments submitted, the Council approved the establishment of a laser fire protection project in July 1989. The resultant document (designated NFPA 115) was intended to supplement existing NFPA documents and other standards involving lasers. Where a particular hazard, such as a flammable liquid, was appropriately addressed by another NFPA document, that document was referenced.

Lasers can be a significant fire hazard. Class 4 and some Class 3b lasers (classification is from ANSI Z136.1, *Safe Use of Lasers*) are powerful enough that the beam is an ignition hazard. During use, particularly in the medical field, the laser beam is directly adjacent to combustible materials and, in certain clinical procedures, flammable gastrointestinal gases and prepping agents. Fire incidents have occurred when the laser beam has impinged on a material other than the intended target.

Additionally, some lasers use flammable liquids as an integral part of their operation. The flammable liquids are pumped and flow through tubing, which can be quartz or plastic. Both types of tubing are prone to damage, either by breaking or melting, when exposed to a fire. When this occurs, a flammable liquid pool fire is created.

Materials used to fabricate laser systems are often inappropriate with respect to fire safety — that is, manufacturers do not always choose component materials with regard to their ignition and heat-release properties. Lasers can involve the use of high-energy power supplies. Motors for use with flammable liquids need to be intrinsically safe or of approved electrical classification.

As part of an ongoing effort to document the fire hazards of lasers, there is a database of fires involving lasers. (Documented incidents have occurred in hospitals, research laboratories, and industrial applications.) According to the data gathered thus far, the majority of incidents involve the laser beam as the ignition source. Materials ignited include adjacent combustibles as well as components of the laser itself. Other incidents have involved components of the laser overheating or igniting due to a failure of the laser system.

In the 1999 edition of this document, changes were made to conform to the NFPA *Manual of Style*. In addition, many of the references to "flammable" liquids were changed to "ignitible" liquids because "flammable" was too restrictive.

In the 2003 edition, the document changed from a recommended practice to a standard. Therefore, all of the language within the body of the document was changed to enforceable language, and any recommendations or advisory information was moved to the annexes.

The 2008 edition was revised in order to stay current with all other NFPA documents. The definitions were updated and the language was changed where appropriate, in order to add

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clarity. A new requirement was added, which called for fire training for health care facilitators wherever a patient may be in contact with lasers.

The 2012 edition was updated and definitions changed in accordance with the *NFPA Glossary of Terms*. The language was clarified for pre-fire planning for staff members to be trained and knowledgeable in emergency procedures.

The 2016 edition has been updated with the current references and definitions in accordance with the NFPA *Glossary of Terms*. In addition to the language being revised to clarify requirements, the list of degraded components that could lead to a fire in the Performance Monitoring section was updated.

Technical Committee on Laser Fire Protection

Sharon S. Gilyeat, *Chair*
Koffel Associates, Inc., MD [SE]

Daniel Capostagno, SPI Lasers, CA [M]
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William J. Pate, University of Texas Medical Branch, TX [U]
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Fred P. Seeber, Laser Institute of Technology, NJ [U]
Karl R. Umstadter, KLA-Tencor, CA [M]
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Jacqueline R. Wilmot, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on fire protection for laser equipment, including their safe installation, use, and maintenance.

NFPA 115

Standard for

Laser Fire Protection

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex F. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex F.

Chapter 1 Administration

1.1 Scope.

1.1.1 This document shall provide minimum fire protection requirements for the design, manufacture, installation, and use of lasers and associated equipment.

1.1.2 Criteria for training for and responding to fire emergencies involving lasers shall be included.

1.2 Purpose. This document shall provide requirements intended to prevent or mitigate the effects of fire involving lasers.

1.3 Application. This document shall apply to lasers capable of producing a beam ignition hazard, lasers utilizing materials or components presenting a fire hazard, and the areas where such lasers are used.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Interface with Existing Codes and Standards.

1.6.1 When interface with existing NFPA or other consensus codes and standards occurs, reference shall be made in the text to the appropriate source.

1.6.2 Due to the unique fire hazards associated with lasers and their operations, this standard shall provide additional fire safety requirements beyond that of other documents.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 99, *Health Care Facilities Code,* 2015 edition.

NFPA 101®, Life Safety Code®, 2015 edition.

NFPA 600, *Standard on Industrial Fire Brigades,* 2015 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2012 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. Laser Institute of America, Secretariat of ANSI Z136, 13501 Ingenuity Drive, Suite 128, Orlando, FL 32826 (www.laserinstitute.org).

ANSI Z136.1, *Safe Use of Lasers*, 2014.

ANSI Z136.3, *Safe Use of Lasers in Health Care Facilities*, 2011.

ANSI Z136.5, *Safe Use of Lasers in Educational Institutions*, 2009.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D5, *Standard Test Method for Penetration of Bituminous Materials,* June 1, 2013.

ASTM D4359, *Standard Test for Determining Whether a Material Is a Liquid or a Solid*, 2012.

2.3.3 CGA Publications. Compressed Gas Association, 4221 Walney Road, 5th Floor, Chantilly, VA 20151-2923.

CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, 2013.

2.3.4 IEC Publications. Available from American National Standards Institute, 25 West 43rd Street, 4th floor, New York, NY 10036, U.S. National Committee for the IEC (www.ansi.org).

IEC 60825-1, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*, Ed 1.2, 2007-03.

2.3.5 U.S. Government Publications. U.S. Government Printing Office, Superintendent of Documents, Washington, DC 20402.

OSHA Instruction Pub 8-1.7, *Guidelines for Laser Safety and Hazard Assessment*, August 5, 1991.

Title 21, Code of Federal Regulations, Part 1040, Chapter 1, "Performance Standards for Light Emitting Products," April 1, 2014.

Title 21, Code of Federal Regulations, Parts 1040.10 and 1040.11, April 1, 2013.

Title 29, Code of Federal Regulations, Part 1910.38(b)(4)(i).

Title 40, Code of Federal Regulations.

Title 49, Code of Federal Regulations.

2.3.6 Other Publications.

The Joint Commission documents.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.

NFPA 53, *Recommended Practice on Materials, Equipment, and Systems Used in Oxygen-Enriched Atmospheres,* 2011 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG),* 2013 edition.

NFPA 99, *Health Care Facilities Code,* 2015 edition.

NFPA 306, *Standard for the Control of Gas Hazards on Vessels,* 2014 edition.

NFPA 600, *Standard on Facility Fire Brigades,* 2015 edition.

NFPA 921, *Guide for Fire and Explosion Investigations,* 2014 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1* Accessible Emission Limit (AEL). The maximum accessible emission level permitted within a particular class.

3.3.2* Beam. A collection of rays that can be parallel, divergent, or convergent.

3.3.3 Beam Intensity Profile (Irradiance Distribution). A description of the variations that can be present in the cross-section of a laser beam or in a focused laser spot.

3.3.4* Continuous Wave (cw). The output of a laser operated in a continuous rather than a pulsed mode.

3.3.5* Energy. The capacity for doing work.

3.3.6* Explosion. The sudden conversion of potential energy (chemical, mechanical, or nuclear) into kinetic energy that produces and violently releases gas.

3.3.7* Flammable Liquid Storage Cabinet. A cabinet for the storage of flammable and combustible liquids.

3.3.8 Flammable Vapors. A concentration of constituents in air that exceeds 25 percent of its lower flammable limit (LFL).

3.3.9* Flash Point. The minimum temperature at which a liquid or a solid emits vapor sufficient to form an ignitible mixture with air near the surface of the liquid or the solid.

3.3.10 Gas.

3.3.10.1 ***Compressed Gas.*** Any material or mixture having, when in its container, an absolute pressure exceeding 40 psi (an absolute pressure of 276 kPa) at 21.1°C (70°F) or, regardless of the pressure at 21.1°C (70°F), having an absolute pressure exceeding 104 psi (an absolute pressure of 717 kPa) at 54.4°C (130°F).

3.3.10.2 ***Flammable Gas.*** Any substance that exists in the gaseous state at normal atmospheric temperature and pressure and is capable of being ignited and burned when mixed with the proper proportion of air, oxygen, or other oxidizers. [**99,** 2015]

3.3.10.3* ***Reactive Gas.*** A gas that, by itself, is readily capable of detonation, explosive decomposition, or explosive reaction at normal or elevated temperatures and pressures.

3.3.11* Hazardous Chemical. A chemical with one or more of the following hazard ratings as defined in NFPA 704: Health — 2, 3, or 4; Flammability — 2, 3, or 4; Reactivity — 2, 3, or 4.

3.3.12 Facility Fire Brigade. An organized group of employees at a facility who are knowledgeable, trained, and skilled in at least basic fire-fighting operations, and whose full-time occupation might or might not be the provision of fire suppression and related activities for their employer. [**600,** 2015]

3.3.13 Irradiance. The power of a laser divided by the area of the laser beam at the target surface, expressed in watts per centimeter squared (W/cm^2).

3.3.14* Joule. The preferred SI unit of heat, energy, or work. [**921,** 2014]

3.3.15 Laboratory Apparatus. Furniture, laboratory hoods, centrifuges, refrigerators, and commercial or made-on-site equipment used in a laboratory.

3.3.16* Laser. A device that produces an intense, coherent, directional beam of light by stimulating electronic or molecular transitions to lower energy levels (an acronym for Light Amplification by Stimulated Emission of Radiation).

3.3.16.1 ***Embedded Laser.*** An enclosed laser with an assigned class number higher than the inherent capability of the laser system in which it is incorporated, where the system's lower classification is appropriate due to the engineering features limiting accessible emission.

3.3.16.2 ***Pulsed Laser.*** A laser that delivers its energy in the form of a single pulse or a train of pulses; a single pulse or a train of pulses with a pulse duration of <0.25 second.

3.3.16.3 ***Q-Switched Laser.*** A laser that emits short (approximately 10 to 250 nanoseconds), high-power pulses by means of a Q-switch.

3.3.17* Laser Safety Personnel (LSP). One who has authority to monitor and enforce the control of laser hazards and to effect the knowledgeable evaluation and control of laser hazards.

3.3.18* Laser System. An assembly of electrical, mechanical, and optical components that includes a laser.

3.3.19 Lecture Bottle. A small compressed gas cylinder with a physical volume of less than 500 cm^3.

3.3.20 Liquid. Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D5, *Standard Test Method for Penetration of Bituminous Materials*, or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance with ASTM D4359, *Standard Test for Determining Whether a Material Is a Liquid or a Solid.* [**30,** 2015]

3.3.20.1 ***Combustible Liquid.*** Any liquid that has a closed-cup flash point at or above 37.8°C (100°F). [**306,** 2014]

3.3.20.1.1 ***Combustible Liquid, Class II.*** Any liquid that has a flash point at or above 100°F (37.8°C) and below 140°F (60°C). [**30:**4.3.2]

3.3.20.1.2 ***Combustible Liquid, Class IIIA.*** Any liquid that has a flash point at or above 140°F (60°C), but below 200°F (93°C). [**30:**4.3.2]

3.3.20.1.3 ***Combustible Liquid, Class IIIB.*** Any liquid that has a flash point at or above 200°F (93°C). [**30:**4.3.2]

3.3.20.2 ***Flammable Liquid.*** A liquid that has a closed-cup flash point that is below 37.8°C (100°F) and a maximum vapor pressure of 2068 mm Hg (absolute pressure of 40 psi) at 37.8°C (100°F)

3.3.20.2.1 ***Flammable Liquid Class I.*** Any liquid that has a closed-cup flash point below 37.8°C (100°F) and a Reid vapor pressure not exceeding 2068.6 mm Hg (absolute pressure of 40 psi) at 37.8°C (100°F).

3.3.20.2.2 ***Flammable Liquid Class IA.*** Any liquid that has a flash point below 22.8°C (73°F) and a boiling point below 37.8°C (100°F).

3.3.20.2.3 ***Flammable Liquid Class IB.*** Any liquid that has a flash point below 22.8°C (73°F) and a boiling point at or above 37.8°C (100°F).

3.3.20.2.4 ***Flammable Liquid Class IC.*** Any liquid that has a flash point at or above 22.8°C (73°F), but below 37.8°C (100°F).

3.3.20.3 ***Ignitible Liquid.*** Any liquid or the liquid phase of any material that is capable of fueling a fire, including a flammable liquid, combustible liquid, or any other material that can be liquefied and burn.

3.3.21 Lower Explosive Limit or Lower Flammable Limit. The minimum concentration of combustible vapor or combustible gas in a mixture of the vapor or gas and gaseous oxidant above which propagation of flame will occur on contact with an ignition source.

3.3.22* Maintenance (Laser Products). Performance by the user of those adjustments or procedures specified in user information provided by the manufacturer with the laser or laser system to ensure the intended performance of the product.

3.3.23* Maximum Allowable Working Pressure. The maximum gauge pressure permissible at the top of completed equipment, a container, or a vessel in its operating position for a design temperature. [**59A,** 2013]

3.3.24* Noncombustible. Not capable of igniting and burning when subjected to a fire.

3.3.25* Operation. The performance of the laser or laser system over the full range of its intended functions (normal operation).

3.3.26 Oxidizing Material. Any material that readily yields oxygen or other oxidizing gas or that reacts chemically to oxidize combustible materials.

3.3.27 Oxygen-Enriched Atmosphere (OEA). An atmosphere in which the concentration of oxygen exceeds 21 percent by volume or its partial pressure exceeds 21.3 kPa (160 torr). [**53,** 2011]

3.3.28* Plasma. A state of ionization in a gas, solid, or liquid that can be generated by the very high electromagnetic field strengths of focused laser beams or by the impact of high-power laser beams.

3.3.29 Power. The rate at which energy is emitted, transferred, or received; the units of power are watts (joules/second).

3.3.30 Proper(ly). In accordance with the manufacturer's specifications or as recommended by the manufacturer.

3.3.31* Protective Housing. An enclosure that surrounds the laser or laser system that prevents access to laser radiation above the applicable maximum permissible exposure (MPE) level.

3.3.32* Q-Switch. A device for producing very short (approximately 30 nanoseconds), intense laser pulses by enhancing the storage and dumping of electronic energy in and out of the lasing medium, respectively.

3.3.33* Radiant Exposure. Energy received by the surface in joules/cm^2.

3.3.34 Safety Factor. The ratio of the calculated failure pressure (or actual failure pressure, if known) to the MAWP.

3.3.35* Service (Laser Products). The performance of those procedures or adjustments described in the manufacturer's service instructions that can affect any aspect of the performance of the laser or laser system.

3.3.36 Watt (W). Unit of power, or rate of work, equal to one joule per second, or the rate of work represented by a current of one ampere under the potential of one volt. [**921,** 2014]

Chapter 4 Classification of Lasers

4.1 Classification Methods. Lasers shall be classified in accordance with International Electrotechnical Commission (IEC) IEC 60825-1, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*, or 21 CFR Parts 1040.10 and 1040.11. *(See Annex D.)*

4.2 Application of Requirements. The fire protection requirements provided within this standard shall apply to the following classification of lasers:

(1) Class 3b
(2) Class 4

Chapter 5 Evaluation of Laser Beam Ignition Potential

5.1 General.

5.1.1* Continuous wave (cw) laser beams producing irradiances in the order of 0.5 W/cm^2 or greater shall be considered to be ignition hazards.

5.1.2 Other factors that shall be considered with pulsed lasers include the following:

(1) Radiant exposure
(2) Pulse duration
(3)*Pulse repetition rate

5.1.3 Class 4 lasers shall always be considered to be beam ignition hazards.

5.1.4* Lasers in the upper power and energy levels of Class 3b shall be considered as beam ignition hazards if the irradiance is greater than 0.5 W/cm^2.

5.2 Factors Affecting Ignition Potential. Factors affecting ignition potential shall include the following:

(1) Irradiance at the fuel, duration of exposure, and nature of the fuel
(2) Low irradiance laser beams capable of being focused to an irradiance sufficient to cause ignition
(3) Irradiance and the exposure time at the target
(4) Oxygen-enriched atmospheres
(5) Target thickness
(6) Irradiance modalities capable of generating plasma

Chapter 6 Laser Beam Ignition

6.1 General. Before a laser is used, the alignment shall be verified, the appropriate beam stop materials shall be in place, and the facility, control measures, safety, and training programs shall be established in accordance with ANSI Z136.1, *Safe Use of Lasers.*

6.2 Before Using Laser.

6.2.1 Beam Alignment. If an alignment beam is present, proper coincidence with the treatment beam shall be verified in accordance with the manufacturer's recommendations.

6.2.2 Beam Stop Materials. Before the laser is used, it shall be determined that the appropriate beam stop materials are in place.

6.3 Education.

6.3.1 Health Care.

6.3.1.1 Education shall be in accordance with that stated in ANSI Z136.3, *Safe Use of Lasers in Health Care Facilities.*

6.3.1.2* Detailed training in laser safety shall be required for those health care personnel who use a medical laser or are responsible for patient care during the use of a medical laser.

6.3.1.3 Training shall include extinguishing laser fires when a patient is directly involved in a laser fire event.

6.3.2 Other. Education shall be in accordance with that stated in ANSI Z136.1, *Safe Use of Lasers.*

6.4 Facility.

6.4.1 Health care facilities where laser systems are used shall comply with the following:

(1) ANSI Z136.3, *Safe Use of Lasers in Health Care Facilities*
(2) NFPA *101*, for detection, suppression, and means of egress
(3) NFPA 99, for electrical systems, electrical equipment, gas and vacuum systems, and gas equipment

6.4.2 Other. Facilities where laser systems are used shall comply with the following:

(1) ANSI Z136.1, *Safe Use of Lasers*
(2) NFPA *101*, for detection, suppression, and means of egress
(3) *NFPA 70*

6.4.3 Flammable and Combustible Conditions.

6.4.3.1 Nothing shall be considered fire safe when impinged upon by a laser beam in the presence of an oxygen-enriched atmosphere, except for the noble metals.

6.4.3.2 Potential fuels shall include, but not be limited to, the categories listed in 6.4.3.2.1 and 6.4.3.2.2.

6.4.3.2.1 Health care categories shall include the following:

(1) *Patients.* Hair, gastrointestinal gases (methane, hydrogen, and hydrogen sulfide)
(2) *Prepping Agents.* Degreasers (ether, acetone, aerosol adhesives, alcohol), tinctures (Hibitane™, Merthiolate™, collodion, benzoin)
(3) *Fabric Products.* Towels, surgical drapes, dressings, gowns, masks, shoe covers, caps/hoods, gauze, sponges, patient warming devices
(4) *Plastic/Rubber Products.* Surgical drapes, gloves, anesthesia masks, tracheal tubes, breathing circuits, patient warming devices
(5) *Ointments.* Petroleum-based jelly
(6) *Laser Circuitry.* Beam tubes, fiber-optic cables

6.4.3.2.2 Gas categories shall include the following:

(1) *Flammable Gases.* Flammable gastrointestinal gases such as methane, hydrogen, and hydrogen sulfide present a unique hazard. Precautions to eliminate or manage these gases shall be taken.
(2) *Oxidizing Gases.* Ignition can be enhanced by the use of oxygen-enriched atmospheres that are created by the use of respiratory or anesthetic gases, or both — for example, oxygen and nitrous oxide.
(3) *Nonflammable Gases.* Nonflammable anesthetic gases and vapors have replaced flammable anesthetic gases and vapors in the United States.

Chapter 7 Fire Safety Requirements for Laser Equipment

7.1 General. Selection of materials used in the construction of the laser shall include consideration of fire safety requirements for the following:

(1) Circuit boards and support structures
(2) Acoustical, thermal, and electrical insulation
(3) Cabinetry
(4) Cooling equipment
(5) Control equipment

7.2 Laser Equipment Employing Ignitible Liquids or Flammable Gases.

7.2.1 Laser equipment employing ignitible liquids shall have a means to control or contain ignitible liquid spills using noncombustible materials.

7.2.2 When ignitible solvents are used, such as in dye lasers, products with the highest possible flash point consistent with the necessary solvent properties shall be used.

7.2.3 Laser equipment having oil-cooled components shall employ a nonflammable fluid or a fluid with the highest flash point and ignition temperature that is consistent with the necessary coolant properties.

7.2.4* Pumps, motors, and other electrical components in laser equipment that employ ignitible liquids or flammable gases shall be of intrinsically safe design or shall be appropriately rated for the application.

7.2.5 Tubing.

7.2.5.1 Metal tubing shall be used for ignitible liquids or flammable gases.

7.2.5.2 Plastic tubing shall be permitted provided it has a pressure rating of 1.5 times the maximum allowable working pressure, be of a material with the highest melting point and ignition temperature consistent with other necessary properties, and be of the shortest length possible.

7.3* Materials of Construction.

7.3.1 The use of combustible materials shall be minimized.

7.3.2 Materials used inside the laser equipment enclosure shall be evaluated for ignition and heat release properties.

7.4 Laser Equipment Ventilation. Exhaust from laser enclosures shall be directed to an area where the exhaust will not cause unacceptable damage if a fire occurs inside the laser enclosure.

7.5 Alarms and Controls.

7.5.1 Circuits.

7.5.1.1 Laser systems utilizing materials and components that present a fire hazard shall incorporate circuitry that can be used for emergency shutdown by fire detection systems, manually, or by other means.

7.5.1.2 The design of the circuit shall not permit automatic restart with restoration of power following a remote shutdown.

7.5.1.3 The design of the circuit shall not allow automatic restart until the fire detection system or manual alarm system has been reset.

7.5.2 Coolants and Ignitible Liquids.

7.5.2.1 The temperature of coolants and ignitible liquids shall be monitored to warn of excessive rate of heating or approach to threshold temperature.

7.5.2.2 Provisions shall be made for alarm and automatic shutdown should such conditions be detected.

7.5.3* Monitors.

7.5.3.1 The laser equipment cabinet or exhaust shall be monitored for the presence of pre-combustion products, such as hydrogen chloride or submicron particulate, that can be produced by component overheating or from products of combustion.

7.5.3.2 Multiple alarm thresholds such as "warning," "alarm," and "automatic shutdown" shall be considered.

7.5.4 Performance Monitoring.

7.5.4.1 Degradation of components that lead to a fire shall be monitored according to parameters that shall include one or more of the following:

(1) Component temperature
(2) Device electrical parameters (current, voltage)
(3) Laser power
(4) Frequency or magnitude of power excursions
(5) Light leakage or scatter

7.5.4.2 The monitoring function shall be accomplished by automatic or manual means at time intervals determined by the manufacturer.

7.6 Manuals and Training.

7.6.1 Fire safety features and fire hazards specific to the systems shall be included in manufacturers' instructions on laser system operations.

7.6.2 Manufacturers' instructions shall provide guidance for dealing with fire emergencies and the post-fire testing and restoration of the equipment.

7.6.3 Laser system users and service staff shall be trained on the laser system fire safety features and procedures for responding to fire emergencies prior to the user's first use and shall continue ongoing training in accordance with ANSI Z136.1, *Safe Use of Lasers*.

Chapter 8 Flammable Gases

8.1 General.

8.1.1 The general requirements of NFPA 55 shall be followed.

8.1.2 To determine if a gas is flammable, the rating as listed in CGA V-1, *Standard for Compressed Gas Cylinder Valve Outlet and Inlet Connections*, shall be used.

8.2 Work Practices.

8.2.1 Laser systems utilizing or containing flammable gas(es) shall be so labeled.

8.2.2 Gas shutdown capability shall be provided both at the location of use and remotely.

8.2.3 "Flammable Gas — No Smoking" signs shall be posted conspicuously near the supply and usage locations of the flammable gases.

8.2.4 Piping for flammable gases shall be capped when not in use.

8.2.5 No modifications shall be made to pressure containers or pressure relief devices by anyone except the supplier.

8.2.6 Systems shall be regularly maintained as recommended by the manufacturer.

8.3 Fire Safety.

8.3.1 Combustible gas sensors shall be located near the area of use of the flammable gases except where demonstrated by calculation that 25 percent of the lower explosive limit (LEL) cannot be reached if the entire contents were to discharge.

8.3.2 If the supply of flammable gases is located indoors, combustible gas sensors shall be used except where demonstrated by calculation that 25 percent of the LEL cannot be reached if the entire contents were to discharge.

8.3.3 When installed, combustible gas sensors shall be interlocked with the ventilation system and the exhaust ventilation increased at 25 percent of the LEL.

8.3.4 At 25 percent of the LEL, combustible gas sensors shall sound an audible alarm.

8.3.5 At 50 percent of the LEL, the combustible gas sensors shall sound an audible alarm and automatically shut off the supply of gases.

8.4 Facilities and Equipment.

8.4.1 General.

8.4.1.1 Indoor cylinder use shall be limited to lecture bottle size unless the cylinder(s) is kept in an approved ventilated cabinet or the room is provided with sufficient ventilation to keep the gas concentration below 25 percent of the LEL if the entire contents of the cylinder(s) in use were to discharge.

8.4.1.2* Outside flammable gas supplies in excess of 11.3 m^3 (400 ft^3) shall be separated from oxidizing gases by 6.1 m (20 ft) or a 2-hour fire-rated barrier.

8.4.1.3 Flammable Gas Supplies.

8.4.1.3.1 Exterior flammable gas supply capacity shall be evaluated so as to not exceed combustibility limits if accidentally released into any closed area where supply gas lines are routed.

8.4.1.3.2 Evaluation of closed areas where combustible gas mixtures might occur shall include assessments of installed ventilation system air exchange rates and exhaust systems, if present.

8.4.1.3.3 Combustible gas sensors shall be installed in enclosed areas where flammable gases could exceed combustibility limits.

8.4.1.3.4 A combustible gas sensor alarm shall shut off the gas supply at the source and vent the gas supply lines from the enclosed area(s) to a safe location.

8.4.1.3.5 General air dynamics within the closed areas shall be evaluated for determination of location for combustible gas sensors.

8.4.1.4 Exhaust Vents.

8.4.1.4.1 Exhaust vents shall be located at least 15.3 m (50 ft) away from air intakes for hydrogen and at least 7.6 m (25 ft) for other exhaust materials.

8.4.1.4.2 When venting above a roof, piping shall be high enough to mitigate the chance of flammable gas buildup in an undesirable location.

8.4.2 Piping.

8.4.2.1 Piping shall be clean and compatible with the gas.

8.4.2.2 Piping shall be designed to a safety factor of 4 and tested to 1.5 times the MAWP.

8.4.2.3 Piping shall be pressure-tested and then leak-checked prior to initial use and after repair and modification.

8.4.2.4 Flammable gas vent lines shall be dedicated and separate from oxidizing gas vent lines and shall terminate in a safe location.

8.4.3* Regulators.

8.4.3.1* Flammable gas regulators with bonnet fittings for piping external venting shall be used in enclosed areas.

8.4.3.2 If low pressures are required, a two-stage regulator shall be used.

8.4.3.3 Flow Control.

8.4.3.3.1 A flow control valve or a supplementary valve downstream of the regulator shall be used for control of flow.

8.4.3.3.2 The regulator shall not be used as a flow control.

8.5 Electrical Requirements. Electrical circuits, devices, fixtures, and grounding in the area of a laser classified as hazardous and for direct connection of the laser shall be installed in accordance with the applicable sections of *NFPA 70*.

8.6 Training.

8.6.1 A thorough training program in emergency procedures shall be provided for all staff members working with flammable gases.

8.6.2 The training program shall include drills, fire protection features awareness, coordination with fire-fighting personnel, and knowledge of remote shutoff for gases.

Chapter 9 Reactive Gases

9.1 General. The general requirements of NFPA 55 shall be followed.

9.2 Work Practices.

9.2.1 The reactive gas system shall be labeled to identify its contents.

9.2.2 Gas shutdown capability shall be provided both at the location of use and remotely.

9.2.3 Where possible, the gas cabinet shall be located outdoors.

9.2.4 When not in use, compressed gas cylinders containing reactive gases shall be capped.

9.2.5 When connecting or disconnecting bottles, the manifold system shall be purged to minimize the effect of corrosion of the system.

9.2.6 Maintenance.

9.2.6.1 Systems shall be maintained regularly as recommended by the manufacturer.

9.2.6.2 A system data package, including a maintenance log, shall be maintained.

9.2.6.3 The data package shall include installed exhaust calibration data.

9.2.7 Reactive gases cylinders shall be located in an approved ventilated cabinet consistent with NFPA 55.

9.2.8 No modifications shall be made to pressure containers or pressure relief devices except as authorized by the supplier.

9.3 Fire Safety.

9.3.1 Written procedures shall be followed for cylinder changing and maintenance.

9.3.2 A limiting orifice shall be installed on each cylinder to limit the release rate of the gas.

9.3.3* Gas Cabinets.

9.3.3.1 Gas cabinets shall be provided with a sprinkler system inside of the cabinet and shall be protected from corrosion where necessary.

9.3.3.2 Sprinkler installation shall comply with NFPA 13.

9.3.4 Gas Quantity and Concentration.

9.3.4.1 Only the smallest quantity or percent of reactive gas necessary shall be used.

9.3.4.2 Premixed gases shall be used to minimize the need for highly concentrated reactive gases.

9.3.5 The regulator chosen for use shall be compatible with the reactive gas.

9.4 Facilities and Equipment.

9.4.1 General.

9.4.1.1 When the ventilated cabinet is located indoors, connecting the cabinet to emergency power shall be considered to ensure continued exhaust capability.

9.4.1.2 Laser system exhaust shall be diluted to below reactive levels or mixed with an inert gas.

9.4.1.3 Exhaust systems shall be designed to ensure that the exhaust does not stagnate in exhaust piping.

9.4.1.4 The supply control valve shall be a solenoid valve designed to close in the event of loss of electrical power.

9.4.1.5 Exhaust.

9.4.1.5.1 The piping exhaust shall be located at least 7.6 m (25 ft) away from air intakes.

9.4.1.5.2 When venting above a roof, piping shall be high enough to minimize the possibility of reactive gas buildup in an undesirable location.

9.4.2 Piping.

9.4.2.1 Piping shall be clean and compatible with the gas.

9.4.2.2 Piping shall be designed to a safety factor of 4 and tested to 1.5 times the MAWP.

9.4.2.3 Piping shall be pressure-tested and leak-checked prior to initial use and after repair and modification.

9.4.2.4* Piping shall be purged with an inert gas during long periods of nonuse, maintenance, or servicing.

9.4.2.5 Fittings.

9.4.2.5.1 "Face-seal"–type fittings shall be considered acceptable.

9.4.2.5.2* Threaded or compression fittings shall not be used.

9.4.2.6 Traps or check valves shall be installed if there is the possibility of system contamination by other gases or foreign material.

9.4.3 Regulators.

9.4.3.1 Vents from regulators shall be piped to a safe location.

9.4.3.2 When low pressures are required, a two-stage regulator shall be used.

9.4.3.3 Regulator diaphragm failures shall be considered when locating a reactive gas regulator in an enclosed area.

9.4.3.4* Reactive gas regulators with bonnet fittings for piping external venting shall be used in enclosed areas.

9.4.3.5 Vents shall be piped to a safe location.

9.4.4 Flow Control.

9.4.4.1 A flow control valve or a supplementary valve downstream of the regulator shall be used for control of flow.

9.4.4.2 The regulator shall not be used as a flow control.

9.5 Electrical Requirements. Electrical circuits, devices, fixtures, and grounding in the area of a laser classified as hazardous and for direct connection of the laser shall be installed in accordance with the appropriate sections of *NFPA 70*.

9.6 Training.

9.6.1 A thorough training program in emergency procedures shall be provided for all staff members working with reactive gases.

9.6.2 The training program shall include drills, fire protection features awareness, coordination with fire-fighting personnel, and knowledge of remote shutoff for gases.

Chapter 10 Ignitible Liquids Used in Laser Systems

10.1* General. The requirements of this chapter shall be followed to minimize the risk of fire involving ignitible liquids.

10.2 Work Practices.

10.2.1 Signs such as "Caution: Flammable Liquids — No Smoking; No Open Flames" shall be posted in conspicuous locations in the area and at approaches to the area.

10.2.2 Lines (piping and tubing) containing flammable or combustible liquid shall be capped when not in use.

10.2.3 Flammable Liquids.

10.2.3.1 Containers of flammable liquids shall be closed and stored in a cool place.

10.2.3.2 Secondary containment for all flammable liquids shall be provided.

10.2.3.3 Each container and the flammable liquid circulation hardware shall have a label that includes the word "flammable."

10.2.4 Ignitible liquid dye solutions shall be transported in closed, labeled containers made of impact-resistant and dye solution–compatible materials.

10.2.5 Flammable and combustible liquids that are to be dispensed shall be stored in safety cans as described in NFPA 30, Chapter 9.

10.3 Fire Safety.

10.3.1 Solutions of ignitible liquids shall be kept away from heat, flames, electrical receptacles, and other sources of ignition.

10.3.2 Oxidizing materials shall be kept separate from flammable dye mixtures and ignitible liquids.

10.3.3 Waste Containment.

10.3.3.1 Flammable and combustible liquid waste shall be stored in wide-mouthed safety cans.

10.3.3.2 Containers shall be labeled "For Flammable Liquid Waste Only."

10.3.3.3 Hazardous (flammable, combustible, and corrosive) materials shall be collected and stored pursuant to 40 CFR and 49 CFR.

10.3.4 Cabinets.

10.3.4.1 Flammable- and combustible-liquid containers shall be stored in approved flammable liquid storage cabinets.

10.3.4.2 Only a working quantity of liquids shall be allowed outside such cabinets.

10.3.5 Ventilation shall be provided to prevent a buildup of ignitible vapor/air mixtures in excess of 25 percent of the LEL in areas where flammable liquids are used.

10.3.6* Equipment or activities likely to produce a static spark shall be electrically interconnected (i.e., bonded) to the grounding system in the area.

10.4 Facilities and Equipment.

10.4.1 Ignitible Liquid Dye Work Area.

10.4.1.1 The ignitible liquid dye work area shall be kept clean and orderly to minimize the fuel paths that facilitate the spread of fire.

10.4.1.2 Combustibles shall not be located adjacent to the dye circulator pump.

10.4.2 Ignitible liquid dye circulating systems shall be leak-tight.

10.4.3 Compression-type or clamped fittings shall be used for ignitible liquid lines.

10.4.4 Circulating Systems.

10.4.4.1 Ignitible liquid circulating systems and components shall be pressure tested to 1.5 times the MAWP prior to initial use.

10.4.4.2 Special attention shall be given to tubing connections.

10.4.4.3 The integrity of all tubing and connections shall be checked to ensure that degradation has not occurred.

10.4.5 Noncombustible containment pans shall be installed under pumps and reservoirs of sufficient capacity to contain the total volume of the ignitible liquid circulating system.

10.5 Electrical Requirements. Electrical circuits, devices, fixtures, and grounding in the area of a laser classified as hazardous and for direct connection of the laser shall be installed in accordance with the applicable sections of *NFPA 70*.

10.6 Large-Volume Ignitible Liquid Systems.

10.6.1 Where large-volume ignitible liquid systems [18.9 L (5 gal) or more] are used, NFPA 30 shall be followed.

10.6.2 Pressure sensors, flow sensors, or both, shall be installed to automatically turn off the circulating pumps in the event of a rupture or leak of the flow system.

10.6.3 Liquid level sensors shall be installed on the pump reservoir to detect a decrease in system liquid volume due to leak or rupture and shall be interlocked with the pumping system to shut down upon activation of the sensors.

10.6.4 Enclosed areas shall be ventilated at a rate sufficient to maintain the vapor concentration within the area at or below 25 percent of the LEL, confirmed by one of the following methods:

(1) Calculations based on the anticipated fugitive emissions as described in NFPA 30, Annex F
(2) Sampling of the actual vapor concentration under normal operating conditions as described in NFPA 30, Chapters 6, 17, and 18

10.6.5 Combustible vapor sensors shall be interlocked with exhaust ventilation and with the pumping system.

10.6.5.1 The exhaust ventilation shall switch to high speed at 25 percent of the LEL to prevent the buildup of flammable vapor concentrations.

10.6.5.2 At 50 percent of the LEL, an alarm shall sound, and the pumping system shall shut down.

10.6.6 A liquid detection device(s) shall be installed to detect leaks or spills within laser enclosures.

10.6.7 Remote Shutdown.

10.6.7.1 Remote shutdown capability for the laser pumping system (i.e., crash buttons) shall also be provided for personnel to activate in case of emergency.

10.6.7.2 The crash buttons shall be located near main exits of the area.

10.6.8 Building Construction.

10.6.8.1 Buildings or structures housing large-volume flammable liquid systems shall be of fire-resistive or noncombustible construction.

10.6.8.2 Combustible construction shall be permitted where automatic fire sprinklers or equivalent protection is provided, subject to the approval of the authority having jurisdiction.

10.6.8.3 Where walls are required for separation from other occupancies or property lines, they shall have a fire resistance rating of at least 2 hours consistent with the requirements of NFPA 30.

10.7 Spill Cleanup.

10.7.1 Ignitible liquid spills shall be mitigated pursuant to 40 CFR.

10.7.2 In the event of a large-volume ignitible liquid spill, the fire department shall be notified.

10.8* Waste Disposal. Ignitible liquids absorbed into solids, objects contaminated with ignitible liquids, and ignitible liquid dye solutions shall be managed as hazardous waste pursuant to 40 CFR.

10.9 Training.

10.9.1 Employees shall be apprised of the fire safety hazards of the materials and processes to which they are exposed. *[See 29 CFR 1910.38(b)(4)(i).]*

10.9.2 Employees shall review upon initial assignment those parts of the fire prevention plan and the procedures necessary to protect themselves in the event of an emergency.

10.9.3 The written fire prevention plan shall be kept in the workplace and made available for employee review.

10.10 Maintenance.

10.10.1 All equipment shall be maintained in accordance with manufacturers' instructions.

10.10.2 A safety inspection schedule for those portions of laser systems that could present a fire hazard shall be established.

10.10.3 A written log of these inspections shall be maintained.

Chapter 11 Operations/Administration

11.1 Safety Operations and Administration.

11.1.1 Lasers. Lasers and laser systems shall be operated and maintained in accordance with the following documents:

(1) ANSI Z136.1, *Safe Use of Lasers*, revised
(2) ANSI Z136.3, *Safe Use of Lasers in Health Care Facilities*
(3) Occupational Safety and Health Administration (OSHA) Instruction Pub 8-1.7
(4) NFPA 99, pertaining to electrical systems, electrical equipment, gas and vacuum systems, and gas equipment
(5) The Joint Commission documents
(6) State rules and standards

11.1.2 Laser Safety Officer (LSO). Where lasers presenting a fire hazard are used, specific personnel shall be designated to monitor and enforce the control of laser hazards and effect the knowledgeable evaluation and control of laser hazards.

11.1.3 Laser Modifications.

11.1.3.1 Modifications to certified or uncertified lasers shall meet all requirements of the minimum standards and shall be reviewed and approved by the LSO.

11.1.3.2 Whenever deliberate modifications are made that could change the laser class and affect the output power, operating characteristics, or fire hazards, the LSO shall specify whether any changes in control measures are required.

11.1.4 Fire-Extinguishing Agents.

11.1.4.1 Fire extinguishers shall be of a type and size to extinguish a fire occurring within the laser equipment and as a result of the laser beam.

11.1.4.2 Extinguishing agents shall be readily available to the laser location(s) and shall be maintained in accordance with NFPA 10.

11.1.4.3 The LSO shall determine the type and quality of extinguishing agents necessary for the specific laser installation(s) and shall consult with the manufacturers for their suggestions.

11.1.4.4 Training shall be provided on the use of portable fire extinguishers.

11.1.5* Fire-Resistant Materials. Materials adjacent to a laser that can be an ignition hazard shall be evaluated for their fire properties.

11.2 Housekeeping.

11.2.1 Laser equipment, systems, installation, and supporting materials and equipment shall be maintained in a clean, neat, and orderly condition.

11.2.2 Electrical and mechanical ventilation equipment shall be maintained to remain safe and fully operational.

11.2.3 The LSO shall ensure that the laser installation fully complies with the requirements of this and the referenced documents.

11.3 Maintenance and Service.

11.3.1 Maintenance shall be performed by trained personnel.

11.3.2 Service shall be performed by trained personnel.

11.3.3 Laser products certified by a manufacturer to be compliant with certain standards, such as the federal laser product performance standards of 21 CFR 1040, applicable at the date of manufacture, shall be maintained in compliance with such requirements.

11.3.4 The LSO shall ensure that regular maintenance schedules for each type of laser are established.

11.3.5 The LSO shall retain documentation of all maintenance and service performed.

11.3.6 Maintenance checks shall include all supporting equipment.

11.3.7 All electrical and mechanical systems shall be maintained in compliance with the documents listed in 11.1.1.

11.4 Training and Education.

11.4.1 A training program shall be established for staff members using and supporting the safe application of laser systems.

11.4.2 All training shall follow OSHA guidelines, ANSI Z136.1, *Safe Use of Lasers*, ANSI Z136.3, *Safe Use of Lasers in Health Care Facilities*, and ANSI Z136.5, *Safe Use of Lasers in Educational Institutions*.

11.4.3 The LSO shall ensure the necessary training records are maintained.

11.4.4 New staff members shall be trained.

11.4.5 When new lasers are introduced or existing laser systems are modified, staff members shall receive instruction on these systems.

11.4.6 The LSO shall monitor compliance with all training and education requirements.

Chapter 12 Emergency Preparedness

12.1 Pre-Fire Planning.

12.1.1 Staff members shall be trained and knowledgeable in exit locations and emergency procedures, including use of fire extinguishers and laser shutdown procedures.

12.1.2 Emergency services organizations shall be made aware of location and hazards of lasers.

12.1.3 Facility emergency response personnel shall be familiar with emergency shutdown procedures for the laser(s).

12.2 Training.

12.2.1 All staff members working with lasers shall receive instruction in the hazards of lasers and the use of fire-fighting equipment.

12.2.2 Emergency drills shall be conducted no less than once per year.

12.3 Fire Brigades. Established industrial fire brigades shall receive training on the hazards of lasers, fire-fighting tactics, and emergency shutdown procedures, in conjunction with the requirements of NFPA 600.

12.4 Emergency Shutdown.

12.4.1 A master emergency electrical shutdown switch that will immediately de-energize the laser shall be provided.

12.4.2 The switch shall be located inside or outside of each room, at the facility's discretion.

12.5 Fire Procedure. The following actions shall be considered:

(1) Alert others in the work area upon discovery of a fire.
(2) Whoever is closest to a manual fire alarm pull station, activate the alarm to alert all building occupants and summon the industrial fire brigade or fire department.
(3) Whoever is closest to the master emergency electrical shutdown switch, de-energize the laser.
(4) Use a portable fire extinguisher to contain, control, and extinguish the fire if possible.
(5) If the fire location involves medical oxidizing gases or industrial oxidizing gases, shut off the oxidizing gas supply.
(6) Simultaneously, other staff members evacuate the area of hazard.
(7) Close all doors in fire area.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Accessible Emission Limit (AEL). This definition is extracted from ANSI Z136.1, *Safe Use of Lasers,* and 21 CFR 1040.10.

A.3.3.2 Beam. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers.*

A.3.3.4 Continuous Wave (cw). In this document, a laser operation with a continuous output for a period ≥0.25 seconds is regarded as a cw laser. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers.*

A.3.3.5 Energy. Energy content is commonly used to characterize the output from pulsed lasers, and is generally expressed in joules (J). This definition is extracted from ANSI Z136.1, *Safe Use of Lasers.*

A.3.3.6 Explosion. An explosion can be accompanied by a shock wave or the disruption or enclosing of material or structures, or both. An explosion might result from chemical changes such as rapid oxidation, decomposition, or runaway polymerization (usually detonations); deflagration; or detonation.

A.3.3.7 Flammable Liquid Storage Cabinet. The cabinet should be constructed in accordance with NFPA 30. Some local jurisdictions require bottom-venting of flammable liquid storage cabinets. While this is not required by NFPA 30, some manufacturers provide plugged vent connections to accommodate these local jurisdictions.

A.3.3.9 Flash Point. See Annex E.

A.3.3.10.3 Reactive Gas. Reactive gases can also be corrosive.

A.3.3.11 Hazardous Chemical. For hazard ratings of many chemicals, see NFPA *Fire Protection Guide to Hazardous Materials*.

A.3.3.14 Joule. A joule is the heat produced when one ampere is passed through a resistance of one ohm for one second, or it is the work required to move a distance of one meter against a force of one newton. There are 4.184 joules in a calorie, and 1055 joules in a British thermal unit (Btu). A watt is a joule/second. [**921,** 2014]

A.3.3.16 Laser. This definition and definitions in 3.3.16.1 through 3.3.16.3 are extracted from ANSI Z136.1, *Safe Use of Lasers*, and 21 CFR 1040.10.

A.3.3.17 Laser Safety Personnel (LSP). This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*.

A.3.3.18 Laser System. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*.

A.3.3.22 Maintenance (Laser Products). It does not include *operation* or *service* as defined in this document. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*, and 21 CFR 1040.10.

A.3.3.23 Maximum Allowable Working Pressure. For a more complete definition, see Section VIII of the ASME *Boiler and Pressure Vessel Code*, Division 1, Appendix 3. [**59A,** 2013]

A.3.3.24 Noncombustible. Materials that are reported as passing ASTM E136 are considered noncombustible. *(See NFPA 220.)*

A.3.3.25 Operation. It does not include *maintenance* or *service* as defined in this document. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*, and 21 CFR 1040.10.

A.3.3.28 Plasma. Very high temperatures are associated with laser-generated plasmas that can appear as sparks, plumes, or flames.

A.3.3.31 Protective Housing. The aperture through which the useful beam is emitted is not part of the protective housing. The protective housing can enclose associated optics and a workstation and should limit access to other associated radiant energy emissions and to electrical hazards associated with components and terminals. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*, and 21 CFR 1040.10.

A.3.3.32 Q-Switch. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*.

A.3.3.33 Radiant Exposure. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*.

A.3.3.35 Service (Laser Products). It does not include *maintenance* or *operation* as defined in this document. This definition is extracted from ANSI Z136.1, *Safe Use of Lasers*, and 21 CFR 1040.10.

A.5.1.1 Lower values can be possible, particularly in an oxygen-enriched atmosphere, depending on the thickness and the physical properties of the material. See NSBIR 81-2271 and ASTM STP822.

A.5.1.2(3) Very high repetition rates can produce ignition hazards similar to cw laser beams.

A.5.1.4 Lasers in the lower power and energy levels of Class 3b are often incapable of being beam ignition hazards.

A.6.3.1.2 Those personnel include the surgeon or physician using the laser, the laser safety officer, anesthesia personnel, nursing staff, and other health care personnel as appropriate.

A.7.2.4 See Article 500 of *NFPA 70*.

A.7.3 Materials to consider include thermal and acoustical insulation, laminates, hoses, filters, and coil forms. From a fire safety design perspective, materials that have low ignition potential and low rates of heat release if ignited are most desirable. Heat release rate for a material is expressed in terms of kilowatts released for each square meter of material burning and is related to the physical and chemical or combustion characteristics of that material.

ASTM E1354 is useful for evaluating candidate materials. It is recommended that the materials being evaluated be tested at two different levels of incident flux, a low level (25 kW/m^2 to 30 kW/m^2) and a high level (55 kW/m^2 to 65 kW/m^2). Most materials will have a higher rate of heat release at the high flux. The additional test at a high flux level provides an indication of the expected heat release rate in a well-developed fire in a confined space.

Materials that have the lowest heat release rate at the high flux and the longest ignition time at low flux should be selected. If several candidate materials have similar heat release and ignition characteristics, the material with the lowest smoke production should be considered.

A.7.5.3 Significant particulate production can occur well in advance of smoldering or flaming fire. Increases in background particulate levels can indicate an incipient problem.

A.8.4.1.2 See NFPA 55 for additional information.

A.8.4.3 Regulator diaphragm failures should be considered when locating a flammable gas regulator in an enclosed area.

A.8.4.3.1 Standard gas regulators do not have these fittings and release supply gases through vent holes located in the bonnet in the event of a regulator diaphragm failure.

A.9.3.3 Some gases can be incompatible with water. Water reactivity should be evaluated.

A.9.4.2.4 A method for purging piping with inert gas is to have a series of evacuations followed by an inert gas fill.

A.9.4.2.5.2 These types of fittings can trap contaminants and be difficult to purge.

A.9.4.3.4 Standard gas regulators do not have these fittings and release supply gases through vent holes located in the bonnet in the event of a regulator diaphragm failure.

A.10.1 Dye lasers normally use a lasing medium composed of a complex fluorescent organic dye dissolved in an organic solvent. Practically all solvents suitable for dye solutions are ignitible. Some dye solutions come premixed from the manufacturer, in which case efforts should be made to determine which solvent was used for the preparation.

A.10.3.6 For example, nonpolar solvents flowing through plastic tubing can develop a static charge. As another example, a grounding wire should be incorporated into plastic tubing to dissipate static charge that can accumulate when nonpolar solvents flow through nonconducting tubing.

A.10.8 See the NFPA *Fire Protection Handbook* for a list of liquids subject to self-heating and autoignition.

A.11.1.5 Examples of fire properties to be evaluated include ignition, flame spread, and oxygen index.

A study on the flammability of surgical drapes has been described in Bauman, "Laser Drape Fires: How Much of a Risk?"

Annex B Nature of Hazards

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Nature of Hazard. A beam ignition hazard might exist during the use of a laser — for example, in a research, commercial, industrial, military, or health care facility.

Annex C Education and Training

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 The LSO (laser safety officer), laser users, and maintenance or service personnel should be trained in laser fire safety and in recognizing fire hazards associated with the use of lasers. This training should be updated at least annually and any time there are changes in the laser use that can present different fire safety concerns. The following issues should be addressed during the training:

(1) Awareness of installed fire protection features in the facility and laser system
(2) Preplanning for fires, involving the appropriate emergency response personnel such as fire department or plant brigade
(3) Information on the location and method to shut off power, gases, and flammable liquids
(4) Understanding the role of employees in the fire safety plan for the facility (For example, are they expected to extinguish incipient fire? If so, appropriate training should be provided.)
(5) The safety hazards of the materials and procedures to which employees or emergency response personnel are exposed, with proper information and training provided

The following issues should be addressed during the training provided to health care facility laser users:

(1) Health care workers using medical lasers should be educated as to the fire safety problems associated with lasers in the surgical suite.
(2) General fire safety information can include an understanding of the classes of fires, extinguishing requirements of those classes of fires, and knowledge of the proper operation of handheld portable fire-fighting equipment.
(3) Training on the hazards found in the surgical suite with regard to combustible substances, gases, and oxygen-enriched atmospheres should be conducted on an annual basis.
(4) Training on any changes in equipment or procedures that can affect fire safety should be addressed prior to the use of such equipment or procedures.
(5) To reduce the incidence of fire, training on special hazards associated with the operative site when using a medical laser should be routinely reviewed and updated as new products or equipment are brought into the arena.
(6) Fire safety training can include the following:
    (a) The action(s) to be taken if drapes are burning
    (b) The responsibilities of the anesthesiologist
    (c) Responsibilities of each individual in the surgical suite if a patient fire develops
(7) Training on the facility's fire safety plan, location of fire alarms, location of fire-fighting equipment, and emergency evacuation should be conducted on an ongoing basis.

Annex D Classification of Lasers

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 This annex contains a brief explanation of the classification schemes for lasers. It is intended only to give an overview. The reader should consult the normative references in Chapter 4 to obtain detailed information about the laser hazard classes.

The laser safety standards in Chapter 4 have been in existence for approximately 30 years. These standards are aimed at preventing or reducing personal injuries resulting from exposure to hazardous levels of laser radiation. These standards operate by establishing hazard classes for lasers and by imposing equipment, informational, and administrative control measures that are appropriate for the degree of hazard.

Although the hazard classes were developed with respect to the potential for causing biological injury, they can also be useful as indicators of the ignition potential of the lasers. The processes by which lasers can cause biological injury are the same as those by which they can cause ignition. The big difference is that for biological injury from lasers in the visible and near-infrared spectral regions, the most sensitive organ is the eye because of the ability to focus laser spots on the retina. Although there are differences between the classes in the standards, there are more similarities than differences. There are four general classes: 1, 2, 3, and 4 (or I, II, III, and IV). With the exception of Class 4, the classes have limits, accessible emission limits (AEL), that consider power, emission duration, and beam propagation properties. Lasers are classified according to the level of laser radiation that is accessible during "operation," that is, when the laser is performing its intended function.

Class 1 (I) lasers either emit radiation at levels so low that they are not recognized to be capable of producing an injury or are more hazardous but are safely contained within a protective housing. Class 1 lasers can emit radiation anywhere in the optical spectrum with wavelengths between 180 nanometers and 1 meter. Some Class 1 lasers, however, contain embedded lasers of higher classes. An example would be Class 4 lasers contained within Class 1 laser machine tools.

Class 2 (II) lasers emit in the visible spectrum, between 400 and 700 nanometers, but at levels for which, although recognized to be hazardous to the eyes, a person's aversion to looking into a bright light source is sufficient to avoid an injury to the retina of the eye.

IEC 60825-1, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide*, has, in its latest version, two subclasses, Classes 1M and 2M. These M classes mean that a biological hazard could be created for Class 1M, or increased for Class 2M, if a collecting optical instrument such as a telescope or loupe were used to view the laser radiation. It is likely that the ANSI Z136 Committee and the U.S. Food and Drug Administration (FDA) will adopt a similar classification scheme in the near future.

Class 3a lasers (Class IIIa lasers in 21 CFR 1040.10 and 1040.11 and Class 3R lasers in IEC 60825-1) are less than 5 times the level of either Class 1 or Class 2. They are recognized to be hazardous, but the degree of risk of a radiation injury is considered to be too low to justify severe control measures.

In addition to the biological hazard, Classes 3b and 4 possess potential for ignition.

Class 3b (IIIb) has a large range. At the low end, Class 3b lasers are considered to have a reasonable potential for retinal injury and at the high end to be a skin hazard as well.

Class 4 (IV) has no upper limit. Class 4 lasers are considered to be hazardous not only by direct exposure but also by exposure to laser radiation scattered by diffuse targets.

Since the laser hazard classes are already in place, the ignition potential of the classes can be considered. The potential for ignition involves many factors, including the following:

(1) Power or energy
(2) Irradiance or radiant exposure
(3) Size of the laser spot on the target
(4) Duration of exposure
(5) Environmental factors such as the presence of fabric drapes, volatile solvents, or oxygen-enriched atmospheres (OEAs) in health care facilities
(6) Thickness of the target material
(7) Thermal conductivity of the target material

A general assessment of the ignition potential for the classes is given in Table D.1.

Table D.1 Laser Ignition Potential

Classification	Examples	Ignition Potential	Remarks
1, 2 (I, II)	CD players, laser printers, fiber-optic telecommunications, bar code scanners	Negligible	Not considered in NFPA 115
1M, 2M	Distance-measuring instruments, police radar, infrared telecom	Conceivable but improbable	Unlikely that one would position a lens in front of such a laser and focus it to cause ignition; not considered in NFPA 115
3a (IIIa), 3R	Laser pointers, laboratory lasers	Possible under extreme circumstances	Necessitates a deliberate attempt to cause ignition; not considered in NFPA 115
3b (IIIb), 3B	Industrial machine vision, laboratory lasers, medical lasers (e.g., for tattoo removal)	Possible at the high end of the class	Focusing optics or an irradiance >0.5 W/cm^2; requirements in NFPA 115
4 (IV)	Surgical lasers, industrial lasers, commercial light shows, laboratory lasers	Probable for highly absorbent materials	Requirements in NFPA 115

Annex E Flash Point

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 The following text is extracted from the 2015 edition of NFPA 30.

Flash point is a direct measure of a liquid's ability to emit flammable vapors. The lower the flash point, the greater the risk of fire. Flash point is determined using one of several different test procedures and apparatus that are specified in Section 4.4 of NFPA 30.

A liquid that has a flash point at or below ambient temperature is easy to ignite and will burn quickly. On ignition, the spread of flame over the surface of such a liquid will be rapid, because it is not necessary for the fire to expend energy heating the liquid to generate more vapor. Gasoline is a familiar example. A liquid with a flash point above ambient temperature presents less risk because it must be heated to generate enough vapor to become ignitible; it is more difficult to ignite and presents less potential for the generation and spread of vapor. A common example is home heating oil (Fuel Oil No. 2). Home heating oil must be atomized to a fine mist in order for it to be easily ignited.

Certain solutions of liquids in water exhibit a flash point using the standard closed-cup test procedures but will not burn and could even extinguish a fire. To assist identifying such solutions, the following standards are helpful:

(1) ASTM D4207, *Standard Test Method for Sustained Burning of Low Viscosity Liquid Mixtures by the Wick Test*
(2) ASTM D4206, *Standard Test Method for Sustained Burning of Liquid Mixtures Using the Small Scale Open-Cup Apparatus*

Liquid mixtures that do not sustain combustion for a specified time at a specified temperature are considered to be noncombustible. The tests described in the references listed in (1) and (2) provide additional data for determining proper storage and handling of such mixtures. In a confined space, such mixtures could still create an ignitible vapor–air mixture, depending on the amount of flammable liquid in the mixture and the quantity of the spill.

Related to the flash point is the *fire point*. The fire point of a liquid is the temperature at which ignition of vapors will result in continued burning. As the term *flash point* suggests, the vapors generated at that temperature will flash but will not necessarily continue to burn. The difference between flash point and fire point has some significance when conducting flash point tests *[see 9.1.4 of NFPA 30 for references to ASTM D92, Standard Test Method for Flash and Fire Points by Cleveland Open Cup, and 49 CFR (U.S. Department of Transportation Hazardous Materials Regulations), Method of Testing for Sustained Combustibility]. However, a closed-cup flash point is used to classify the liquid and characterize its hazard.*

For more information, see ASTM E502, *Standard Test Method for Selection and Use of ASTM Standards for the Determination of Flash Point of Chemicals by Closed Cup Methods*, and the *ASTM Manual on Flash Point Standards and Their Use*.

Annex F Informational References

F.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

F.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2013 edition.

NFPA 70®, *National Electrical Code®*, 2014 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA *Fire Protection Guide to Hazardous Materials*, 14th edition, 2010.

NFPA *Fire Protection Handbook®*, 20th edition, 2008.

F.1.2 Other Publications.

F.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z136.1, *Safe Use of Lasers*, 2014.

F.1.2.2 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, 2013.

F.1.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D92, *Standard Test Method for Flash and Fire Points by Cleveland Open Cup*, July 1, 2012.

ASTM D4206, *Standard Test Method for Sustained Burning of Liquid Mixtures Using the Small Scale Open-Cup Apparatus*, 2013.

ASTM D4207, *Standard Test Method for Sustained Burning of Low Viscosity Liquid Mixtures by the Wick Test*, 2012.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*, 2012.

ASTM E502, *Standard Test Method for Selection and Use of ASTM Standards for the Determination of Flash Point of Chemicals by Closed Cup Methods*, 2013.

ASTM E1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2013.

ASTM STP822, Quintiere, J. G., and Harkleroad, M. T., “New Concepts for Measuring Flame Spread Properties,” *Fire Safety: Science and Engineering*, pp. 239–269, 1985.

ASTM Manual on Flash Point Standards and Their Use, 1992.

F.1.2.4 IEC Publications. International Electrotechnical Commission. Available from American National Standards Institute, 25 West 43rd Street, 4th Floor, New York, NY 10036, U.S. National Committee for the IEC (www.ansi.org).

IEC 60825-1, Ed. 1.2: 2007-3, *Safety of laser products — Part 1: Equipment classification, requirements and user's guide.*

F.1.2.5 NIST Publications. National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899-1070.

NSBIR 81-2271, Babrauskas, V., “Will the Second Item Ignite?” 1982.

F.1.2.6 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 21, Code of Federal Regulations, Part 1040, Performance standards for light-emitting products.

Title 49, Code of Federal Regulations.

F.1.2.7 Additional Publications.

Bauman, N., “Laser Drape Fires: How Much of a Risk?” *Laser Medicine & Surgery, News & Advances*, Vol. 7, No. 4, August 1989.

F.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

F.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D56, *Standard Test Method for Flash Point by the Tag Closed Tester*, 2010.

ASTM D93, *Standard Test Method for Flash Point by the Pensky-Martens Closed Tester*, 2013.

ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, 2004.

ASTM D3828, *Standard Test Methods for Flash Point by Small Scale Closed Tester*, 2012.

F.2.2 Published Articles on Fires Involving Lasers and Related Equipment.

Bean, A. K., MD, and Ceilley, R.I., MD, “Reducing Fire Risks of the Flashlamp Pumped 585-nm Pulse Dye Laser,” *Journal of Dermatologic Surgery and Oncology*, Vol. 20, p. 224, 1994.

Brodman, M., MD, et al., “Operating Room Personnel Morbidity from Carbon Dioxide Laser Use During Preceptored Surgery,” *Obstetrics and Gynecology*, Vol. 81, pp. 607–9, 1993.

Domin, M. A., “Safety Precautions for Laser Surgery,” *Journal of Healthcare Material Management*, Vol. 9, No. 5, June 1991.

Jacobson, E., “New Hospital Hazards: How to Protect Yourself,” *American Journal of Nursing*, February 1990.

Lobraico, R. V., MD, “Laser Safety in Health Care Facilities: an Overview,” *American College of Surgeons Bulletin*, Vol. 76, No. 8, pp. 17–22, August 1991.

Maley, R. A., and Harding, G., “Controlling Risks in the Use of Lasers,” *Journal of Healthcare Risk Management*, Vol. 1, No. 13, Winter 1993.

Mowrer, F. W., and Ashman, M. N., "Flammability of Surgical Drapes," Report No. FP93-01, April 9, 1993 (Available from F. W. Mowrer, Dept. of Fire Protection Engineering, University of Maryland, College Park, MD 20742).

Ossof, R. H., DMD, MD, and Kaplan, M.S., MD, "Safe Instrumentation in Laser Surgery," *Otolaryngology, Head & Neck Surgery*, Vol. 92, No. 6, December 1984.

Rupke, G., RN, "Vigilance, Education Are Keys to Overcoming Laser Safety Complacency," *AORN Journal*, Vol. 56, No. 3, p. 523, September 1992.

"Safety Standards to Prevent Laser Burns," *American Journal of Nursing*, Vol. 89, No. 4, April 1989.

Smalley, P. J., RN, "Clinical Laser Safety Issues Survey," *Journal of Laser Applications*, Winter 1991.

Wagner, M., "Accidents Detract from Laser's Potential," *Modern Healthcare*, March 25, 1991.

F.3 References for Extracts in Informational Sections.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2013 edition.

NFPA 921, *Guide for Fire and Explosive Investigations*, 2014 edition.

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NFPA® 120

Standard for

Fire Prevention and Control in Coal Mines

2015 Edition

This edition of NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, was prepared by the Technical Committee on Mining Facilities. It was issued by the Standards Council on November 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 120 was approved as an American National Standard on December 1, 2014.

Origin and Development of NFPA 120

In 1977, with the formation of the Mining Committee, this standard, NFPA 120, formerly NFPA 653, was reassigned to the Committee on Mining Facilities. The change in numerical identity of the standard was in keeping with the numbering sequence assigned to the Mining Committee for other documents now under development. NFPA 120 represents a complete revision of former NFPA 653 and also includes changes in style in accordance with the NFPA *Manual of Style*.

The 1971 edition of NFPA 653, *Coal Preparation Plants*, was the same as the 1959 edition and was adopted at the NFPA 1971 Annual Meeting. The 1959 edition of NFPA 653 was prepared by the NFPA Committee on Dust Explosion Hazards and was adopted at the 1958 Annual Meeting with an amendment adopted in 1959.

The 1994 edition of NFPA 120 included a variety of technical and editorial updates. Previous editions not already mentioned include versions issued in 1984 and 1988.

The 1999 edition addressed the need for emergency lighting, expanded the types of portable fire extinguishers used, and expanded and clarified the types of fire suppression equipment used. The water supply requirements also were clarified.

The 2004 edition applied the NFPA *Manual of Style* to the document. It also incorporated all the appropriate sections of NFPA 121 and NFPA 123, which was done in an effort to consolidate common requirements.

The Coal Mining Task Group for the 2004 edition consisted of the following members: Matt Bujewski, Chair, Marsh Inc.; Tim Gierer, Alltype Fire Protection; Dennis Brohmer, Ansul Inc.; Jay Senn, Peabody Energy Group; Charlie Russell, Arch Coal Inc.; Brent Sullivan, Coteau Properties; Carol Boring, Mine Safety and Health Administration; Alex Smith, NIOSH; Mario Orozco, Zurich Services Corp.; Mike Wegleitner, Falkirk Mining Co. (alternate for Brent Sullivan); and Bill Wilson, U.S. Department of Labor (alternate for Carol Boring).

For the 2010 edition, the technical committee has revised the fire prevention and fire protection provisions for coal mines by requiring the use of means to manage the spontaneous combustion potential of the coal being mined, including adding an inspection plan for carbon monoxide detection systems. The fire prevention practices for coal mines have been improved by referencing the inspection and maintenance practices of fire suppression systems in the corresponding NFPA fire suppression standard. The Committee has provided improved fire protection for transformers by referencing *NFPA 70, National Electrical Code*, and adding NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, as an annex reference. Similarly, the standard has been revised to make it consistent with fire protection industry practices and the updated provisions in NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*.

For the 2014 edition, the technical committee rewrote the sprinkler requirements in a more coherent manner and provided additional guidance for underground sprinkler systems. The committee established a common definition and a protection scheme for self-propelled, mobile, and portable equipment.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding life and property against fire, explosion, and related hazards associated with underground and surface coal and metal and nonmetal mining facilities and equipment.

NFPA 120

Standard for

Fire Prevention and Control in Coal Mines

2015 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall cover minimum requirements for reducing loss of life and property from fire and explosion in the following:

(1) Underground bituminous coal mines
(2) Coal preparation plants designed to prepare coal for shipment
(3) Surface building and facilities associated with coal mining and preparation
(4) Surface coal and lignite mines

1.1.2 This standard shall not apply to the following:

(1) Flammable and combustible liquids produced in underground coal mines
(2) Other equipment and processes, such as coal pulverizers, used to condition coal for firing in boilers at power-generating plants or gasification plants or for utilization in certain special processes

1.2 Purpose. This standard shall be intended for the use and guidance of those charged with designing, constructing, purchasing, testing, installing, examining, approving, operating, or maintaining fire prevention, fire protection, or fire-fighting equipment in underground bituminous coal mines, coal preparation plants, and surface mining equipment and processes.

1.3* Application.

1.3.1 This standard shall be based on the current state of the art, and application to existing installations shall not be mandatory. Nevertheless, operating mines are urged to adopt those features of this standard that are considered applicable and reasonable for existing installations.

1.3.2 At times it will be necessary for those responsible for the storage of flammable and combustible liquids and the use of diesel-powered equipment within underground bituminous coal mines to consult an experienced fire protection specialist, and it shall be permitted.

1.3.3 Only those skilled in fire protection shall be considered competent to design and supervise the installation of mine fire protection systems.

1.3.4 Coal preparation plants shall be designed by experienced persons familiar with fire and explosion hazards in coal-processing plants.

1.3.5 At times it will be necessary for those charged with purchasing, testing, approving, and maintaining fire protection equipment for self-propelled and surface mining equipment to consult an experienced fire protection specialist.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.4.4 Operators are urged to avail themselves of any information that will prevent dust dispersions, eliminate sources of ignition, or otherwise reduce fire and explosion hazards by improving conditions in their plants.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.
NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2010 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.
NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.
NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2013 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.
NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.
NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.
NFPA 68, *Standard on Explosion Protection by Deflagration Venting,* 2013 edition.
NFPA 69, *Standard on Explosion Prevention Systems,* 2014 edition.
NFPA 70®, National Electrical Code®, 2014 edition.
NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.
NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2015 edition.
NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids,* 2015 edition.
NFPA *101®, Life Safety Code®,* 2015 edition.
NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2012 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.
NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting,* 2012 edition.
NFPA 1961, *Standard on Fire Hose,* 2013 edition.
NFPA 1962, *Standard for the Care, Use, Inspection, Service Testing, and Replacement of Fire Hose, Couplings, Nozzles, and Fire Hose Appliances,* 2013 edition.
NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2015 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems,* 2011.

2.3.2 API Publications. American Petroleum Institute, 1220 L Street NW, Washington, DC 20005-4070.

API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks,* 2009 edition.

2.3.3 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, 2013.

2.3.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D5, *Standard Test Method for Penetration of Bituminous Materials,* 2013.

ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method),* 2008.

ASTM D4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid,* 2012.

2.3.5 CSA Publications. Canadian Standards Association, 5060 Spectrum Way, Mississauga, Ontario, Canada L4W 5N6.

CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code,* 2009.

2.3.6 U.S. Bureau of Mines Publications. National Technical Information Service (NTIS), 5301 Shawnee Road, Alexandria, VA 22312.

Schedule 2G, March 1968.

2.3.7 USDA Forest Service Publications. U.S. Department of Agriculture Forest Service, 1400 Independence Avenue, SW, Washington, DC 20250-0003.

Specification 5100-186, *Hose, Cotton-Synthetic Jacketed, Lined 1-inch and 1½-inch Hose,* 2006.

2.3.8 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.
NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2013 edition.
NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.
NFPA 52, *Vehicular Gaseous Fuel Systems Code,* 2013 edition.
NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.
NFPA 99, *Health Care Facilities Code,* 2015 edition.
NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities,* 2015 edition.
NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Adequate Ventilation. Air volume and velocity that is sufficient to dilute, render harmless, and carry away flammable or explosive concentrations of dusts and vapors.

3.3.2 Atmospheric Tank. A storage tank that has been designed to operate at pressures from 760 mm Hg through 812 mm Hg (atmospheric through 1.0 psig) measured at the top of the tank.

3.3.3 Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. [**30,** 2015]

3.3.4 Closed Container. A container as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures. [**30,** 2015]

3.3.5 Coal Preparation. The separation, crushing, screening, washing, drying, storage, and loadout of coal to make ready for market.

3.3.6 Combustible. Capable of undergoing combustion.

3.3.7 Combustible Liquid. Any liquid that has a closed-cup flash point at or above 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. Combustible liquids are classified according to Section 4.3 of NFPA 30. [**30,** 2015]

3.3.8 Combustible Liquid Storage Area — Fixed. An area used for storage of Class II and Class III combustible liquids that is infrequently moved, and where the aggregate quantity present shall not exceed 18,925 L (5000 gal). Handling of liquids incidental to transfer can take place within a storage area.

3.3.9 Combustible Liquid Storage Area — Mobile. Self-propelled or mobile equipment fitted with suitable containers or tanks and other related fixtures used for the storage, transport, and dispensing of Class II and Class III combustible liquids. The aggregate quantity of combustible liquid carried on such equipment does not exceed 3785 L (1000 gal).

3.3.10 Combustible Liquid Storage Area — Portable. An area used for storage of Class II and Class III combustible liquids that is periodically moved, and where the aggregate quantity present does not exceed 3785 L (1000 gal). Handling of liquids incidental to transfer can take place within a storage area.

3.3.11 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame. [**5000,** 2015]

3.3.12 Container. Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids. [**30,** 2015]

3.3.13 Diesel-Powered Equipment. Any device powered by a diesel engine. [**122,** 2015]

3.3.14 Dry Pipe Sprinkler System. A sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinklers. [**13,** 2013]

3.3.15 Emergency Egress. An egress from a compartment or work station in emergencies when the normal egress is unusable.

3.3.16 Equipment Operator. The authorized person who starts, controls, or stops mining equipment.

3.3.17 Fire Detector. An automatic device designed to detect the presence of fire and initiate action. [**122,** 2015]

3.3.18 Fire-Resistant Construction. Masonry walls or equivalent having at least a 1-hour fire rating, including compressible materials having an equivalent fire resistance capability.

3.3.19 Fire-Resistant Enclosure. An enclosure that is constructed of fire-resistant construction.

3.3.20 Fire Risk Assessment. The evaluation of the relative danger of the start and spread of fire; the generation of smoke, gases, or toxic fumes; and the possibility of explosion or other occurrence endangering the lives and safety of personnel or causing significant damage to property. [**122,** 2015]

3.3.21 Fixed Fire Suppression System. An engineered or pre-engineered total flooding or local application system consisting of a fixed supply of extinguishing agent permanently connected for fixed agent distribution to fixed nozzles that are arranged to discharge an extinguishing agent into an enclosure (total flooding), directly onto a hazard (local application), or a combination of both; or an automatic sprinkler system. [**122,** 2015]

3.3.21.1 ***Engineered Systems.*** Engineered systems are those systems requiring individual calculation and design to determine the flow rates, nozzle pressures, pipe size, area, or volume protected by each nozzle, quantity of suppression agent, number and types of nozzles and their placement in a specific system.

3.3.21.2 ***Pre-Engineered Systems.*** Those systems having predetermined flow rates, nozzle pressures, and quantities of extinguishing agent and having specific pipe size, maximum and minimum pipe lengths, flexible-hose specifications, number of fittings, and number and types of nozzles. [**17,** 2013]

3.3.22 Flammable Liquid. Any liquid that has a closed-cup flash point that is below 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30 and a Reid vapor pressure that does not exceed an absolute pressure of 276 kPa (40 psi) at 37.8°C (100°F), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to 4.3 of NFPA 30. [**30,** 2015]

3.3.23 Flammable Liquid Storage Area. Area used for storage of Class I liquids.

3.3.24 Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitable mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.4 of NFPA 30. [**30,** 2015]

3.3.25 Hand Hose Line System. A hose and nozzle assembly connected by fixed piping or connected directly to a supply of extinguishing agent. [**122,** 2015]

3.3.26 Hydrant. A valved hose connection.

3.3.27 Important Structures. A structure that is considered not expendable in an exposure fire.

3.3.28 Inby. A mining term that means in the direction of the face of the mine or further into the mine.

3.3.29 Intrinsically Safe. As applied to equipment and wiring, equipment and wiring that are incapable of releasing sufficient electrical energy under normal or abnormal conditions to cause ignition of a specific hazardous atmospheric mixture. [**99,** 2015]

3.3.30 Liquid. Any material that (1) has a fluidity greater than that of 300 penetration asphalt when tested in accordance with ASTM D5, *Standard Test Method for Penetration of Bituminous Materials*, or (2) is a viscous substance for which a specific melting point cannot be determined but that is determined to be a liquid in accordance ASTM D4359, *Standard Test for Determining Whether a Material is a Liquid or a Solid*. [**30,** 2015]

3.3.31 Low Pressure Tank. A storage tank designed to withstand an internal pressure above 3.5 kPa (0.5 psig) but not more than 102.4 kPa (15 psig).

3.3.32 Mine Operator. Any owner, lessee, or other person who operates, controls, or supervises a mine. [**122,** 2015]

3.3.33* Mobile Equipment. Wheeled, skid-mounted, track-mounted, or rail-mounted equipment capable of moving or being moved.

3.3.34 Noncombustible. Not capable of supporting combustion.

3.3.35 Normal Operation. The regular performance of those functions for which a machine or accessory is designed.

3.3.36 Operating Area. An area where mining of coal is taking place or area where construction is underway.

3.3.37 Outby. A mining term that means in the direction away from the face of the mine or toward the outside of the mine; opposite of inby.

3.3.38 Permissible Equipment. A completely assembled machine or accessory for which formal approval has been issued, allowing operation in a potentially explosive methane and air-mixture environment.

3.3.39 Pipeline System. An arrangement of piping, valves, connections, and allied equipment installed in a mine for the purpose of transporting, transferring, or dispensing flammable or combustible liquids. [**122,** 2015]

3.3.40 Portable Extinguisher. An extinguisher of the hand-held or wheeled type that is capable of being carried or moved about, or a transportable system consisting of a hose reel or rack, hose, and discharge nozzle assembly connected to a supply of suppressant.

3.3.41 Portable Tank. Any vessel having a liquid capacity over 227 L (60 gal) intended for storing liquids and not intended for fixed installation. [**30,** 2015]

3.3.42 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code* or the CSA B51, *Boiler Pressure Vessel and Pressure Piping Code*. [**52,** 2013]

3.3.43 Rock Dust. Crushed limestone applied on surfaces in mines to make coal dust incombustible in the event of a gas explosion.

3.3.44 Safety Can. A listed container, of not more than 20 L (5.3 gal) capacity having a screen or strainer in each fill and pour opening and having a spring-closing lid and spout cover designed to safely relieve internal pressure when exposed to fire. [**30,** 2015]

3.3.45 Self-Closing Doors. Doors that, when opened and released, return to the closed position. [**80,** 2013]

3.3.46 Self-Propelled Equipment. Any unit that contains a motive power train as an integral part of the unit.

3.3.47 Suitable. That which is appropriate and has the qualities or qualifications to meet a given purpose, occasion, condition, function, or circumstance. [**122,** 2015]

3.3.48 Tank. A closed vessel having a liquid capacity in excess of 227 L (60 gal). [**122,** 2015]

3.3.49 Task Trained. Instructed in the safety and health aspects and safe work procedures of the task prior to performing such tasks.

3.3.50 Unattended. Any machine or device that is not regularly operated by a miner or not in direct line of sight of a miner that is assigned within 152.4 m (500 ft) of the equipment during each production shift.

Chapter 4 Underground Mining Operations

4.1 General. This chapter shall cover minimum requirements for reducing loss of life and property from fire in underground coal mines.

4.2* Fire Prevention. Precautions shall be taken to prevent the ignition of flammable vapors and combustible materials.

4.2.1 Smoking materials, matches, and lighters shall not be allowed underground.

4.2.2 Rock Dusting. Rock dust shall be provided on the ribs, ceiling, and floor of the mine from the mine entry to the working face in all areas of the mine that are active (not sealed).

4.2.2.1 Rock dust shall be maintained at a concentration of 80 percent.

4.2.3 Cutting and Welding. Cutting and welding and compressed gas usage shall be in accordance with Section 7.1.

4.2.4 Housekeeping.

4.2.4.1 Maintenance and operating practices shall prevent the accidental release of flammable or combustible liquids.

4.2.4.2 A cleanup plan shall be established, implemented, and monitored to prevent the accumulation of loose coal and other combustible materials.

4.2.4.3 Where flammable or combustible liquids are used or handled, means shall be provided to dispose of leakage or spills.

4.2.4.4 Waste receptacles shall be provided for combustible refuse.

4.2.4.5 Routes designated for access to fire protection equipment shall be kept clear of obstructions.

4.2.5 Underground Maintenance Shops.

4.2.5.1* Underground maintenance shops that are intended for use longer than 6 months shall be enclosed structures of fire-resistant construction, including floor, roof, roof supports, doors, and door frames, or shall be protected with an automatic sprinkler fire suppression system in accordance with 4.3.3.3.

4.2.5.2 The shop area shall be ventilated directly to a return airway.

4.2.6* Belt Conveyors. Belt conveyors installed in underground coal mines shall, as a minimum, meet all the requirements of Section 9.4 of this standard.

4.2.7 Hydraulic Fluids.

4.2.7.1 Fire-resistant hydraulic fluid shall be approved by the authority having jurisdiction.

4.2.7.2 Unattended hydraulic equipment shall employ fire-resistant hydraulic fluid and be protected by an automatic fire suppression system.

4.2.7.3 Where fire-resistant fluids are required, samples of in-use fire-resistant fluids of the invert emulsion type shall be collected quarterly.

4.2.7.3.1 Samples of the in-use fire-resistant fluids shall be tested individually to determine if the water content will make the fluid fire resistant.

4.2.7.3.2 When a sample of the in-use fire-resistant fluids indicates that the water content is insufficient for the fluid to be fire resistant, the fluid shall be replaced or water shall be added to restore the fire resistance of the fluid.

4.2.7.3.3 When water is added to the hydraulic system of any machine, a sample shall be taken and analyzed within 24 hours.

4.2.8 Flammable Liquids Storage and Use. The storage and use of flammable liquids underground shall conform to Section 7.5.

4.2.9 Combustible Liquids Storage and Use. The storage and use of combustible liquids underground shall conform to Section 7.6.

4.2.10 Methane Control. Methane within the coal mine shall be reduced to not more than 1 percent on the intake air and 2 percent on the return air.

4.2.10.1 Methane monitors shall be provided on equipment used to cut coal from the face.

4.2.10.1.1 The methane monitors shall alarm at 1 percent concentration and be interlocked to shut down the machine at a 2 percent concentration of methane.

4.2.11* Spontaneous Combustion.

4.2.11.1 Mine operators shall determine the spontaneous combustion potential of the coal being mined.

4.2.11.2* Mines with a high spontaneous combustion potential shall take means to minimize the spontaneous combustion risk.

4.3* Fire Protection.

4.3.1 Water Supply for Mine Fire Protection.

4.3.1.1 General Requirements.

4.3.1.1.1* Water distribution lines shall extend from the surface to each operating area.

4.3.1.1.2 Water distribution lines from a suitable underground supply of water shall be permitted to replace the surface distribution lines if sufficient quantity is available and power for the pump(s) will not be affected or interrupted during a fire.

4.3.1.1.3 The operator shall choose the entry in which the water line is located, and it shall be protected by the choice of location.

4.3.1.1.4 Water flow and ventilation airflow shall be in the same direction unless provision is made to ensure the availability of fire-fighting water on the upwind side of a fire in the entry containing the water line.

4.3.1.1.5 Where applicable, water lines shall be protected against freezing.

4.3.1.1.6 Water lines that are 50 mm (2 in.) or larger in diameter shall be joined with flanges, mechanical grooved fittings, threaded fittings, or other fittings.

4.3.1.1.7 At least every third joint shall be capable of allowing limited motion and emergency rearrangement.

4.3.1.1.8 Pipe and fittings shall be of metal construction and designed to withstand the anticipated water pressure.

4.3.1.1.9* Water lines shall be equipped with shutoff valves at intervals not exceeding 1524 m (5000 ft).

4.3.1.1.10 A shutoff valve shall be provided in each branch line at the point where it is coupled to the main water line.

4.3.1.1.10.1 Shutoff valves for fire protection shall be sealed, locked, or supervised in the open position.

4.3.1.2 Water Demand.

4.3.1.2.1* All coal mine water systems shall be capable of simultaneously supplying three hose streams, each with a flow rate of at least 190 L/min (50 gpm), and a nozzle pressure of at least a gauge pressure of 345 kPa (50 psi) for a total of 570 L/min (150 gpm), applied through the maximum expected lay of hose.

4.3.1.2.2* The mine water system shall be capable of supplying the required hose stream water demand continuously for 24 hours or the sprinkler water demand continuously for 2 hours, whichever is the greater supply.

4.3.1.3 Hydrants.

4.3.1.3.1* The mine operator shall choose the entry in which hydrants are to be located, except for belt conveyor entries where hydrants shall be located in the same entry as the belt, locate personnel doors, and provide fire hose that reaches parallel entries where risk of fires exists.

4.3.1.3.2* Hydrants that supply water to a fire hose shall be provided on the water line at intervals not exceeding 91.4 m (300 ft) for belt conveyors and 152.4 m (500 ft) for haulage tracks.

4.3.1.3.3 Hydrants shall be located in the belt entry and accessible.

4.3.1.3.3.1 If staggered crosscuts are used, hydrant locations and crosscuts with personnel doors shall be located to provide a route for laying a fire hose to parallel entries.

4.3.1.3.3.2 At least one hydrant shall be located upwind of the area protected by an automatic sprinkler system.

4.3.1.4 Maintenance. The water supply system shall be maintained operable.

4.3.2* Protective Signaling Fire Detection Systems.

4.3.2.1 General Requirements.

4.3.2.1.1* The design and installation of all fire detection systems shall be approved for the intended use.

4.3.2.1.2 Fire detectors and related signaling system components used to initiate an audible or visual alarm, automatic activation of a fire suppression system, or equipment shutdown shall be listed or approved for the intended use.

4.3.2.1.3* Signaling system input, alarm, and releasing circuits shall be supervised.

4.3.2.1.3.1 The presence of a fault, alarm, or release shall initiate a signal in the protected area and remotely in a constantly attended location.

4.3.2.1.3.2 The signal specified in 4.3.2.1.3.1 shall indicate which condition has occurred.

4.3.2.1.3.3 A trouble signal shall not be required when the main power supply is intentionally shut off during periods of mine inactivity.

4.3.2.1.4* All components of protective signaling systems used inby the last open crosscut or in return air shall be classified as permissible or intrinsically safe.

4.3.2.2 Selection and Application.

4.3.2.2.1* Carbon monoxide (CO) detectors or the equivalent shall be installed along all belt conveyors and at all unattended automatic belt heads (where mine cars are loaded automatically).

4.3.2.2.2* Compartment sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area shall determine the placement, type, sensitivity, and, where applicable, number of detectors.

4.3.2.2.3 The fire alarm shall identify a fire within each belt flight (segment).

4.3.2.2.4 Fire detection systems shall be installed so as to minimize the possibility of damage from roof falls and from the moving belt and its load.

4.3.2.2.5 The voltage of automatic fire alarm systems shall not exceed 120 volts.

4.3.2.2.6 The system shall be designed to provide an alarm up to 4 hours after the source of power to the belt is shut off.

4.3.2.2.7 An audible and visual alarm shall be provided either at the location of the belt or at a constantly attended location that has a telephone or equivalent communication with those miners who might be endangered.

4.3.2.2.8 The alarm system shall be equipped with a "trouble" signal to indicate open circuits, shorts, ground faults, or any other defects.

4.3.2.2.9 The alarm system shall include a manual reset feature.

4.3.2.3 Inspection, Maintenance, and Testing.

4.3.2.3.1 Fire detection systems and associated equipment shall be tested after installation according to the manufacturer's or designer's instruction manual.

4.3.2.3.2 The detection system shall be inspected visually weekly.

4.3.2.3.3 Carbon monoxide detection systems shall be visually inspected daily, functionally tested weekly, and calibrated monthly, not to exceed 31 days between calibrations.

4.3.3 Fire Protection Systems.

4.3.3.1 General Requirements.

4.3.3.1.1 Mining equipment requiring a fixed fire protection system shall be protected by a system with the capacity to suppress the largest anticipated fires in the protected areas and shall meet the following criteria:

(1) They shall be listed or approved for the purpose.
(2) They shall be located or guarded so as to be protected against physical damage.
(3)*They shall be actuated either automatically, manually, or both.
(4)*They shall be provided with an agent distribution hose or pipe secured and protected against damage, including abrasion and corrosion, and shall be flame resistant.
(5) They shall be provided with discharge nozzle blowoff caps or other devices or materials to prevent the entrance of moisture, dirt, or other material into the piping. The discharge nozzle protective device shall blow off, blow out, or open upon agent discharge.
(6)*Water-based systems shall not be required to have nozzle blowoff caps as long as the nozzles are kept free of blockage at all times.
(7) The fire protection system shall be installed so that system actuation causes shutdown of the protected equipment.
(8) Discharge nozzles or sprinklers shall not be covered with any material that will reduce the effectiveness of the system.

4.3.3.1.2 Automatically actuated systems other than water-based sprinkler systems shall have a manual actuator capable of being activated from the operator's compartment or other accessible location.

4.3.3.1.3 Unless otherwise noted in this standard, fire protection systems shall be installed and operate in accordance with the applicable NFPA standard.

4.3.3.1.3.1 Pre-engineered systems shall be designed, installed, and tested in accordance with the fire suppression system manufacturer's listed installation and maintenance manual.

4.3.3.1.4* Where the nature of a coal mine does not allow the NFPA standards to be followed, systems that provide equivalent protection shall be approved by the authority having jurisdiction.

4.3.3.2 Applications.

4.3.3.2.1* The following equipment and facilities shall be protected by approved automatic fire protection systems. Where sprinkler systems are used, they shall satisfy the requirements of 4.3.3.3 through 4.3.3.5.4. Where dry chemical systems are used, they shall satisfy the requirements for self-propelled equipment in 4.3.3.6.1.

(1)*Drive areas of belt conveyors shall be protected in accordance with 9.4.6.
(2) Flammable and combustible liquid storage areas shall be protected by either one of the following:
   (a) Automatic water-based fixed fire protection systems installed for the protection of Class I or Class II liquid storage areas shall be of the Class B foam–water type.
   (b) Fixed diesel or other Class II combustible liquid storage areas shall be protected with a dry chemical system or a system that provides equivalent protection according to the authority having jurisdiction.
(3) Unattended hydraulic equipment shall use fire-resistant hydraulic fluid.
(4) Unattended electrical equipment such as enclosed electric motors, controls, transformers, rectifiers, battery chargers, and other equipment that does not have a hydraulic system shall be protected by an approved automatic fire protection system.
(5) Unattended electrical equipment located on noncombustible material and spaced at least 0.61 m (2 ft) from coal or other combustible material shall not be required to be protected with an automatic fire suppression system.
(6) Unattended electrical equipment located on noncombustible material and separated from coal or other combustible material by a fire-resistive layer or wall shall not be required to be protected with an automatic fire suppression system.

4.3.3.2.2* Air Compressors. Air compressors with motors that exceed 5 horsepower shall be protected by an approved automatic fire protection system interlocked to shut down the power to the compressor and by one of the following:

(1) A person in constant attendance, within the line of sight of the compressor, and equipped with a portable fire extinguisher
(2) Containment within an enclosure that is constructed of noncombustible materials, ventilated to prevent overheating of the compressor, and designed to provide containment of any possible fire involving the compressor

4.3.3.3 Sprinkler System Requirements.

4.3.3.3.1* Water Supply. The water supply shall have enough pressure and flow to provide sprinkler coverage as the sprinkler design is intended.

4.3.3.3.1.1 An approved strainer with a flush-out connection and a manual shutoff valve shall be provided at the point of the sprinkler system connection to the main water line.

4.3.3.3.1.2 An indicating, full-flow, slow-opening water control valve shall be located at the tap of the water line supplying the sprinkler system.

4.3.3.3.1.3 When the sprinkler system is put into operation, the slow-opening valve specified in 4.3.3.3.1.2 shall be sealed or locked in the open position, or be provided with a supervisory alarm.

4.3.3.3.1.4 A pressure gauge shall be provided at the point of connection.

4.3.3.3.1.5 The water line from the water main to the sprinkler system shall be metallic.

4.3.3.3.1.6 The water line from the water main to the sprinkler system of a belt drive shall be flexible metal or reinforced nonmetal if excessive vibration could reduce the reliability of the sprinkler system.

4.3.3.3.1.7 Fittings and piping shall have a rated pressure higher than the anticipated maximum pressure on the system.

4.3.3.3.2 General Installation Requirements.

4.3.3.3.2.1* Piping in sprinkler systems shall comply with NFPA 13.

4.3.3.3.2.2 Nonmetallic pipe shall not be used downstream of the sprinkler control valve unless investigated and approved for this purpose.

4.3.3.3.2.3 Hangers supporting sprinkler piping shall be metallic.

4.3.3.3.2.4 At least one hanger shall be attached to each length of pipe.

4.3.3.3.2.5* Sprinklers shall be standard orifice pendent, upright, or sidewall-type automatic sprinklers.

4.3.3.3.2.6* For sprinkler systems installed to protect the equipment and facilities indicated in 4.3.3.2.1(2) through 4.3.3.2.1(6), sprinklers shall be spaced no more than 3.66 m (12 ft) apart, and the protection of any one sprinkler shall not exceed 9.3 m^2 (100 ft^2).

4.3.3.3.2.7* Sprinklers shall be located so that the discharge will not be obstructed.

4.3.3.3.2.8 Sprinkler deflectors shall be located at a distance below the roof of not less than 25.4 mm (1 in.) nor greater than 508 mm (20 in.).

4.3.3.3.2.9 Roof cavities containing combustible material such as wood or coal in the area to be protected shall be protected by installation of upright sprinklers within the cavity at the top of riser pipes so that the deflectors are within 508 mm (20 in.) of the roof.

4.3.3.3.2.10 Wet-pipe sprinkler systems shall not be used where chance of freezing exists.

4.3.3.3.2.11 Provisions shall be made to drain all parts of the system.

4.3.3.3.2.12 Drain connections shall be sized as shown in Table 4.3.3.3.2.12.

4.3.3.3.2.13 Trapped piping sections shall be equipped with auxiliary drains or otherwise arranged to facilitate draining.

Table 4.3.3.3.2.12 Sizes of Drain Connections

Riser or Main Size	Size of Drain Connection
Up to 2 in.	¾ in. or larger
2½ in. to 3½ in.	1¼ in. or larger
4 in. and larger	2 in. only

For SI units, 1 in. = 25.4 mm.

4.3.3.3.3 General Alarm Requirements for Sprinkler Systems.

4.3.3.3.3.1 A waterflow switch or alarm valve capable of detecting the flow through one opened sprinkler shall be installed in the piping feeding the sprinklers.

(A) An inspector's test connection shall be provided at the end of the most remote line of the sprinkler system.

(B) The inspector's test connection shall simulate one sprinkler head in operation for sprinkler systems other than belt drive systems.

(C) In addition to 4.3.3.3.3.1(B), the inspector's test connection for belt drive systems shall simulate a minimum of eight sprinkler heads activating at the same time.

4.3.3.3.3.2 The alarm device shall be connected to an alarm system that will alarm at a constantly attended location. The alarm device shall provide a local audible and visual alarm.

4.3.3.3.3.3 The alarm system shall identify the sprinkler system involved.

4.3.3.3.3.4 In dry-pipe automatic sprinkler systems, the alarm system shall be actuated by a pressure switch associated with the trim on the dry-pipe device.

4.3.3.3.3.5 A paddle-type water flow switch shall be installed in wet systems only.

4.3.3.3.4 Antifreeze System. Where danger of freezing exists, sprinkler systems filled with antifreeze solution shall be permitted and shall meet the requirements of 7.6.2 and 7.6.3 of NFPA 13.

4.3.3.3.5* Dry-Pipe System. Where danger of freezing exists, a dry-pipe sprinkler system shall be permitted and shall meet the requirements of 4.3.3.3.5.1 through 4.3.3.3.5.7.

4.3.3.3.5.1 The dry-pipe valve and its accessories shall be installed in a separate area and shall be protected against freezing and mechanical injury.

4.3.3.3.5.2 If the separate area described in 4.3.3.3.5.1 is ventilated with return air, all electrical components shall be permissible or intrinsically safe.

4.3.3.3.5.3 Water pressure shall be regulated not to exceed the maximum pressure specified by the manufacturer of the dry-pipe valve.

4.3.3.3.5.4 The dry-pipe valve shall be installed in accordance with the manufacturer's instructions.

4.3.3.3.5.5 Mechanical grooved couplings, including gaskets used on dry-pipe systems, shall be listed for dry-pipe service.

4.3.3.3.5.6 Operation of the dry-pipe system and supervision of the system, including pressure of the air supply, shall be signaled to an attended location. Signaling to an attended location shall be permitted to utilize alarm systems serving fire detection equipment.

4.3.3.3.5.7 The system air supply shall be provided from a reliable source such as a dedicated compressor and shall be equipped with an air maintenance device.

4.3.3.3.5.8 Sprinklers shall be installed in the upright position on a dry-pipe system or be listed dry type or horizontal sidewall sprinklers installed according to the listing for dry-pipe systems.

4.3.3.3.6 Protection of Specific Hazards.

4.3.3.3.6.1* Automatic water-based fixed fire protection systems installed for the protection of Class I or Class II liquid storage areas shall be of the foam–water type.

4.3.3.3.6.2* Where the requirements of 9.4.6 dealing with underground belt drives are satisfied by installing automatic sprinkler systems, such systems shall comply with the requirements of 4.3.3.3.1.2 and 4.3.3.3.1.3.

4.3.3.4 Automatic Sprinkler System Acceptance Testing.

4.3.3.4.1 Flushing of Water-Line Connections.

4.3.3.4.1.1 Water-line connections and lead-in connections shall be flushed at the maximum flow rate available before connection is made to the sprinkler piping in order to remove foreign material.

4.3.3.4.1.2 Flushing shall be continued until the water is clear.

4.3.3.4.2 Flow Testing of Sprinkler Systems.

4.3.3.4.2.1 Wet-pipe closed automatic sprinkler systems shall be flow-tested by operating flow through at least one sprinkler head for non–belt drive areas and at least eight sprinkler heads for belt drive areas.

4.3.3.4.2.2 If the system contains fewer than eight sprinklers, all sprinklers or an inspector's test simulating all sprinklers shall be flow-tested as specified in 4.3.3.4.2.1.

4.3.3.4.2.3 With a water flow and pressure that is present under normal mine operating conditions, if the residual pressure measured downstream of the opened sprinklers is 70 kPa (10 psi) or greater for belt drive systems and 140 kPa (20 psi) for all other systems, the system shall be considered acceptable.

4.3.3.4.2.4 Closed sprinkler systems installed to protect areas where the water discharge could damage the area or its contents shall not be required to be tested by operating flow through opened sprinklers.

4.3.3.4.2.5 Where the condition(s) in 4.3.3.4.2.4 exist, the alternative test of operating flow through a 51 mm (2 in.) valve test connection shall be permitted to be used.

4.3.3.4.2.6 Portable sprinkler systems that are dismantled and reinstalled in new areas shall be flow-tested following the initial installation.

4.3.3.4.3 Tests of Dry-Pipe Sprinkler Systems.

4.3.3.4.3.1 Where there is no risk of freezing, new dry-pipe systems shall be flow-tested and hydrostatically tested in accordance with NFPA 13.

4.3.3.4.3.2 A dry-pipe valve shall be tested according to the manufacturer's recommendations.

4.3.3.4.3.3* Where there is risk of freezing in dry-pipe systems, an air pressure of 276 kPa (40 psi) shall be pumped up and allowed to stand 24 hours, and all leaks that allow a loss of pressure over 10.3 kPa (1½ psi) during the 24 hours shall be stopped.

4.3.3.5 Inspection, Maintenance, and Testing.

4.3.3.5.1 All fire suppression systems shall be tested after installation in accordance with the appropriate NFPA standard.

4.3.3.5.2 If an applicable NFPA standard does not exist, then a fire suppression system shall be tested in accordance with the manufacturer's or designer's instruction manual.

4.3.3.5.3 Testing shall not require the discharge of suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system can be verified.

4.3.3.5.4* All persons who inspect, test, operate, or maintain fire suppression systems shall be trained.

4.3.3.5.5 Sprinkler System Maintenance.

4.3.3.5.5.1 All sprinkler systems shall be maintained in accordance with the manufacturer's requirements or in accordance with NFPA 25.

4.3.3.5.5.2* As a minimum, all closed-head sprinkler systems, except antifreeze systems, shall be flushed annually by operating flow through the end of the line drain(s) for the system to remove any silt buildup.

(A) If pendent sprinklers are used on wet-type sprinkler systems, the end sprinkler on each line shall be removed and examined annually to check for silt buildup.

(B) If silt buildup is found, all sprinklers on the line shall be removed, the line flushed, and new sprinklers installed.

4.3.3.5.5.3* As a minimum, deluge sprinklers and deluge water-spray systems shall be flow-tested on a monthly basis.

4.3.3.5.5.4 The strainer shall be flushed on a weekly basis, at a minimum.

4.3.3.5.6 Antifreeze Systems.

(A) Each year at the onset of freezing weather, a small amount of antifreeze shall be drawn from the drain valve and the test valve(s) and tested with a hydrometer to ensure that the solution is suitable for the lowest temperature expected.

(B) If the test described in 4.3.3.5.6(A) shows that the solution is not suitable, the solution shall be replaced.

4.3.3.6 Fire Suppression for Self-Propelled Equipment.

4.3.3.6.1* Fire suppression systems consisting of an agent container and a network of agent distribution hose or pipe with discharge nozzles attached shall be used to protect self-propelled equipment and shall comply with the following:

(1) The system shall suppress any potential fire on the equipment it is intended to protect.
(2) The fire suppression system shall be approved for the purpose, and the components shall be located or guarded to protect against damage.
(3) Fire suppression systems shall be actuated automatically, manually, or both.
(4) Automatically actuated systems designed to incorporate manual actuation shall be equipped with one or more such devices accessible for actuation and shall be maintained in operable condition.
(5) Discharge nozzles shall be provided with blow-off caps or other devices to prevent the entrance of moisture or other environmental materials into the piping.
(6) The protective device shall blow off, blow out, or open upon agent discharge.
(7) The electrical components of systems installed on equipment that might be operated in the last open crosscut or in return air shall be permissible.
(8) A standby source of power shall be provided if electrical power is the only means of actuation.
(9) All fire suppression equipment and systems shall be tested after installation in accordance with the manufacturer's or designer's recommendations.
(10) Testing shall not require the discharge of agent unless there is no other feasible way to evaluate the system.
(11)*An owner's or operations manual shall be provided for all fire suppression systems.
(12)*Fire suppression systems shall be inspected and maintained in accordance with the appropriate NFPA standard.

4.3.3.6.2* Fire suppression systems shall be provided for protection of attended, electrically powered, self-propelled equipment such as cutting machines, continuous miners, shearers, roof and coal drills, loaders, shuttle cars, scoops, and locomotives that use hydraulic fluid, unless fire-resistant hydraulic fluid is used.

4.3.3.6.3 Cutting machines, continuous miners, shearers, and other machines that supply water through a hose for dust control during mining shall be permitted to use this water source for fire protection, provided a diversion valve is at or out by the operator's station to permit quick and convenient diversion of water to the fire suppression nozzles.

4.3.4 Manual Fire Fighting.

4.3.4.1 Portable Fire Extinguishers.

4.3.4.1.1 General Requirements.

4.3.4.1.1.1* Portable fire extinguishers used in underground coal mines shall be listed, multipurpose (ABC) dry-chemical types having a minimum nominal capacity of 4.6 kg (10 lb) of extinguishing agent, and shall meet the requirements of NFPA 10.

4.3.4.1.1.2 Portable extinguishers shall be kept in their designated places.

4.3.4.1.1.3 Extinguishers shall be located where they will be accessible in the event of fire.

4.3.4.1.1.4 In areas where visual obstruction cannot be completely avoided, visible markings shall be provided to indicate the location.

4.3.4.1.1.5 Extinguishers subject to dislodgment shall be installed in brackets specifically designed for this problem.

4.3.4.1.1.6 Extinguishers shall be protected from physical damage.

4.3.4.1.1.7 Damaged extinguishers shall be repaired, replaced, or removed from service.

4.3.4.1.1.8 At least one hand-portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 10-A:60-B:C shall be located outside of, but not more than 3.0 m (10 ft) from, the opening into each flammable and combustible storage area and maintenance shop.

4.3.4.1.1.9 The installation of manual or automatic fire suppression systems shall not waive the requirement of 4.3.4.1.1.8.

4.3.4.1.1.10 Where portable fire extinguishers are provided within flammable and combustible storage areas, travel distance to a portable extinguisher shall not exceed 12.2 m (40 ft).

4.3.4.1.2 Selection and Application.

4.3.4.1.2.1 Multipurpose (ABC) dry-chemical extinguishers shall be provided for protection of the following:

(1) Ventilation doors on trolley wire-supplied track haulageways
(2) Pumps and pump rooms
(3) Conveyor belt drives
(4) Belt head loading equipment
(5) Air compressors
(6) Electrical equipment such as transformers, load centers, rectifiers, circuit breakers, generators, and starters
(7) Rotary dump areas
(8) Battery-charging areas
(9) Intervals of 23 m (75 ft) along a longwall face unless washdown hose is present
(10) Flammable and combustible liquid storage areas
(11) Mobile equipment used for the storage, transport, and dispensing of combustible liquids
(12) Electric- or diesel-powered mobile equipment
(13) Self-propelled equipment

4.3.4.1.2.2 The installation of an automatic or manually operated fire suppression system shall not eliminate the requirement for a portable fire extinguisher.

4.3.4.1.2.3* At least one multipurpose (ABC) dry-chemical extinguisher having a nominal capacity of 13.6 kg (30 lb) or greater of agent or two multipurpose (ABC) dry-chemical extinguishers having a nominal capacity of 9.1 kg (20 lb) or greater of agent each shall be provided in each working section of a mine, including the headgate of a longwall face.

4.3.4.1.3 Inspection and Maintenance.

4.3.4.1.3.1 Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, Chapter 7, and shall include the requirements of 4.3.4.1.3.2 through 4.3.4.1.3.9.

4.3.4.1.3.2* Visual Inspection.

(A) Portable fire extinguishers shall be inspected visually at least monthly.

(B) The visual inspection shall confirm the following:

(1) The extinguisher is in its designated place.
(2) The tamper seals are intact.
(3) The extinguisher gauge is in the operable range (if extinguisher is stored pressure type).
(4) There is no obvious physical damage or condition to prevent operation.

4.3.4.1.3.3 Extinguishers shall be subjected to a thorough maintenance examination at least once every 12 months.

4.3.4.1.3.4 Maintenance procedures shall include a thorough examination of the extinguisher, including mechanical parts, extinguishing agent, and the means of expulsion.

4.3.4.1.3.5 Any detected troubles or impairments shall be corrected or replaced immediately by competent personnel.

4.3.4.1.3.6 Each extinguisher shall have a durable tag or label securely attached on which the date of the maintenance services shall be recorded.

4.3.4.1.3.7 All extinguishers shall be recharged after any discharge.

4.3.4.1.3.8 All extinguishers shall be recharged as deemed necessary through inspection and maintenance.

4.3.4.1.3.9 Portable extinguishers shall be hydrostatically tested at intervals not exceeding those specified in NFPA 10, Chapter 8.

4.3.4.2 Hand Hose Line Systems.

4.3.4.2.1 Selection and Application.

4.3.4.2.1.1* Fire hose for use in underground coal mines shall be a minimum of 38 mm (1½ in.) in diameter, single or multiple jacket, and of a type suitable for coal mine use.

4.3.4.2.1.2 The hose shall meet the minimum applicable standards of NFPA 1961.

4.3.4.2.1.3 Hose lines employing natural fibers shall not be used in underground coal mines.

4.3.4.2.1.4* Fire hose, including couplings, shall be rated for the maximum line pressure that can exist on the mine water system, or there shall be provision for limiting the line pressure to the working pressure of the hose.

4.3.4.2.1.5 Nozzle flow pressure shall be adjusted to provide hose control.

4.3.4.2.1.6* Couplings for fire hose used in underground coal mines shall have straight, iron pipe threads or National Standard Thread.

4.3.4.2.1.7 Where hose or hose-connected equipment is brought in from outside the mine, compatible adapters shall be available.

4.3.4.2.1.8 Hose nozzles shall be capable of delivering a straight stream and a spray discharge.

4.3.4.2.1.9* Fire hose shall be stored in caches, and caches shall contain hose to reach all areas covered by the hydrants that the cache will serve.

4.3.4.2.1.10 Each cache shall contain at least one hose nozzle and one hose wrench.

4.3.4.2.1.11* Caches of fire hose shall be provided at strategic underground locations as follows:

(1) At each intersection with an active submain
(2) At the mouth of each panel
(3) At and on the intake side of each conveyor belt drive
(4) At the entrance to each shop and storage area as defined in 4.2.5, 4.2.8, and 4.2.9
(5) In each operating area
(6) At intervals not to exceed 1524 m (5000 ft) along the main haul route or travelway

4.3.4.2.1.12 Hand hose line systems, if used, shall be installed in accordance with NFPA 14 and shall be a minimum of either 38 mm (1½ in.) lined or 25.4 mm (1 in.) hard rubber.

4.3.4.2.1.13 Hand hose lines that are designated for fire fighting and that have the capability to be used in Class I or Class II liquid storage areas shall be equipped to discharge a foam–water solution and shall be in accordance with the applicable sections of NFPA 11.

4.3.4.2.2* Maintenance. Caches of fire hose shall be checked at least every 6 months to ensure that the inventory of hose, nozzles, wrenches, and adapters is complete, and the following requirements shall apply:

(1) At least one length of hose from each cache shall be pressure-tested annually in accordance with NFPA 1962.
(2) The tested hose shall be tagged and dated so that a different length of hose is tested each year.
(3) If any length of hose fails the pressure test, all lengths of hose in the cache shall be tested.
(4) Hose lines that fail the test shall be replaced.

4.3.4.3 Portable Foam-Generating Devices.

4.3.4.3.1 General Requirements.

4.3.4.3.1.1 Portable foam generators, fire hose, foam concentrate, and emergency fire-fighting materials in accordance with 4.3.4.5 shall be accessible within 60 minutes of fire notification.

4.3.4.3.1.2 Portable foam-generating devices and associated equipment shall be listed or approved for that purpose.

4.3.4.3.2 High-Expansion Foam.

4.3.4.3.2.1 Where high-expansion foam is used, provision shall be made to supply uncontaminated air for foam making.

4.3.4.3.2.2 The foam system shall be tested with the water supply to determine the quality of the foam-making capabilities.

4.3.4.3.3 Maintenance.

4.3.4.3.3.1 At least annually, a thorough maintenance examination of the foam-generating devices and associated equipment, including foam concentrate, shall be made by the mine operator.

4.3.4.3.3.2 Operation of foam-generating equipment during training sessions conducted at least annually shall satisfy the maintenance examination requirement.

4.3.4.4 Rock Dust.

4.3.4.4.1 At least 109 kg (240 lb) of bagged, dry rock dust shall be stored upwind and kept available for fire fighting at or near the following areas:

(1) Maintenance and shop areas
(2) Combustible liquid storage area
(3) Working section
(4) Belt drive area
(5) Belt-head loading area
(6) Ventilation doors on trolley wire–supplied track haulageways

4.3.4.4.2 Where it is impractical to store for fire extinguishment purposes, rock dust shall be permitted to be replaced with an additional portable extinguisher having a nominal capacity of 4.5 kg (10 lb) of multipurpose (ABC) dry-chemical extinguishing agent.

4.3.4.5 Emergency Materials.

4.3.4.5.1 Emergency materials for fighting mine fires shall be near the shaft bottom or other entrance to the mine.

4.3.4.5.2 If the shaft bottom or other entrance to the mine is more than 3.2 km (2 mi) from a working section, additional caches of emergency materials shall be located within 3.2 km (2 mi) of the working section.

4.3.4.5.3 Emergency materials shall include fire hose and necessary adapters, multiple hydrants, wrenches and nozzles, brattice boards and cloth, wood posts, cap pieces, wood wedges, spad guns and spads, or other specialized equipment for installing line brattice, nails, bags of sealant or cement, saws, hammers, axes, shovels, and picks.

4.3.4.5.4 Caches of emergency materials shall be checked at least every 6 months to ensure that the inventory of materials is complete.

4.3.4.6* Training.

4.3.4.6.1 All miners shall be instructed annually in fire prevention and fire-fighting techniques.

4.3.4.6.2 All employees shall be instructed in emergency evacuation procedures.

4.3.4.6.3 All persons who inspect, test, operate, or maintain fire suppression systems shall be trained in the functions they are to perform.

Chapter 5 Surface Mining Operations

5.1 General. This chapter shall cover surface bituminous and subbituminous coal and lignite mining operations.

5.2* Fire Prevention. Risk reduction practices shall follow the principles of minimizing ignition sources and reducing exposure of combustible materials to ignition sources.

5.2.1 Housekeeping.

5.2.1.1 Spills, leaks, excess lubricants, and combustible materials such as oil-soaked wastes, rubbish, and accumulations of environmental debris shall not be allowed to accumulate in quantities that could create a fire hazard.

5.2.1.2 Approved metal receptacles shall be provided where oil-soaked wastes or rubbish are not immediately removed to a safe place for disposal.

5.2.1.3 The storage and handling of flammable or combustible liquids on or within equipment shall be in accordance with NFPA 30.

5.2.1.4 Access to fire protection equipment on mining equipment shall be kept clear of obstructions.

5.2.2 Inspection and Maintenance of Equipment. Hydraulic, coolant, lubrication and fuel lines, and electrical wiring shall be inspected and maintained in accordance with the manufacturers' recommendations.

5.2.3 Flammable and Combustible Liquid Storage on Equipment and in Buildings. Flammable and combustible liquid storage and usage shall be in accordance with Sections 7.3 and 7.4.

5.2.4 Compressed Gas Storage and Usage. Compressed gas storage and usage shall be in accordance with Section 7.1.

5.3 Fire Protection.

5.3.1 Fire protection for the purposes of this standard shall be defined in the broad sense to include fire detection and fire suppression.

5.3.2 Fire suppression systems shall include dry chemical, wet chemical, gaseous, water mist, foam, or sprinklers.

5.3.3 Fire suppression systems and fire alarm systems shall be installed in accordance with applicable NFPA standards.

5.3.3.1 Fire suppression systems shall be tested and maintained in accordance with the appropriate NFPA standard.

5.3.3.2 Water Supplies. Fire suppression water supply shall be of sufficient quantity to extinguish the largest anticipated fire. This shall be accomplished with water trucks in pit areas or fire hydrants in coal processing areas.

5.3.4 Fire Extinguishers for Equipment.

5.3.4.1* A 9.1 kg (20 lb) ABC-type fire extinguisher shall be provided at intervals not to exceed 15.2 m (50 ft) travel distance, including the lower frame areas of draglines.

5.3.4.2 The fire-extinguishing agent applied by hand-portable extinguishers to hazards involving energized electrical equipment shall be nonconductive.

5.3.4.3 Portable extinguishers shall be maintained in accordance with NFPA 10 and kept in their designated places at all times.

5.3.4.4 Extinguishers shall be located on each vehicle and shall be accessible.

5.3.4.5 In areas where obstruction to visual observation cannot be completely avoided, visible markings shall be provided to indicate the location of the fire extinguishers.

5.3.4.6 Extinguishers installed under conditions where they can be subject to physical damage shall be guarded to protect against damage.

5.3.4.7 The installation of an automatic or manually operated fire suppression system shall not eliminate the portable fire extinguisher requirement.

5.3.4.8 Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, Chapter 7, and the following:

(1) Portable fire extinguishers shall be inspected visually at least monthly.
(2) The visual inspection shall ensure the following:
    (a) The extinguisher is in its designated place.
    (b) The tamper seals are intact.
    (c) The extinguisher gauge is in the operable range (if the extinguisher is the stored-pressure type).
    (d) There is no obvious physical damage or condition that will prevent proper operation.
(3) Extinguishers found to be defective or deficient by visual inspection shall be replaced.
(4) Extinguishers shall be subjected to a maintenance examination at least once every year.
(5) Maintenance procedures shall include a thorough examination of the extinguishers, including mechanical parts, extinguishing agent, and expellant.
(6) Any troubles or impairments shall be corrected.
(7) All extinguishers shall be recharged after use in accordance with the manufacturer's recommendations.
(8)*Each extinguisher shall have a permanent tag attached on which the inspection date shall be recorded.

5.3.4.9 Portable extinguishers shall be tested hydrostatically at intervals not exceeding those specified in NFPA 10, Chapter 8.

5.3.5 Draglines, Electric Shovels, and Hydraulic/Electric Excavators.

5.3.5.1 Center Pin/Collector Ring Area.

5.3.5.1.1 An automatic fire suppression system shall be installed in the center pin/collector ring area of the dragline. If an electrical spark cannot communicate from the collector ring (e.g., a sealed ring) to the grease around the center pin, a fire suppression system is not required.

5.3.5.1.2 An automatic fire suppression system shall be installed in the ring gear area of shovels.

5.3.5.1.3 Suppression system alarms shall be transmitted to the operator's cab. An audible and visual alarm shall be provided.

5.3.5.1.4 A manual actuator shall be provided just outside the center pin/collector ring area.

5.3.5.2 Hydraulics.

5.3.5.2.1* An automatic fire suppression system shall be installed to protect hydraulic pump(s), hydraulic control valves, associated lines and equipment in the hydraulic pump area, and other areas where fires can propagate to.

5.3.5.2.1.1 If approved fire-resistive hydraulic fluid is used, then a fire suppression system is not required.

5.3.5.2.1.2 If an ignition source is not readily available, then a fire suppression system is not required.

5.3.5.2.2* The system shall send audible and visual alarms to the operator's cab.

5.3.5.2.3 A manual actuator shall be located just outside the hydraulic compartment area.

5.3.5.3 Lube Oil Pumping and Storage.

5.3.5.3.1* Automatic lube oil systems that are located in a segregated room shall be provided with an automatic fire suppression system.

5.3.5.3.2 The system shall send an audible and visual alarm to the operator's cab.

5.3.5.3.3 A manual actuator shall be located just outside the lube oil room.

5.3.5.3.4 Lube oil rooms shall have automatic door closers or shall have the door interlocked to shut upon actuation of the fire suppression system.

5.3.5.4 Transformers.

5.3.5.4.1 Oil-filled transformers located in the tail section, enclosed rooms, or other inaccessible locations shall be provided with an automatic fire suppression system.

5.3.5.4.1.1 The system shall transmit an audible and visual alarm to the operator's cab.

5.3.5.4.1.2 A manual actuator shall be located just outside the transformer area.

5.3.5.4.2* Transformers located in areas other than those listed in 5.3.5.4.1 shall be protected with a Class BC, minimum 45.4 kg (100 lb), fire extinguisher.

5.3.5.4.3 Oil analysis, including dissolved gas, shall be conducted on combustible oil-filled transformers based upon manufacturer's recommendations or ANSI/NETA MTS-,*Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*, whichever is more stringent.

5.3.5.4.4 Thermographic scanning shall be performed on transformers at least annually.

5.3.5.5 Electrical Room or Cabinet.

5.3.5.5.1 Enclosed electrical rooms shall be protected with a total flooding gaseous extinguishing agent or equivalent fire suppression system.

5.3.5.5.1.1 The system shall be installed in accordance with NFPA 2001 or other applicable NFPA standards.

5.3.5.5.1.2 The system shall be actuated by a smoke, ultraviolet/infrared (UV/IR), or heat detector system and send an audible and visual alarm to the operator's cab.

5.3.5.5.1.3 The ventilation system shall be interlocked to the gaseous extinguishing system to shut down upon first detection.

5.3.5.5.1.4 The room shall be sealed to maintain the design gaseous extinguishing concentration.

5.3.5.5.1.5 Pre-discharge alarms shall be provided in rooms provided with automatic suppression systems.

5.3.5.5.2 Electrical rooms shall be maintained at a positive pressure to reduce the chances of dust entering the room.

5.3.5.5.3 Electrical cabinets shall be protected with a gaseous fire suppression system or equivalent fire protection system.

5.3.5.5.3.1 The system shall be installed in accordance with NFPA 2001 or other applicable NFPA standards.

5.3.5.5.3.2 The system shall be actuated by a smoke, UV/IR, or heat detector system and send an audible and visual alarm to the operator's cab.

5.3.5.5.4* Thermographic scanning shall be performed on the electrical switchgear and motor starters at least annually.

5.3.5.6 Manual Extinguishing Equipment.

5.3.5.6.1 Minimum 45.4 kg (100 lb) A:B:C-type extinguishers shall be accessible to persons on the main deck of the dragline.

5.3.5.6.2 The location and number of extinguishers shall be determined by what is practical for the machine.

5.3.6 Hydraulic/Diesel Excavators.

5.3.6.1 An automatic fire suppression system shall be provided to protect the engine compartment, hydraulic pumps, and associated equipment.

5.3.6.1.1 For hydraulic systems above 567.8 L (150 gal) in the lines, a dual agent system shall be provided.

5.3.6.1.2 A manual actuator shall be located in the operator's cab and at the means of egress from the machine.

5.3.6.2 The machine shall be interlocked to shut down upon discharge of the extinguishing system.

5.3.6.3 A means shall be provided to automatically relieve the hydraulic pressure upon discharge of the extinguishing system.

5.3.6.4 Adequate fire resistance shielding shall be provided between the hydraulic hoses and the turbocharger and engine manifold to prevent hydraulic fluid from being sprayed on hot mechanical parts.

5.3.6.5 The fire detection electrical wiring within fire hazard areas, such as battery compartments, engine compartments, and so forth, shall be outfitted with a fire-resistant sleeve.

5.3.6.6* Fire-suppression system manual actuation lines shall not be routed near high heated surfaces and shall not be routed within fire hazard areas unless fitted with fire-resistant sleeves.

5.3.7 Mobile Equipment.

5.3.7.1 Fire Protection. Portable extinguishers installed on mobile mining equipment, including but not limited to mobile generators and compressors, shall have a minimum rating of 2-A:10-B:C and a nominal capacity of 2.3 kg (5 lb) of extinguishing agent.

5.3.8 Self-Propelled Equipment.

5.3.8.1 Portable Fire Extinguishers.

5.3.8.1.1* All self-propelled surface mining equipment, including but not limited to bulldozers, front-end loaders, haulage trucks, cranes, graders, scrapers, draglines, drills, shovels, and diesel and electrical equipment, shall be equipped with at least one listed portable, multipurpose (ABC), dry-chemical extinguisher having a nominal capacity of 4.5 kg (10 lb) of agent or greater.

5.3.8.1.2 Portable extinguishers installed on small units of self-propelled mining equipment, including but not limited to miniature loaders and individual personnel transports, shall have a minimum rating of 2-A:10-B:C and a nominal capacity of 2.3 kg (5 lb) of extinguishing agent.

5.3.8.2 Fire Detection.

5.3.8.2.1 Fire detectors shall be permitted to be used to initiate audible or visual warning, automatic actuation of a fire suppression system, or equipment shutdown.

5.3.8.2.2 Fire detectors shall be tested and listed for the application.

5.3.8.2.2.1 If fire detectors are used with a pre-engineered fire suppression system then they shall be included in the fire suppression system listing.

5.3.8.2.3 Compartment sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area shall determine the placement, type, sensitivity, durability, and, where applicable, number of detectors.

5.3.8.2.4 All fire detection systems and applicable equipment shall be tested after installation in accordance with *NFPA 72* and fire suppression systems standards.

5.3.8.2.4.1 It shall not be necessary for testing to require the discharge of any associated fire suppression system.

5.3.8.2.5* At least every 6 months, all fire detection systems, including alarms, shutdowns, and other associated equipment, shall be thoroughly examined and checked for proper operation in accordance with the manufacturer's recommendations.

5.3.8.2.5.1 Any equipment found deficient shall be repaired or replaced, and the system retested for operation in accordance with the manufacturer's instructions.

5.3.8.2.6 Between the maintenance examinations or tests, the detection system shall be inspected visually, in accordance with an approved schedule necessitated by conditions as determined by the mine operator.

5.3.8.3 Fixed Suppression Systems.

5.3.8.3.1 Haul trucks with a capacity of over 77 metric tons (85 tons) shall have a fixed fire suppression system protecting the engine compartment and hydraulic pump and other hazard areas.

5.3.8.3.2* Other large mining equipment such as but not limited to dozers, endloaders, drills, graders, and scrapers shall have a fixed fire suppression system protecting the engine compartment and hydraulic pump and other hazard areas.

5.3.8.3.3 Mining equipment requiring a fire suppression system shall be protected by a system to suppress potential fires in the protected areas and shall comply with the following:

(1) The fire suppression system shall be listed or approved for the purpose.
(2) Where installed, the equipment shall be located or guarded so as to be protected against physical damage.
(3) Fire suppression systems shall be automatically actuated.
(4)*Automatically actuated systems shall also have a manual actuator capable of being activated from the operator's compartment or other location.
(5) Agent distribution hose or pipe shall be secured and protected against damage, including abrasion and corrosion.
(6) Except for automatic sprinkler systems, discharge nozzles shall be protected against entrance of environmental debris, including moisture, dust, dirt, or insects, by blow-off caps or other similar devices or materials.
(7) Except for automatic sprinkler systems, the nozzle cover shall open or blow off upon discharge of the system.
(8) The automatic fire suppression system shall be installed so that system actuation causes shutdown of the protected equipment.
(9) Up to a 30-second delay shall be included in the design of the interlock system for the operator to maintain control of the equipment.

5.3.8.3.4 A standby source of power shall be provided where electrical power is the only means of fire suppression system actuation.

5.3.8.3.5 All fire suppression equipment and systems shall be tested after installation in accordance with the manufacturer's or designer's recommendations.

5.3.8.3.5.1 Testing shall not require the discharge of suppressant unless there is no other manner in which the reliability and integrity of the system can be verified.

5.3.8.3.6 An installation-and-maintenance or owner's manual that describes system operation and maintenance requirements shall be provided for all fire suppression equipment.

5.3.8.3.7* In accordance with the manufacturers' or designers' recommended inspection and maintenance procedures and schedules, but not to exceed every 6 months, all fire suppression systems, including alarms, shutdowns, and other associated equipment, shall be thoroughly examined and checked for proper operation by trained and competent personnel.

5.3.8.3.7.1 Any equipment found deficient shall be repaired or replaced, and the system retested for proper operation.

5.3.8.3.7.2 Between regular maintenance examinations or tests, the system shall be inspected visually, in accordance with the manufacturer's or designer's recommended schedule.

5.3.8.3.7.3 Testing shall be in accordance with the applicable NFPA standards.

5.3.8.3.8 Fire suppression systems shall be maintained in operating condition at all times.

5.3.8.3.9 Use, impairment, and restoration of the system shall be reported to the mine operator.

5.3.8.3.10 All persons who can be expected to inspect, test, maintain, or operate a fire suppression system shall be trained to perform their intended tasks.

5.3.8.3.11 Where inadvertent discharge of the fire suppression system during servicing could result in injury to personnel, provisions shall be made to safeguard against accidental actuation of the system.

5.3.8.3.12 All operators, supervisors, and maintenance personnel of self-propelled and mobile equipment shall be trained in the use of fire suppression equipment.

Chapter 6 Coal Processing

6.1 General. This chapter covers coal preparation, crushing, screening, and drying.

6.1.1 Materials and Construction.

6.1.1.1 Coal mine surface buildings and structures, housing, and supporting coal-processing and coal-handling equipment shall be of noncombustible construction.

6.1.1.2 Dry coal screening, crushing, dry cleaning, and other operations producing coal dust shall be conducted in open structures to prevent the accumulation of dust concentration levels that can create explosion hazards.

6.1.1.2.1 Where open structures are impractical, enclosed buildings shall be provided with explosion venting in accordance with 6.2.3 and shall be located so as to minimize fire and explosion exposure to major buildings and equipment.

6.1.1.2.2 Location of the processes described in 6.1.1.2 in the main plant building shall be permitted, provided the dust-producing area is equipped with explosion venting in accordance with 6.2.3 and is separated from the remainder of the building by construction designed to withstand the pressure buildup from an explosion prior to pressure relief by means of explosion vents.

6.1.2 Coal Dust Control.

6.1.2.1 Dedusters.

6.1.2.1.1 All dedusting equipment shall be connected directly to a suction system capable of moving enough air to prevent the leakage of dust from the system.

6.1.2.1.2 The suction system shall discharge the dust-laden air by the shortest possible route to collectors outside the building.

6.1.2.2* Pneumatic Cleaners.

6.1.2.2.1 Dust-collecting systems with suction hoods at the cleaners, suction ducting that maintains at least a 20 m/sec (4000 ft/min) air velocity, and dust collectors having pressure release venting shall be installed.

6.1.2.2.2 Belt conveyor–type transfers and loading points associated with the cleaners shall be hooded similarly and connected to dust collectors.

6.1.3 Coal Storage. Coal storage facilities shall be in accordance with 9.5.2.

6.2 Fire and Explosion Prevention.

6.2.1 Electrical Classification of Hazard.

6.2.1.1 Plant areas of open construction where coal dust or any combustible gases liberated from the coal are dispersed to the open atmosphere shall be classified nonhazardous.

6.2.1.2 Plant areas isolated from the coal process, such as control rooms, electrical equipment rooms, or substations, that are provided with ventilation to prevent the accumulation of combustible gases or coal dust shall be classified nonhazardous.

6.2.1.3 Enclosed areas of processing plants where coal is wet to prevent particles from becoming airborne or where dry coal dust does not accumulate shall be classified nonhazardous.

6.2.1.4* Enclosed areas where the failure or malfunction of the ventilation would result in the accumulation of explosive concentrations of methane gas shall be designated as Class I, Division 2 locations in accordance with Article 500 of *NFPA 70*.

6.2.1.4.1* Electrical equipment approved as "permissible" by the Mine Safety and Health Administration (MSHA) shall be acceptable in locations classified Class I, Division 1.

6.2.1.5 Areas of a processing plant normally designated as Class I shall be permitted to be considered nonhazardous, provided the following conditions are met:

(1) Ventilation to prevent an accumulation of an explosive or ignitible mixture of gases
(2) Failsafe continuous methane monitoring designed to sound an alarm when the methane–air mixture reaches 20 percent of the lower explosive level (LEL) or 1 percent methane by volume
(3) An interlock to stop the process equipment automatically when the methane–air mixture reaches 40 percent of the LEL or 2 percent methane by volume
(4) An electrical system arranged so that when methane concentrations reach 40 percent of the LEL, all electrical circuits including control circuit conductors are deenergized
(5) Any equipment that is needed to restore the plant to a methane–air mixture of less than 20 percent of the LEL or 1 percent methane by volume, such as lighting, ventilation, or sump pumps, installed in accordance with Class I, Division 1 requirements

6.2.1.6* Enclosed areas in which coal dust is not in suspension in explosive or ignitible quantities or in which coal dust might be present in explosive or ignitible quantities or might be in suspension in the air due to a malfunction shall be designated as Class II, Division 2 in accordance with Article 500 of *NFPA 70*.

6.2.1.7* The structure of a preparation plant shall be connected to a common electrical ground.

6.2.1.7.1 Any electrical equipment that is mounted on a concrete pad shall be grounded to the metal structure with a shunt.

6.2.1.7.2 Where the structure is nonmetallic, a separate grounding grid for equipment shall be provided.

6.2.1.8 Positive pressure shall be maintained in process control rooms to prevent the entry of fugitive dust.

6.2.1.9 Electrical Equipment Rooms. Positive pressure shall be maintained in electrical equipment rooms, such as switchgear rooms, motor control centers, and cable-spreading rooms, that have a potential for fugitive dust entry.

6.2.1.9.1 Thermographic scanning shall be performed on switchgear and motor starters on an annual basis.

6.2.1.10 Tools that are actuated by electrical power shall not be used in areas with explosive gases or dusts.

6.2.1.11 Transformers. Oil analysis, including dissolved gas, shall be conducted on combustible oil-filled transformers based upon manufacturer's recommendations or ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*, whichever is more stringent.

6.2.1.12 A smoke detector system shall be provided in MCC rooms or other critical electrical rooms. The system shall be installed in accordance with *NFPA 72* and send an alarm to a constantly attended location.

6.2.2 Dust Collectors and Dust Removal Equipment.

6.2.2.1 Dust collectors or dust suppression systems using water-based sprays shall be used to reduce dust in suspension at coal transfer points.

6.2.2.2 Those areas in which combustible dust is or might be in suspension in the air continuously, intermittently, or periodically under normal operating conditions shall be provided with a dust-collecting system or systems to collect such dust and prevent its discharge to the atmosphere.

6.2.2.2.1 All coal-handling equipment or machinery that produces dust shall be connected to a dust collector with ducts and hoods that are designed to provide suction volume and velocity to collect and transport all the dust produced.

6.2.2.2.2 Hoods, enclosures, and ducts shall be of noncombustible construction, designed and maintained in accordance with NFPA 91.

6.2.2.2.3 All dust collectors, other than those that are an integral part of dust-producing equipment, shall be located outside the working areas, preferably outside the building or in separate rooms that are vented to the outside.

6.2.2.3 When a plant or handling facility is planned, special consideration shall be given to the location of the dust-producing equipment with respect to the location of the dust collection devices to ensure that the connecting ducts will be as straight and as short as possible.

6.2.2.3.1* All dry dust collectors shall be of noncombustible construction, equipped with explosion doors or vents.

6.2.2.3.2 The entire dust-collecting system shall conform to NFPA 91.

6.2.2.4 In no case shall the design of the dust removal system be such that the dust is drawn through the fan before entering the collector. Fans shall be of noncombustible construction.

6.2.2.5* Ducts shall be designed to maintain a velocity of not less than 22.9 m/sec (4500 ft/min) to ensure the transport of both coarse and fine particles and to ensure re-entrainment if for any reason the particles should fall out before delivery to the dust collector (e.g., in the event of a power failure).

6.2.2.5.1 In bag-type dust collectors, the bags shall be constructed of antistatic, fire-resistant material and shall be provided with an electrical ground.

6.2.2.5.2 Dust collector hoppers shall be sloped at approximately 60 degrees to ensure material flow.

6.2.2.5.2.1 Zero-speed switches and high-level alarms shall be used to identify conditions that can lead to spontaneous combustion.

6.2.2.5.2.2 Hopper discharge valves or screw conveyors shall be provided to discharge the dust continually.

6.2.2.5.2.3 Hoppers shall not be used as storage bins.

6.2.2.5.3 Hood takeoffs shall have a minimum area of four times the area of the duct.

6.2.2.5.3.1 Ductwork also shall be supplied with blast gates and dampers for individual pickup volume adjustment.

6.2.3 Explosion Venting.

6.2.3.1* Explosion venting shall be provided in areas where coal dust might be present in explosive or ignitible quantities, such as in coal preparation plant buildings, and in sections of buildings housing screens, pneumatic coal-cleaning equipment, dryers, and other dust-producing machinery.

6.2.3.2 Ventilating hoods and exhaust ducts shall not be acceptable as explosion-venting devices unless they are designed for a dual purpose and function to provide direct release of excess pressure to the outside.

6.2.3.3 Equipment vents or ducts used to direct the energy of an explosion in equipment to the outside of the building or a safe location shall be as short as possible and shall be designed to withstand the explosion pressure.

6.2.3.3.1 Vent closures, which might be necessary to permit proper functioning of equipment and to prevent the escape of dust during normal operation, shall be designed to open at the lowest possible increase in pressure or shall be of flexible or frangible materials that blow out or rupture to permit the release of explosion pressure.

6.2.4* Flammable and Combustible Liquids and Liquefied Petroleum Gas. Flammable and combustible liquids and compressed gases shall be stored and used in accordance with Chapter 7.

6.2.5 Maintenance. The user shall have responsibility for establishing a maintenance program that ensures that equipment is in working order.

6.2.5.1 All coal-handling equipment and machinery shall be maintained in accordance with the manufacturers' recommendations.

6.2.6 Housekeeping. Provision shall be made for cleaning to prevent the accumulation of coal dust.

6.2.6.1 Combustible waste materials shall not be permitted to accumulate in locations where a fire or an explosion hazard can be created.

6.3* Preparation Plants and Crusher Buildings. This section shall apply to preparation plants, tipples, crushers inside buildings, and crushers in belowgrade areas. Open air crushers do not pose a significant hazard and shall be excluded from the requirements of this section.

6.3.1 Building Construction.

6.3.1.1 Buildings and equipment shall be shaped, installed, or protected so as to minimize the surface area on which coal dust can accumulate.

6.3.1.2 Access for cleaning or washing down shall be provided.

6.3.1.3 Access platforms or walkways installed between floors shall be permitted to be open-grid construction to facilitate cleaning.

6.3.1.4 Walls or partitions isolating sections of the plant that contain dust-producing operations shall be constructed and installed to minimize the transmission of dust to adjacent areas.

6.3.1.5 To prevent the accumulation of dust on exposed wall or partition framing, metal siding or other equivalent material shall be installed on the side facing the dust-producing section.

6.3.1.6 Doors in the walls or partitions required by 6.3.1.4 shall be self-closing.

6.3.1.7 Drain systems shall be provided in areas where cleaning is accomplished by washing down.

6.3.1.8 Two remote means of egress shall be provided on each floor of the plant.

6.3.1.9 Emergency lighting shall be provided at the means of egress stairways in accordance with NFPA *101*, Section 7.9.

6.3.1.10* Emergency exit signs shall be provided at the means of egress stairways in accordance with NFPA *101*, Section 7.10.

6.3.1.11 If lightning protection is required, it shall be in accordance with NFPA 780.

6.3.1.12 Electrical Equipment. Transformers, switchgear, motor starters, and other electrical equipment shall be installed in accordance with *NFPA 70*.

6.3.1.12.1* Transformers located outside of the preparation plant shall be far enough away or provided with a fire barrier wall and containment or drainage to limit damage to the building if the transformer were on fire.

6.3.1.12.2* Combustible oil-filled transformers located inside the preparation plant shall be enclosed in a transformer vault constructed in accordance with *NFPA 70*.

6.3.1.12.3* Where a combustible oil-filled transformer is located on the roof of the preparation plant, it shall be provided with a fire barrier and spill containment to limit fire damage to the building.

6.3.2 Fire Protection.

6.3.2.1 Portable Extinguishers.

6.3.2.1.1 Every building or room of a plant where combustible material is present or dry coal is processed or handled shall be provided with approved portable multipurpose fire extinguishers.

6.3.2.1.2 The number of approved portable extinguishers, their type, and their distribution shall be in accordance with NFPA 10 except that the smallest extinguisher shall have a nominal capacity of 9.1 kg (20 lb) of agent and a minimum rating of 10-A:60-B:C.

6.3.2.1.3 Extinguishers employing agents having a B:C rating shall be permitted to be used if the hazard is confined solely to electrical equipment.

6.3.2.2 Fixed Fire Protection Systems.

6.3.2.2.1* Where required by the authority having jurisdiction, fixed fire protection systems shall be provided and shall be designed in accordance with the appropriate NFPA standards, depending on the agent utilized.

6.3.2.2.1.1 Where a pre-engineered fire suppression system is used, it shall be designed and installed in accordance with the fire suppression system manufacturer's listed installation and maintenance manual.

6.3.2.2.2 Working plans for the fixed fire protection system shall be submitted for approval to the authority having jurisdiction.

6.3.2.2.3 Combustible hydraulic and lube oil systems that exceed 94.6 L (25 gal) and are located in below-grade areas shall be protected by an automatic fire suppression system.

6.3.2.3 Standpipe and Hose Systems.

6.3.2.3.1* Class III standpipe systems shall be provided in all coal preparation plants and crusher buildings in accordance with NFPA 14.

6.3.2.3.2 When automatic sprinkler systems are to be supplied through the standpipe system, hydraulic calculations shall be used to ensure that the piping and the water supply meet the hose and automatic sprinkler demands simultaneously.

6.3.2.3.3 Hose stations on or in conveyor galleries shall be provided with hoses that are of length equal to the distance between water supply connections.

6.3.2.3.4 Fire hose shall be provided in an accessible area in order to fight a fire involving spirals.

6.3.2.4 Water Supply.

6.3.2.4.1* Availability. An available supply of water shall be provided for fire protection systems and manual fire-fighting purposes.

6.3.2.4.2 Fire Mains. Where fire mains and hydrants are provided, the water supply system shall be installed and maintained in accordance with NFPA 24.

6.3.2.4.3 Other Water Supplies. Where public or private fire mains are not provided, alternative water supplies complying with NFPA 1142 shall be provided.

6.3.2.4.4* Capacity.

6.3.2.4.4.1 The water supply capacity shall be capable of providing the estimated water needed for fire-fighting purposes for a minimum duration of 2 hours.

6.3.2.4.4.2 Water pumps installed as part of a process water system and designed for the calculated flows and pressures required for fire fighting shall be permitted to be used to supply fire mains.

6.3.2.5 Inspection and Maintenance of Fire Protection Equipment.

6.3.2.5.1 Portable extinguishers shall be maintained in accordance with NFPA 10.

6.3.2.5.1.1 Fire extinguishers shall be inspected on a 6-month basis.

6.3.2.5.2 Water-based fire protection systems shall be maintained in accordance with NFPA 25.

6.3.2.5.3 Any fire protection system, including sprinklers, installed in accordance with the requirements of this standard shall be maintained to provide assurance that the system will operate.

6.3.2.5.4 All persons who inspect, test, or maintain fixed fire protection systems shall be trained in accordance with the appropriate NFPA standards and the manufacturers' specifications.

6.3.2.6 Surveillance.

6.3.2.6.1 Periodic surveillance for fire hazards shall be conducted when the plant, or any part thereof, is not in operation or not constantly attended.

6.3.2.6.2 Frequency of surveillance shall be dependent on the type of coal product involved and its susceptibility to self-heating and other site conditions.

6.3.2.6.3* Smoke detectors shall be provided in electrical equipment rooms.

6.3.2.6.3.1 Fire alarm systems shall be installed in accordance with *NFPA 72*.

6.3.2.6.3.2 Audio and visual notification alarms shall be provided in the area, and the signal shall be transmitted to a constantly attended location.

6.4 Dryers.

6.4.1* General.

6.4.1.1 Thermal coal-drying systems shall be located at least 30.5 m (100 ft) from any underground coal mine opening.

6.4.1.2 Dryers that have been idle for more than 30 days or shut down because of a fire or any other emergency condition during normal operation shall be checked to ensure that there is no burning material within the system before being placed back in service.

6.4.2 Loss Prevention Design Features. Dryer heating units that are fired by pulverized coal shall be installed, operated, and maintained in accordance with NFPA 85.

6.4.2.1 Dryers of the direct-fired type shall be designed and operated so that combustion is complete as possible within the furnace/air heater before the gases of combustion come in direct contact with the coal drying in the drying chamber.

6.4.2.2 Dryers shall be designed and constructed to be dust-tight, with smooth surfaces to prevent the accumulation of coal.

6.4.2.3 Where coal can be exposed to excessive heat on normal or emergency shutdown, a bypass stack with an automatically controlled damper shall be installed to direct the products of combustion away from the coal.

6.4.2.4 Thermal dryer systems that have a hot gas inlet or plenum chambers where fly ash or coal siftings might accumulate shall be equipped with drop-out doors or ports to facilitate removal of these solids.

6.4.2.4.1 Where continuous means of removing drop-out solids are not provided, checking and manual clean-out shall be provided as conditions warrant.

6.4.2.5* All internal areas of thermal coal dryers where coal solids could possibly hang up or accumulate under any abnormal operating condition, such as in the drying chamber or dry cyclone collector, shall be equipped with explosion relief vents that open directly to the outside atmosphere.

6.4.2.5.1 These explosion relief vents shall be of the quantity, size, and location to operate in excess of the design normal pressure.

6.4.2.5.2 Explosion vents shall be checked or tested at least once each month, and records kept to verify these checks.

6.4.2.5.3 Explosion vents shall be directed away from personnel work areas and walkways.

6.4.2.6 During system operation, visual checks shall be made of all the mechanical components and equipment associated with the drying system as conditions warrant.

6.4.2.7* Indirect heat exchange–type dryers, such as thermal disk processors, shall be given special consideration in the design of fire protection for the dryer and dryer building.

6.4.3 Instrumentation and Control.

6.4.3.1 Instrumentation and control panels on thermal dryers shall be located in an area relatively free of moisture, vibration, dust, and noise.

6.4.3.2 The panel shall be located within the range and view of the supervising operator.

6.4.3.3 The operator control room shall be provided with windows or other means, such as video cameras, that give visual contact with the thermal drying system.

6.4.3.4 The panel shall include recording-type control instruments, monitoring indicators, alarms, and temperature limits set to maintain normal operation.

6.4.3.5 Audible and visual alarms shall be interlocked electrically to provide shutdown of the drier when temperatures are exceeded or other emergency malfunctions occur.

6.4.3.6 Control instruments shall be checked and serviced by a technician at least every 3 months.

6.4.3.7 Where pneumatic controls are used, instrument quality air shall be provided.

6.4.3.8 A schematic diagram showing the locations of thermocouples, pressure taps, and other controls shall be posted at the control panel.

6.4.3.9 Written procedures, including start-up, normal shutdown, and emergency shutdown procedures, shall be provided and posted at the control panel.

6.4.3.10 All main fans shall be inspected and shall have bearing temperature and vibration detectors.

6.4.3.11 Coal feed bins shall have low-level alarms.

6.4.4 Fire Protection for Drying Chambers. Drying chambers shall be protected by an automatic water spray system.

6.4.4.1 The automatic spray system shall include a manual control.

6.4.4.2 The source for the fire protection water shall be such that the required volume flow rate and pressure of clean (solid-free) water are available at all times and that the exposed piping is protected against freezing.

6.4.5* Explosion Venting.

6.4.5.1 Buildings shall be provided with explosion venting in accordance with NFPA 69 and shall be located to minimize fire and explosion exposure to other buildings and equipment.

6.4.5.2 Cyclone collectors used with dryers shall be equipped with explosion vents equal in size to the cross-sectional area of the exhaust sleeve to supplement the venting area provided at the exhaust opening.

6.4.5.3 Dryers shall be designed and installed, if possible, with their explosion vents opening directly to the outside.

6.4.5.3.1 This venting shall be permitted to be accomplished by installation of the dryer along an outside wall of the building, directly under the roof, or by a portion of the dryer being extended through the roof.

6.4.5.3.2 If such locations are not practicable, ducts to the outside of the building shall be as short as possible and designed to withstand explosion pressure.

6.4.5.3.3 Access floors, platforms, walkways, and stairs on the thermal dryer structure shall be located so that personnel are not in the line of an explosion vent.

6.5 Conveyors. Conveyors shall be in accordance with Section 9.1.

6.6 Mobile Equipment. Mobile equipment used in coal processing areas shall conform to 5.3.7.

Chapter 7 Storage and Use of Compressed Gases and Flammable and Combustible Liquids

7.1* Compressed Gas Storage and Usage — Cutting and Welding.

7.1.1 Procedures and Maintenance of Equipment.

7.1.1.1 Cutting and welding shall be performed only by persons who have been task trained.

7.1.1.2 Personal protective equipment shall be worn by personnel during welding or flame cutting operations.

7.1.1.3 Before any cutting or welding is performed, prior approval shall be granted by management or its designated agent.

7.1.1.4 Compressed gas shall be used only for its intended purpose.

7.1.1.5 Compressed oxygen shall not be used to blow coal dust from clothing or machinery.

7.1.1.6 Manifolding of cylinders containing gases used for cutting and welding shall be permitted only in shops ventilated with sufficient quantity and velocity to dilute, render harmless, and clear away flammable or explosive concentrations of vapors.

7.1.1.7 When not in use, the compressed gas cylinder valve shall be closed.

7.1.1.8 Cutting and welding equipment shall be maintained in operating condition with all safeguards in place and functioning.

7.1.1.9 Flashback and backflow preventers shall be installed at the outlets of all pressure regulators and on the hose connections used in cutting, welding, brazing, and soldering torches.

7.1.2 Fire Prevention and Control.

7.1.2.1* Cutting or welding shall not be performed on or within containers or tanks that have stored combustible or flammable materials until such containers or tanks have been purged and cleaned or have been inerted.

7.1.2.2 Cutting or welding shall not be performed within 15.2 m (50 ft), measured horizontally, of explosives, blasting agents, or flammable or combustible liquid storage areas unless separated by a noncombustible barrier.

7.1.2.3 Electrical cutting and welding equipment shall be electrically grounded.

7.1.2.4 All machinery and operations producing combustible dust within range of welding sparks shall be shut down prior to the start of the welding or cutting operation and shall remain inoperative until a final inspection is completed.

7.1.2.5* Before cutting and welding operations are undertaken, the following precautions shall be observed:

(1) The immediate area shall be cleaned and cleared of combustible material and, if underground, wetted down with water or coated with rock dust.
(2) Open gear cases and combustible machine components located within 7.6 m (25 ft) of cutting or welding operations shall be covered with noncombustible material.
(3) Fire-extinguishing equipment, including fully charged and operable multipurpose (ABC) dry-chemical extinguishers, rock dust, or water hose, shall be within 7.6 m (25 ft) of the cutting or welding operation.
(4) In the case of a portable fire extinguisher, a single unit having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 4-A:40-B:C shall be within 7.6 m (25 ft) of the cutting or welding operation.
(5) Tests for methane gas (CH_4) shall be made before cutting or welding in any area where methane gas is likely to be present, and the following shall apply:
    (a) Cutting or welding shall not be permitted to begin or continue unless the concentration of methane gas is less than 1 percent by volume.
    (b) Methane concentration shall be continuously monitored during the cutting and welding operation.
(6) Where cutting or welding is necessary inby the last open crosscut, a continuous fire watch shall be maintained.
(7) Where inby equipment to be modified or repaired can be moved, it shall be moved outby the last open crosscut before cutting or welding.
(8) Ventilation shall be established prior to and maintained during cutting or welding.
(9) Flammable and combustible liquids shall not be dispensed within 15.2 m (50 ft) of cutting or welding operations.
(10) Freshly painted surfaces shall be permitted to dry so that ignitible vapor is not present before cutting or welding.
(11) When conducting cutting and welding operations inside buildings, in draglines, or underground, a permit shall be prepared and signed by the person performing the work and by an individual designated by management to authorize cutting and welding operations.

7.1.2.6 Combustibles posing a fire hazard shall be relocated or protected with a fire-retardant cover or fire-retardant barrier.

7.1.2.7 Where welding or cutting with an arc or a flame is performed where combustible materials are present and cannot be removed or protected from ignition sources, a fire watch shall be provided.

7.1.2.7.1 Where a fire watch is required, it shall be maintained for a minimum of 30 minutes after completion of cutting or welding operations to detect and extinguish smoldering combustibles.

7.1.2.7.2 The fire watch shall have fire-extinguishing equipment available and be trained in its use.

7.1.2.7.3 Fire watchers shall be familiar with the facilities and the procedures for sounding an alarm in the event of a fire.

7.1.2.8 Openings or cracks in walls, partitions, floor decks, or ducts shall be covered tightly with a noncombustible material to prevent the passage of sparks to adjacent areas.

7.1.2.9 Where welding is being performed on a metal wall, partition, ceiling, or roof, precautions shall be taken to prevent ignition of combustibles on the other side due to conduction or radiation.

7.1.2.10 In confined spaces, positive ventilation shall be established prior to start-up of cutting or welding operations.

7.1.2.11 Noncombustible barriers shall be installed below welding or cutting operations that are being performed in or over shafts, silos, and similar openings.

7.1.2.12 Inspection.

7.1.2.12.1 Inspection for sparks, smoldering material, and fire shall be made during cutting or welding.

7.1.2.12.2 After completion of the work, a search of the area, including the floors above and below, shall be made for fires and for development of smoldering fires.

7.1.3 Underground Transport. Compressed gas cylinders for cutting or welding shall be transported as follows:

(1) The cylinders shall be disconnected from regulators.
(2) The cylinders shall be protected with a metal cap or headband (fence-type metal protector around the valve stem).
(3) The cylinders shall be secured by devices that will hold them in place during transit.
(4) The cylinders shall be placed in electrically insulated, substantial containers designed to hold the cylinders during transit on a trolley wire haulage system.
(5) The cylinders shall be labeled "empty" or "MT" if the gas has been expended.

7.1.4 Underground Storage. Compressed gas cylinders stored underground shall meet all the requirements of Section 7.1.

7.1.4.1* Compressed gas cylinders shall be clearly marked using the designations of the U.S. Department of Transportation (DOT).

7.1.4.2 Compressed gas cylinders shall be placed in storage areas that shall be designated for the purpose, constructed of noncombustible material or rock-dusted, and free of trash and combustible or flammable liquids.

7.1.4.3 Compressed gas cylinders shall be stored and secured in an upright position or angled with the valve end elevated.

7.1.4.4 Compressed gas cylinders shall be protected against damage from the following:

(1) Falling material
(2) Contact with power lines and energized electrical machinery
(3) Heat from cutting or welding operations

7.1.4.5 The valves of the compressed gas cylinder shall be closed and protected from physical damage when not in use.

7.1.4.5.1 Hoses from compressed gas shall have flash arresters on the regulator side and shall be drained after use.

7.1.4.6 Compressed gas cylinders shall not be stored or left unattended inby the last open crosscut.

7.1.4.7 Where located in other than underground shops, compressed gas cylinders not in use shall have the regulators removed, and the valves shall be protected by being covered with protective metal caps, by tank design, or by other approved equivalent protection.

7.1.4.8 Flammable compressed gas shall be segregated from oxygen by a fire-resistive barrier (e.g., steel plating or concrete blocks) or by a distance of 6.1 m (20 ft).

7.1.5 Surface Storage.

7.1.5.1 Storage of compressed gases on an excavating machine shall be limited to that used on a daily basis.

7.1.5.2 Acetylene, oxygen, and other compressed gas cylinders shall be kept in the upright position and secured against falling over.

7.1.5.3 A metal or caged barrier shall be provided above cylinders in storage if there is the potential for falling objects.

7.1.5.4 Flammable compressed gas shall be segregated from oxygen by a fire-resistive barrier (e.g., steel plating or concrete blocks) or by a distance of 6.1 m (20 ft).

7.1.5.5 Storage of flammable gases and oxygen shall be located outside buildings or in a room designed in accordance with NFPA 55.

7.1.5.6 All electrical equipment within an enclosed storage room containing flammable gases shall be Class I, Division 2, Group A, B, C, or D.

7.1.5.7 Outside storage areas shall be kept clear of dry vegetation and combustible materials for a minimum distance of 7.6 m (25 ft).

7.1.5.8 Storage areas shall be provided with physical protection from vehicle damage.

7.1.5.9* Compressed gas cylinders shall be clearly marked using the designations of the DOT.

7.1.5.10 Empty cylinders shall be clearly marked “Empty” or “MT” or stored in a separate area.

7.2 Liquid Propane Storage and Use. The storage, use, and handling of liquefied petroleum gases (LP-Gases), such as propane or butane, shall be in accordance with NFPA 58.

7.3 Flammable and Combustible Liquid Storage Tanks on the Surface.

7.3.1* Design and Location of Storage Tanks.

7.3.1.1 Storage tanks shall be built, installed, and used in accordance with NFPA 30.

7.3.1.2* The tank shall be listed for its use.

7.3.1.3 Aboveground flammable liquids storage tanks shall be located a minimum of 15.2 m (50 ft) from important structures.

7.3.1.4 Aboveground combustible liquid storage tanks shall not be stored closer than 1.5 m (5 ft) from important structures.

7.3.1.5 Aboveground tanks shall not be located within 30.5 m (100 ft) of mine openings, fan installations, hoist houses, or any buildings connected to these operations.

7.3.1.6 The contents of the storage tank shall be identified by the designations given in NFPA 704.

7.3.2* Control of Spillage from Aboveground Tanks. Facilities shall be provided so that any accidental discharge will be prevented from endangering important facilities or adjoining property or from reaching waterways.

7.3.3 Normal and Emergency Venting.

7.3.3.1 Atmospheric storage tanks shall be vented in accordance with API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks*.

7.3.3.2 As an alternative to 7.3.3.1, the normal vent shall be at least as large as the largest filling or withdrawal connection, but in no case shall it be less than 31.7 mm (1¼ in.) nominal diameter.

7.3.3.3 Aboveground tanks storing flammable liquids shall have the vent normally closed and be equipped with a flame arrester.

7.3.3.4* Emergency Relief.

7.3.3.4.1 Emergency relief shall be provided for all aboveground tanks storing material with a flash point less than 93.3°C (200°F).

7.3.3.4.2 The relief shall be in the form of a relief valve or a weak roof-to-shell seam.

7.3.3.5 Tanks containing material with a flash point greater than 93.3°C (200°F) that are located in the same diked area as liquids with lower flash points shall also conform to 7.3.3.4.

7.3.3.6* Vent piping shall be located so that the discharge is above the fill pipe opening and at least 3.7 m (12 ft) above the adjacent ground level.

7.3.4 Fuel Lines.

7.3.4.1 Fuel lines shall be equipped with valves to cut off fuel at the source.

7.3.4.2 Fuel lines with flexible piping shall be equipped with a fusible link activated automatic shutoff valve located at the point where the fuel line exits the storage tank.

7.3.5 Leakage and Overfill of Buried Tanks.

7.3.5.1 Buried tanks with flammable liquids shall have a leak detection program in effect.

7.3.5.2 Accurate inventory records of buried tanks with flammable liquids shall be maintained.

7.3.5.3 Buried tanks shall be equipped with an overfill alarm interlocked to shut off the feed when the tank is 95 percent full and to alarm at 90 percent.

7.3.6 Vehicle Barriers. Vehicle barriers shall be provided around aboveground stationary storage tanks or fuel pumps that are located in an area subject to vehicular traffic.

7.3.7 Control of Ignition Sources.

7.3.7.1 Signs warning against smoking or open flames shall be posted so they can be readily seen.

7.3.7.2 Storage tanks containing flammable liquids shall be grounded.

7.3.7.3 Tank trucks with flammable liquids shall be grounded by being electrically bonded to the fill pipe when storage tank filling operations are taking place.

7.3.7.4 Areas surrounding storage tanks shall be kept free of grass, weeds, underbrush, or other combustible material such as trash or leaves for at least 7.6 m (25 ft) in all directions.

7.3.8 Fire Extinguishers. Two fully charged and operable 9.1 kg (20 lb) extinguishers with minimum ratings of 4-A:40-B:C shall be provided within 9.1 m (30 ft) of the tank or pump.

7.4 Flammable and Combustible Liquid Storage on Surface Equipment and in Buildings.

7.4.1 The storage, use, and handling of flammable and combustible liquids in surface buildings shall conform with NFPA 30, except Sections 18.4 and 21.8 and Chapters 1, 2, 3, 4, and 15.

7.4.2 Flammable and combustible liquids on equipment, except in fuel tanks on vehicles, shall be stored and handled in accordance with NFPA 30.

7.4.3 Flammable liquids of a quantity greater than 94.6 L (25 gal) shall be stored in a flammable liquids cabinet.

7.4.4 All flammable aerosols shall be stored in a flammable liquids cabinet.

7.4.5* On equipment, combustible liquid storage in drums or totes shall not exceed a 1-day supply.

7.4.6 Upon request, the mine operator shall provide the authority having jurisdiction with information regarding the composition and flash point of the flammable and combustible materials.

7.4.7 Smoking and Open Flames.

7.4.7.1 Smoking and open flames shall be prohibited in areas or locations where fire or explosion hazards exist.

7.4.7.2 Signs warning against smoking and open flames shall be posted.

7.4.8 Vehicle Refueling.

7.4.8.1 Vehicles using liquid fuels shall be refueled only at locations designated for that purpose and from approved dispensing pumps and nozzles.

7.4.8.2 Engines, except diesel engines, shall be shut off during refueling.

7.5 Flammable Liquids Stored and Used Underground.

7.5.1 General.

7.5.1.1* Electrical equipment in flammable liquid storage areas shall be classified as one of the following:

(1) Class I, Division 1 as specified in *NFPA 70*
(2) "Permissible" electrical equipment

7.5.1.2 Flammable liquids in storage shall be kept in closed containers.

7.5.1.3 Flammable liquids shall be permitted to be used only where there are no open flames or other sources of ignition within the possible path of vapor travel in flammable concentrations.

7.5.1.4 Flammable liquid containers shall be returned to a flammable liquid storage area after use.

7.5.1.5 All aerosol cans shall be treated as containing flammable liquids unless otherwise specifically identified.

7.5.1.6 Individual aerosol cans that are used regularly in normal operations shall be permitted on mobile equipment or in tool cabinets and shall be protected from mechanical damage.

7.5.2 Flammable Liquid Containers.

7.5.2.1 Flammable paints shall be stored only in original containers or cans of not over 19 L (5 gal) capacity.

7.5.2.2 All other flammable liquids shall be transferred to a listed safety can prior to being transported underground.

7.5.2.3 Safety cans containing Class IA flammable liquids shall not exceed 7.6 L (2 gal) capacity.

7.5.2.4 All flammable liquid containers shall be labeled with the word "Flammable."

7.5.2.5 Flammable liquid containers shall be stored in a stable manner.

7.5.3 Flammable Liquid Storage Areas.

7.5.3.1 Flammable liquids shall be stored in one of the following:

(1) Listed or approved noncombustible storage cabinets
(2) Cabinets meeting the requirements specified in Section 9.5 of NFPA 30
(3) An enclosure of fire-resistive construction

7.5.3.2 In operating areas, containers of flammable liquids and aerosol cans shall be stored at least 7.6 m (25 ft) away from potential ignition sources such as energized trolley wire, energized electrical equipment, and other operating equipment.

7.5.3.3 The aggregate quantity of flammable liquids, including aerosol cans, in a flammable liquid storage area shall not exceed 227 L (60 gal).

7.5.4 Dispensing Flammable Liquids.

7.5.4.1 Flammable liquids shall be drawn from or transferred into containers using only the following methods:

(1) From safety cans
(2) From a container by means of a device that draws through an opening in the top of the container
(3) By gravity through a listed or approved self-closing valve or self-closing faucet

7.5.4.2 Transferring flammable liquids by means of an electric pump or pressurizing a container with air shall be prohibited.

7.5.4.3 Transferring flammable liquids by pressure of inert gas shall be permitted only if controls, including pressure relief devices, are provided to limit the pressure so it cannot exceed the design pressure of the container.

7.5.4.4 At least one portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 4-A:60-B:C shall be located not more than 9.1 m (30 ft) from any area where flammable liquid is dispensed.

7.6 Combustible Liquids Stored and Used Underground.

7.6.1 General.

7.6.1.1 This chapter shall not apply to combustible liquids in use, such as the following:

(1) Diesel fuel in the fuel tanks of diesel-powered vehicles
(2) Hydraulic fluid in the reservoirs of hydraulic equipment
(3) Lubricating oil in the lubrication reservoirs of operating equipment

7.6.1.2 Combustible liquids in approved tanks or containers meeting the following requirements shall be exempt from the requirements for storage areas:

(1) Class II combustible liquids stored in containers meeting the requirements of this chapter and not exceeding 227 L (60 gal)
(2) Class III combustible liquids stored in containers or approved tanks as specified in this chapter and not exceeding 2498 L (660 gal)

7.6.1.3 Combustible liquid containers shall be stored and shall be kept closed while stored in the following manner:

(1) Drums holding 208 L (55 gal) and 114 L (30 gal) shall be set vertically, unless seam height will not allow, and not over one drum high.
(2) Drums holding 60.6 L (16 gal) shall be set vertically and not over two drums high.
(3) Pails holding 19 L (5 gal) shall be set vertically and not over four pails high.
(4) Cartons holding grease cartridges shall not be stacked over three cartons high.

7.6.1.4 Ventilation shall be provided wherever combustible liquids are stored to prevent the accumulation of ignitible vapors.

7.6.2 Combustible Liquid Containers and Tanks.

7.6.2.1 Tanks for handling combustible liquids shall be substantially constructed and fitted with filler caps, vents, and discharge valves that are protected in the event of derailment or ribbing of the vehicle carrying the tanks.

7.6.2.2* Containers shall be acceptable to the authority having jurisdiction.

7.6.2.3 Containers larger than 19 L (5 gal) shall be provided with vacuum and pressure relief.

7.6.2.4 The capacity limitations for combustible liquids in containers and portable tanks shall be in accordance with the definitions for *container* and *portable tank* in Chapter 3.

7.6.2.5 Combustible liquid storage tanks intended for fixed installation and portable installations in accordance with NFPA 30 shall be of materials compatible with the liquid stored.

7.6.2.6 Atmospheric tanks shall be built in accordance with NFPA 30.

7.6.2.7 The operating pressure of storage tanks shall not exceed their design working pressure.

7.6.2.8 Low-pressure tanks shall be built in accordance with NFPA 30.

7.6.2.9 The operating pressure of the vessel shall not exceed the design working pressure.

7.6.2.10* Pressure vessels shall be built in accordance with NFPA 30.

7.6.2.11 Storage tanks shall be vented to prevent the development of vacuum or pressure from distorting the shell or roof of the tank as a result of filling or emptying and atmospheric temperature changes.

7.6.2.12 Protection shall also be provided to prevent overpressure from any filling source exceeding the design pressure of the tank.

7.6.2.13* Storage tank vents shall be at least as large as the filling or withdrawing lines but no less than 31.7 mm (1¼ in.) nominal inside diameter.

7.6.2.14 If more than one fill or withdraw line can be used simultaneously, the vent capacity shall be based on the maximum anticipated simultaneous flow.

7.6.2.15 Vent pipes shall be constructed to drain toward the tank without sags or traps to collect liquid.

7.6.2.16 Connections for all tank openings shall be liquidtight.

7.6.2.17 Each connection to a tank through which liquid normally can flow shall be provided with an external valve located at the shell of the tank.

7.6.2.18 Tanks containing combustible liquids shall be provided with a means for quick cutoff of flow in the event of fire in the vicinity of the tank.

7.6.2.19 Openings for manual gauging, if independent of the fill pipe, shall be kept closed when not gauging.

7.6.2.19.1 Each opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded cap or other device.

7.6.2.19.2 Substitutes for manual gauging shall be permitted.

7.6.3* Transfer and Transport of Combustible Liquids.

7.6.3.1 Combustible liquid shall be permitted to be transferred into the mine by pipeline, portable tank, closed container, or safety can.

7.6.3.2 When combustible liquid is transferred into the mine, it shall be transported or transferred directly to the storage area or location where it will be used.

7.6.3.3 Combustible liquid shall not be transported in the same conveyance with personnel unless the items are secured or are small enough to be carried by hand without increasing the risk of an accident.

7.6.3.4 Combustible liquid containers or tanks loaded on rail or trackless vehicles shall be secured against shifting and damage during transit.

7.6.3.5 Rail or trackless vehicles that carry supplies for production areas in addition to combustible liquids shall have provisions for securing or separating those supplies from the lubricants and combustible liquids so that, in the event of derailment or ribbing, the supplies will not puncture containers or tanks.

7.6.3.6 Vehicles carrying combustible liquids shall be kept clean of accumulations of oil, grease, and other combustible material.

7.6.3.7 Spilled combustible liquids shall be cleaned up immediately.

7.6.3.8 Any remaining residue shall be covered with an oil absorbent or rock dust.

7.6.3.9 Combustible liquid containers or tanks shall be at least 305 mm (12 in.) below energized trolley wires or protected from contacting the wire by insulation while being transported by trolley wire–powered systems.

7.6.3.10* The quantity of combustible liquid in containers or tanks off-loaded from transport vehicles and stored in an operating area shall not exceed a 3-day supply for operations in that area.

7.6.3.11 A single tank or container with a capacity exceeding a 3-day supply shall be permitted.

7.6.3.12* Pipeline systems used for combustible liquid transfer shall be permitted to be either wet or dry pipe installations.

7.6.3.12.1 Piping, valves, and fittings used for combustible liquid transfer shall be designed for the expected working pressures and structural stresses as follows:

(1) Piping, valve, and fitting burst strengths shall be at least four times the static pressure.
(2) The pipeline shall be designed to withstand the mechanical and thermal stresses caused by exposure to fire.

7.6.3.12.2 A manual shutoff valve shall be installed in the pipeline at the surface storage tank and at the point of underground discharge.

7.6.3.12.3 An additional shutoff valve shall also be installed in each branch line where the branch line joins the main line.

7.6.3.12.4 The pipeline system shall be guarded and protected against physical damage.

7.6.3.12.5 Guarding by choice of location shall be considered an acceptable practice.

7.6.4 Temporary Areas for the Storage of Combustible Liquids in Portable Containers.

7.6.4.1 Portable combustible liquid storage areas shall meet one of the following criteria:

(1) They shall be located a minimum of 30.5 m (100 ft) from explosives magazines, electrical substations, shops, working faces, or other combustible liquid storage areas.
(2) They shall be separated from explosives magazines, electrical substations, shops, working faces, or other combustible liquid storage areas by unexcavated coal or rock or by a masonry bulkhead.

7.6.4.2 Unless equipped with an approved fire protection system, the storage area shall be a minimum of 30.5 m (100 ft) from any shaft station and 7.6 m (25 ft) from energized trolley wire.

7.6.4.3 A portable combustible liquid storage area shall be recessed or otherwise located and protected from accidental damage by mobile equipment or blasting.

7.6.4.4 The aggregate quantity of diesel fuel in a combustible liquid storage area for portable containers or tanks shall not exceed 1893 L (500 gal).

7.6.4.5 The aggregate quantity of Class II and Class III combustible liquids in a combustible liquid storage area for portable containers or tanks shall not exceed 3785 L (1000 gal).

7.6.5* Fixed Areas for Class II Liquid Storage.

7.6.5.1 Fixed combustible liquid storage areas shall be located as follows:

(1) A minimum of 30.5 m (100 ft) from explosives magazines, electrical substations, shaft stations, slope bottoms, and shops
(2) A minimum of 30.5 m (100 ft) from other flammable or combustible liquid storage areas or separated by one of the following:
    (a) Unexcavated coal
    (b) Rock
    (c) Masonry bulkhead with a minimum thickness of 102 mm (4 in.) of blocks or 51 mm (2 in.) of reinforced gunite
(3) A minimum of 30.5 m (100 ft) from any working face and out of the line of sight of blasting or a minimum of 152 m (500 ft) within line of sight from any working face to avoid damage from fly rock
(4) A minimum of 7.6 m (25 ft) from normally energized trolley wire

7.6.5.2 All fixed combustible liquid storage areas shall be enclosed and protected by an approved, fixed automatic fire suppression system.

7.6.5.2.1 All fixed combustible liquid storage area enclosures shall be of noncombustible construction, including floor, roof, roof supports, doors, and door frames.

7.6.5.2.2 Exposed coal within all fixed combustible liquid storage areas shall be covered with noncombustible materials such as gunite, shotcrete, or preformed masonry.

7.6.5.2.3 Bulkheads, if used, shall be sealed and be built of or covered with noncombustible materials.

7.6.5.2.4 All fixed combustible liquid storage area enclosures shall be constructed to provide suitable spill containment or shall be provided with a suitable floor drain to direct spilled liquid to a containment sump or vessel.

7.6.5.2.5 All openings to the storage area enclosures shall be sealed with fire-resistive stoppings.

7.6.5.2.6 The access opening through which containers are moved shall be located on the intake side.

7.6.5.2.7* All doors shall be of the self-closing type and shall be listed or approved and constructed of noncombustible materials.

7.6.5.2.8 A personnel door shall be provided on the side where air enters the enclosure.

7.6.5.2.9 The storage area enclosure shall be vented directly to the return or the surface.

7.6.5.2.10* Tanks shall rest 305 mm (12 in.) above the ground or on foundations made of concrete, masonry, piling, or steel.

7.6.5.2.11 Tank foundations shall be designed to prevent accumulation of combustible liquid under the tank, to minimize the possibility of uneven settling of the tank, and to minimize corrosion in any part of the tank resting on the foundation.

7.6.5.2.12 All piping, valves, and fittings shall be suitable for the expected working pressures and structural stresses.

7.6.5.2.13 Ventilation shall be provided to prevent the accumulation of ignitible vapors.

7.6.5.2.14 Empty or idle combustible pallet storage within the combustible liquid storage area shall not be permitted.

7.6.5.2.15 The aggregate quantity of Class II and Class III combustible liquids in a fixed combustible liquid storage area shall not exceed 18,927 L (5000 gal), of which Class II shall not exceed 3785 L (1000 gal).

7.6.6 Fixed Storage Areas for Class III Combustible Liquids. Class III combustible liquids shall be stored in fire-resistive containers within an enclosure of fire-resistant construction.

7.6.7 Storage, Transport, and Dispensing of Combustible Liquids Using Mobile Equipment.

7.6.7.1 Where combustible liquids are stored on mobile equipment such as mobile service trucks, the equipment shall be parked at a fixed location or a location that meets the requirements of 7.6.4 when not in use.

7.6.7.2 The aggregate quantity of combustible liquids carried on mobile equipment shall not exceed 3785 L (1000 gal).

7.6.7.3 Diesel fuel tank trucks shall not exceed 1893 L (500 gal) storage capacity.

7.6.8* Dispensing Combustible Liquids.

7.6.8.1 Class III combustible liquids shall be permitted to be dispensed through the application of positive pressure to containers or tanks only where the containers or tanks are certified as pressure vessels.

7.6.8.2 Class II combustible liquids shall not be dispensed using compressed gas.

7.6.8.3 Where electrically powered pumps are used to dispense combustible liquids, a switch or circuit breaker shall be provided at a location away from dispensing devices, including remote pumping systems, to shut off the power to all dispensing devices in an emergency.

7.6.8.4 Dispensing nozzles for Class II combustibles shall be of the self-closing type without a latch-open device.

7.6.8.5 At least one portable fully charged and operable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 4-A:60-B:C shall be located not more than 9.1 m (30 ft) from any area where combustible liquid is dispensed.

7.6.8.6 Dispensing Class II combustible liquid from containers or tanks shall be accomplished by an approved transfer pump or by gravity flow.

7.6.8.6.1 Where needed, containers or tanks shall be equipped with an approved vent.

7.6.8.6.2 If a manual valve is used, it shall be of the self-closing type without a latch-open device.

7.6.8.7 Spillage shall be cleaned up.

7.6.8.8 Remaining residue shall be covered with an oil absorbent or rock dust.

Chapter 8 Mine Surface Buildings

8.1 Construction.

8.1.1 This chapter shall include mine offices, bathhouses, warehouses, vehicle storage, shops, and permanent miscellaneous buildings.

8.1.2 Offices over 1394 m^2 (15,000 ft^2), warehouses over 929 m^2 (10,000 ft^2), and shops over 465 m^2 (5000 ft^2) shall be constructed of noncombustible materials or provided with an automatic sprinkler system installed in accordance with NFPA 13.

8.2 Fire Prevention.

8.2.1 No smoking shall be allowed in warehouses.

8.2.2 Combustible storage shall be maintained at least 0.9 m (3 ft) from electrical panels and electric resistance heaters.

8.2.3 Oily waste or rags that can create a fire hazard shall be placed in covered metal containers.

8.2.4 Battery rooms shall be in accordance with *NFPA 70*, Article 480.

8.2.4.1 Battery-charging installations shall be located in a designated area that is protected against damage from mobile equipment.

8.2.4.2 Each battery-charging installation shall be equipped with the following:

(1) Approved portable multipurpose fire extinguisher(s)
(2) Ventilation for the removal of generated gases from charging batteries
(3) A means for flushing spilled electrolyte

8.3 Life Safety.

8.3.1 Two means of egress shall be provided from multistory buildings.

8.3.2 For office, bathhouse, and warehouse areas, emergency lighting shall be provided in each stairwell or hallway that is the means of egress in accordance with NFPA *101*.

8.3.3 For office, bathhouse, and warehouse areas, emergency exit signs shall be provided along the means of egress.

8.4 Flammable and Combustible Liquids.

8.4.1 All storage and handling of flammable and combustible liquids shall conform to the guidelines established in NFPA 30.

8.4.2 The quantity of flammable liquids and aerosols stored outside a flammable liquids storage cabinet shall not exceed 94.6 L (25 gal).

8.4.3 Other than in shops, the quantity of combustible liquids outside a flammable liquids storage cabinet or room constructed in accordance with NFPA 30 shall not exceed 454 L (120 gal).

8.4.4 Dispensing of flammable or combustible liquids in warehouses shall be prohibited.

8.4.5 Storage of acetylene, oxygen, or other welding gases inside warehouses shall be prohibited.

8.4.6 Drip pans shall be provided to catch leakage or spillage wherever flammable or combustible liquids are dispensed.

8.4.7 Fusible link–actuated automatic closers shall be provided on all parts cleaning tanks.

8.5* Compressed Gas Storage and Usage. Storage and use of compressed gases in and around mine buildings shall be in accordance with Section 7.1.

8.6 Fire Detection and Protection.

8.6.1 For multistory office buildings, a central station or proprietary alarm system shall be installed in accordance with *NFPA 72*.

8.6.1.1 Alarms shall include smoke detectors, duct detectors, and manual pull stations.

8.6.1.2 In addition, if sprinklers are installed, water flow, valve tamper, and low building temperature alarms shall be provided.

8.6.1.3 All equipment shall be listed or approved for its intended use.

8.6.2* If sprinkler systems are installed, they shall be in accordance with NFPA 13.

8.6.3* If fire hydrants are installed, they shall be in accordance with NFPA 24.

8.6.4 If a building is more than two stories high, a standpipe system shall be installed in accordance with NFPA 14.

8.6.5 If a gaseous fire suppression system is installed in a computer or telephone equipment room, it shall be in accordance with NFPA 2001.

8.6.6* Fire extinguishers shall be provided and maintained in accordance with NFPA 10.

8.6.6.1 Fire extinguishers shall be inspected at least every 6 months.

8.7 Water Supplies. If sprinklers or fire hydrants are installed, water supplies shall be capable of providing the required flow rate and pressure necessary for the fire protection features for at least one hour.

Chapter 9 Coal Conveyance and Storage

9.1* Conveyors — General.

9.1.1* Belt conveyors shall meet the following minimum requirements:

(1) Belt alignment limit switches shall be provided on conveyors to shut down belts that are tracking improperly.
(2) Slip switches shall be provided to detect a slipping or jammed belt and shall be interlocked to shut off driving power when the belt stops or slows down by more than 20 percent of its normal speed.
(3) Slip switches shall be tested on an annual basis.
(4) Shutoff power shall be provided on contributing conveyors to prevent any operating conveyor from discharging material to a stopped downstream conveyor.
(5) Means shall be provided to remove tramp metal and other foreign objects as early in the handling process as possible.
(6) Hydraulic systems for belt alignment, if provided, shall use only listed fire-retardant hydraulic fluids or shall be protected by an automatic fire protection system.
(7) Alarms shall annunciate in the operator's control room.
(8) Electrical equipment shall be classified as Class II, Division 2, Group F in all areas where required by *NFPA 70*.
(9) Guarding for machinery in the drive area and at other points along the belt shall be made of noncombustible material.

9.1.2* Structures supporting belt conveyors shall be designed to prevent coal accumulations.

9.1.2.1 The design shall include any surface near the belting that can catch and retain fine coal liable to ignite spontaneously.

9.1.3 Consideration shall be given to the possibility of static electrical discharge at the conveyor head and tail pulleys located in dry climates where bituminous and lower ranking–type coals are handled.

9.1.3.1 Factors that shall be considered are belting materials, belt speed, and housekeeping of spilled coal dust.

9.1.3.2 Where such conditions as described in 9.1.3 exist, the use of static dissipators or eliminators shall be considered.

9.1.4 Attention shall be given to the prevention of and cleaning of accumulations of fine coal dust beneath and close to belt conveyors.

9.2 Overland Conveyors.

9.2.1 Chute plug alarms shall be provided for long runs of belt or critical conveyor systems.

9.2.2 The conveyor path shall be kept free of all grass, weeds, trash, or any other material that could create an exposure to the belt should it catch on fire.

9.2.3 Motor control center (MCC) buildings for conveyor systems shall be kept free of accumulations of coal dust.

9.3 Below-Grade Reclaim Conveyors.

9.3.1 Methane detection shall be provided in below-grade reclaim conveyor areas.

9.3.2 Equipment shall be interlocked to de-energize upon detection of a 2 percent concentration of methane.

9.3.3 Portable methane detectors are an acceptable alternative to fixed detectors, provided a reading is taken once per shift.

9.3.4 Hydraulic units more than 7.6 m (25 ft) inside the entrance and greater than 189 L (50 gal) total capacity shall have listed fire-resistive hydraulic fluid or shall be provided with an automatic fire suppression system. The fire suppression system shall be interlocked to shut down the hydraulic unit and send an alarm to a constantly attended location.

9.4 Underground Conveyors.

9.4.1 Underground conveyor belts shall be of a flame-resistant material and approved by the authority having jurisdiction.

9.4.2 Entries in which belt conveyors are installed shall be kept free of accumulations of coal and coal dust around the belt idlers, pulleys, and belt edges and shall be rock-dusted.

9.4.3* Fixed combustible material such as posts, cribbing, and roof supports shall be guarded from contact with the belt by the use of noncombustible material or by distance and shall be located at a distance of at least 152.4 mm (6 in.) from any idler or pulley.

9.4.4 Belt conveyor installations shall use a support structure without a deck between the upper and lower belt flights.

9.4.5 Belts that carry the load of the belt on a low-friction metal deck without rollers shall be permitted to be used.

9.4.6 Automatic Fire Suppression Systems at the Belt Drive.

9.4.6.1 Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed at main and secondary belt conveyor drives.

9.4.6.1.1 If sprinkler or water systems are installed, they shall comply with 4.3.3.3 and 9.4.6.3 of this standard.

9.4.6.1.2 If dry chemical systems are installed, they shall be installed and maintained in accordance with NFPA 17 and the manufacturer's instructions.

9.4.6.2 Fire suppression systems shall extend to the drive areas of belt conveyors, including drive motor(s), reducer, head pulley, and belt storage unit (takeup), including any hydraulic power unit; its electrical controls; and the top and bottom of the first 15.2 m (50 ft) of belt from the drive on the downwind side.

9.4.6.2.1 Where a pre-engineered dry chemical fire suppression system is to be used, protection shall also be provided for the top surface of both the top and bottom belts, and the bottom surface of the top belt of the first 15.2 m (50 ft) of fire-resistant belt or 45.7 m (150 ft) of non-fire-resistant belt from the drive on the downward side.

9.4.6.3 Water-Based Fire Suppression Systems.

9.4.6.3.1 Water Supply.

9.4.6.3.1.1 The water supply shall be free of excessive sediment and corrosives. An approved strainer with a flush-out connection and manual shutoff valve shall be provided.

9.4.6.3.1.2 The water supply shall provide the required flow for not less than 60 minutes.

9.4.6.3.1.3* Approved or listed flexible connections shall be permitted from the water main to the pressure reducing device or shutoff valve to the sprinkler system.

(A) The flexible connection shall be rated at a pressure that exceeds the maximum water pressure expected on the system.

(B) If a non-metallic connection is used, it shall not be within 3.0 m (10 ft) of the belt drive motors or primary roller drive.

9.4.6.3.1.4 If a pressure regulator is used, it shall be set below the maximum pressure allowed by the pressure rating of the piping and fittings.

9.4.6.3.1.5 If a pressure regulator is used, it shall be inspected and tested on a weekly basis to ensure that it is functioning properly and the sprinkler system has the right amount of pressure.

9.4.6.3.2 General Sprinkler Requirements. Sprinkler systems shall meet the following requirements:

(1) The sprinklers shall be installed in accordance with NFPA 13 as far as practical, and shall have components that have been listed.
(2) The sprinkler head activation temperature shall not be less than 65.6°C (150°F) or greater than 148.9°C (300°F).
(3) Sprinklers shall be kept free of excessive rock dust, muck, conveyor string, or any other material that can block the discharge or insulate the fusible link.
(4) The application rate shall not be less than 10.2 L/min/m^2 (0.25 gpm/ft^2) of the top surface of the top belt, bottom surface of the top belt, and the top surface of the lower belt.
(5) With a water flow and pressure than is present under normal mine operating conditions, the residual pressure measured downstream of the opened sprinklers or the 8-head inspector's test connection of 70 kPa (10 psi) or greater for belt drive systems shall be maintained at all times.
(6) Maximum distance between nozzles on a branch line shall not exceed 2.4 m (8 ft).
(7) Piping for the deluge, foam, or closed-head sprinkler system shall be metal and listed for sprinkler applications.
(8)*Sprinkler piping shall be supported by UL-listed pipe hangers or other substantial metal supports such as angle iron, U bolts, or heavy chain.
(9) The system shall be interlocked to shut down the conveyor and provide an audible and a visual alarm.
(10) The components of the system shall be located so as to minimize the possibility of damage by roof fall or by the moving belt and its load.

9.4.6.3.3 Deluge Water Systems. Deluge water spray systems shall meet the requirements of 9.4.6.3.3.1 through 9.4.6.3.3.4.

9.4.6.3.3.1 The system shall be activated by heat detectors or no less effective means.

(A) Detectors shall be located at the belt drive, hydraulic takeup unit (unless fire-resistive fluid is used), discharge roller, and the roof above the conveyor.

(B) Detectors at the roof line should be spaced 2.4 m to 3.0 m (8 ft to 10 ft) apart along the entire length of the protected area of the belt.

9.4.6.3.3.2 The water spray nozzles shall be full cone, corrosion resistant [if less than 0.95 cm (⅜ in.) inside diameter or K-factor 4.2 or lower], and provided with blow-off dust covers.

9.4.6.3.3.3 If water spray sprinklers or open-head sprinklers are used, blow-off dust covers are not required to keep them clean as long as they are flow tested in accordance with 4.3.3.5.5.3.

9.4.6.3.3.4 A closed sprinkler head shall be used over the electrical controls.

9.4.6.3.4 Foam Systems.

9.4.6.3.4.1 Foam systems shall meet the requirements of 9.4.6.3.4.2 through 9.4.6.3.4.5.

9.4.6.3.4.2 The system shall be activated by heat detectors or no less effective means.

(A) Detectors shall be located at the belt drive, hydraulic takeup unit (unless fire-resistive fluid is used), discharge roller, and the roof above the conveyor.

(B) Detectors at the roof line should be spaced 2.4 m to 3.0 m (8 ft to 10 ft) apart along the entire length of the protected area of the belt.

9.4.6.3.4.3 The nozzles shall be full cone, corrosion resistant [if less than 0.95 cm (3⁄8 in.) inside diameter or K-factor 4.2 or lower], and provided with blow-off dust covers.

9.4.6.3.4.4 The system shall have a capacity to last 25 minutes.

9.4.6.3.4.5 A closed sprinkler head should be used over the electrical controls.

9.4.6.3.5 Maintenance and Testing. Fire suppression systems shall be maintained and tested in accordance with 4.3.3.5.

9.4.7 Manual Extinguishing.

9.4.7.1 Water lines shall be installed parallel to the entire length of belt conveyors and shall be equipped with fire taps with valves at 91.4 m (300 ft) intervals.

9.4.7.2 The threads on the hose taps shall be protected against dirt and rock grit that can prevent a quick connection.

9.4.7.3 The hose tap at the belt drive area shall be at least 15.2 m (50 ft) upwind of the belt drive.

9.4.7.4* At least 152.4 m (500 ft) of fire hose with fittings shall be stored at strategic locations along the conveyor belt, that is, at transfer points, drive areas, and tailpieces.

9.4.7.5 For each conveyor belt exceeding 610 m (2000 ft) in length, an additional cache of materials as specified in 9.4.7.4 shall be provided.

9.4.7.6 For mines using a track haulage system, the same criteria as those in Section 9.2 through 9.2.3 shall be met.

9.4.7.7 The following materials shall be stored within 91.4 m (300 ft) or 5 minutes of a belt drive:

(1) 152.4 m (500 ft) of fire hose or a high-expansion foam device and 61 m (200 ft) of hose
(2) Tools to open a stopping between the belt entry and the adjacent intake entry
(3) 109 kg (240 lb) of rock dust

9.4.7.8 Foam.

9.4.7.8.1 The foam generator shall produce foam sufficient to fill 30.5 m (100 ft) of belt haulageway in not more than 5 minutes.

9.4.7.8.2 A 1-hour supply of foam shall be kept on hand.

9.4.7.9 The entry containing the main water line and crosscuts containing water outlets shall be accessible.

9.4.7.10 Suitable communication lines to the surface shall be provided in the belt haulageway or adjacent entry.

9.4.7.11 A crew consisting of at least five members for each shift shall be trained in fire-fighting operations. Fire drills shall be held at intervals not exceeding 6 months.

9.4.7.12 Two 9.1 kg (20 lb) dry-chemical extinguishers shall be located at the drive areas.

9.4.8* A dust suppression water spray system actuated by a “conflow” switch or similar device shall be provided at the belt feeder.

9.4.9 Electrical equipment shall be permissible where required by the authority having jurisdiction.

9.5* Coal Storage — General. Coal bins, bunkers, and silos shall meet the following requirements:

(1) Storage durations shall be limited to prevent spontaneous combustion.
(2) Equipment shall be of noncombustible construction designed to minimize coal hang-up.
(3) Means shall be provided to remove burning, wet, or smoldering coal so it can be disposed of without producing an explosion or a fire.

9.5.1 Storage Bins.

9.5.1.1 All interior bins handling dusty material shall be vented in accordance with 6.2.2.

9.5.1.2 Storage bins for coal shall be located so that sources of heat not intended specifically to control the temperature of coal do not raise the temperature of the coal in the bin, causing spontaneous combustion materially.

9.5.2 Coal Silos.

9.5.2.1 Coal shall not be stored in silos and bunkers for long periods. If coal must be stored for a long period, air entrainment shall be prevented using the following methods:

(1) Covering the top of the stored coal with a binder material
(2) Inerting the stored coal with recommended inert gas

9.5.2.2 Areas in the storage (hideouts) that can allow pockets of coal to form, dry, and combust spontaneously shall be removed.

9.5.2.3 Storage silos shall be constructed of noncombustible material.

9.5.2.4 Electrical equipment shall be installed to meet the requirements of *NFPA 70* in effect at the time of installation.

9.5.2.5 If a dust collector is provided, it shall be equipped with explosion relief panels in accordance with NFPA 68. The dust collector shall be grounded and have antistatic, fire-resistant bags.

9.5.2.6 Wash-down hoses shall be provided at the bottom of the silo.

9.5.2.7 Dual high-level cutoff switches shall be provided for the silo. The feed conveyor shall be interlocked to shut down on the low–high indication.

9.5.2.8 The silo shall be maintained on a regular cleaning schedule to minimize the buildup of coal beneath the hopper and other areas inside the silo.

9.5.2.9 Deluge water spray systems, foam systems, closed-head sprinkler systems, or dry-chemical systems automatically actuated by rise in temperature shall be installed over the belt drive areas on top of a silo.

9.5.3 Stacker Tubes and Coal Storage Piles.

9.5.3.1 Coal piles shall be designed to minimize the entrainment of air.

9.5.3.1.1 Minimization shall be permitted by development of a compacted edge around the pile.

9.5.3.1.2 The edge described in 9.5.3.1.1 shall be sealed with binder to aid in sealing.

9.5.3.2 Hot spots or areas of spontaneous combustion shall be removed by digging.

9.5.3.3 The use of water for extinguishment shall be used at a minimum.

9.5.3.4 Active storage piles shall be worked to prevent dead pockets of coal, a potential source of spontaneous heating.

9.5.3.5 Coal piles shall not be located above heat sources, such as steam lines, or sources of air, such as manholes.

9.5.3.6 Coal placed in long-term storage shall be piled in layers, appropriately spread, and compacted prior to the addition of subsequent layers to reduce air movement and to minimize water infiltration into the pile.

9.5.3.7 Where possible, storage piles shall be arranged to allow access to the pile with earth-moving equipment in the event of developing hot spots or fire.

Chapter 10 Truck, Rail, and Barge Loadouts

10.1 Construction.

10.1.1 The loadout shall be constructed of noncombustible material.

10.1.2 Conveyor systems shall be in accordance with Section 9.1.

10.2 Fire Prevention.

10.2.1 No smoking shall be allowed in the loadout control room.

10.2.2* Loadout control rooms shall be designed, constructed, and maintained to reduce the chances of coal dust entering the room.

10.2.3 Combustible storage shall be maintained at least 0.9 m (3 ft) from all electrical panels, gas-fired heaters, and electric resistance heaters.

10.2.4 Trash and other unnecessary combustibles shall not be allowed to accumulate in the loadout control room.

10.2.5 Motor control centers shall be thermographically scanned on an annual basis to identify hot spots and loose electrical connections.

10.2.6 Hydraulic equipment shall have the following alarms interlocked to shut down the equipment:

(1) Low oil pressure
(2) High oil temperature
(3) Low oil level

10.3 Life Safety.

10.3.1 Two means of egress shall be provided from the loadout control room if the room is more than two levels high.

10.3.2 For multistory buildings, emergency lighting shall be provided in accordance with NFPA *101*.

10.3.3 For multistory buildings, emergency exit signs shall be provided along the means of egress.

10.4 Fire Detection and Protection.

10.4.1 A smoke detector system shall be installed in the loadout control room in accordance with *NFPA 72*.

10.4.1.1 The smoke detector system shall actuate an audible and visual alarm system.

10.4.1.2 For infrequently occupied or remote locations, the system shall send an alarm to a constantly attended location.

10.4.2* A gaseous fire suppression system shall be installed in loadout control rooms that are not regularly occupied and located in remote areas.

10.4.3 An automatic fire suppression system shall be installed to protect hydraulic pumps that have a capacity over 189.3 L (50 gal) and are located on an upper floor.

10.4.3.1 The system shall be actuated by a heat detector system.

10.4.3.2 The system shall be interlocked to shut off the power to the unit.

10.4.3.3 A listed fire-resistive fluid shall be an acceptable alternative to an automatic fire suppression system.

10.5 Manual Fire Fighting.

10.5.1* Fire extinguishers shall be provided in accordance with NFPA 10.

10.5.2 For multistory buildings, an emergency response plan shall be developed with the input of the local fire department.

10.5.3 For areas subject to flood, an emergency response plan shall be developed to include fire-fighting procedures during a flood.

Chapter 11 Emergency Response, Manual Fire Fighting, and Training

11.1* Emergency Procedures.

11.1.1 Emergency procedures shall be provided to instruct all miners in the location and use of fire-fighting equipment, location of escapeways and exits, and evacuation procedures.

11.1.2 The emergency procedures shall include a specific fire-fighting and evacuation plan with procedures for evacuation of all miners not required for fire-fighting activities, rapid assembly and transportation of personnel and equipment to the fire scene, and operation of the fire suppression equipment available at the mine.

11.1.3 Instruction in emergency procedures shall be provided to all miners on an annual basis.

11.1.4 Instruction in the location of fire-fighting equipment, location of escapeways and exits, and evacuation procedures shall be provided to all miners prior to entering an active mining area for the first time.

11.1.5 All employees shall receive annual instruction on emergency evacuation procedures.

11.1.6 All employees shall receive annual instruction on the procedures for discharging portable fire extinguishers and the proper method of fire attack.

11.1.7 For underground mines, the following additional criteria shall be met:

(1) Fire drills shall be held on a 90-day basis. A record of the drill shall be kept and include the date, the number of

persons participating, the area of the mine involved, the procedures followed, and the equipment used.
(2) At least two miners in each working section on each production shift shall be proficient in the use of all fire suppression equipment in that section and know the location of the equipment.
(3) Visitors shall be trained on the hazards they might encounter and in the appropriate emergency procedures.

11.1.8 The local fire department shall be requested or invited to make an annual tour of the surface area of the mine buildings. The tour shall include all surface buildings, major equipment, the location of flammable and combustible liquid storage, a discussion of the water supply availability, and the location of electrical shutoffs.

11.2 Underground Operations.

11.2.1 General.

11.2.1.1 An emergency response team shall be available and trained in basic fire-fighting techniques that would include, but not be limited to, fire hose, foam generators, fire extinguishers, and smoke control.

11.2.1.2 Each operator of attended equipment and each miner assigned to job duties normally in sight of the equipment shall be proficient in the use of the fire suppression devices on that equipment.

11.2.1.3 On a maintenance shift, the foreman and at least one miner for every five shall be proficient in the use of fire suppression equipment available in the mine and know the location of the equipment.

11.2.2 Fire-Fighting Team. Mines shall have a fire-fighting team trained in basic fire-fighting techniques, for example, hose streams and foam generation.

11.2.2.1 The fire-fighting team shall have at least 16 hours of refresher training per year.

11.2.2.2 The team shall consist of at least five members on each shift.

11.2.2.3 Self-contained breathing apparatus (SCBA) and fire-retardant coats, boots, and gloves shall be provided for the fire-fighting team.

11.2.3 Emergency Vehicle.

11.2.3.1 All mines shall be provided with an emergency vehicle outfitted with fire hose, appropriate fittings, a "Y" or a "siamese" connection, two adjustable fire department–quality fog nozzles, various tools, and pressure regulators (where necessary).

11.2.3.2 If an underground water car is provided, it shall be at least 3785 L (1000 gal) capacity and shall have at least 91.4 m (300 ft) of fire hose with nozzles.

11.2.3.2.1 A water car shall be capable of providing flow through a hose of 190 L/min (50 gpm) at a nozzle pressure of 345 kPa (50 psi).

11.2.3.2.2 A portable dry-chemical car shall be permitted to be provided as long as it carries the extinguishing capacity equivalent to a water car.

11.2.3.2.3 The dry-chemical car described in 11.2.3.2.2 shall be no farther than 3.2 km (2 mi) from each working section.

11.2.4 Foam Generator. A high-expansion foam generator shall be available within 60 minutes of fire notification and have enough foam to supply the fire-fighting operation for 35 minutes.

11.2.5 Fire Hose and Hydrants.

11.2.5.1* Water lines installed parallel to haulage tracks using mechanized equipment in the track or adjacent entry shall be equipped with outlet valves at intervals of not more than 152.4 m (500 ft), and with 152.4 m (500 ft) of fire hose with fittings suitable for connection shall be provided at strategic locations.

11.2.5.2 Hydrants shall be provided along belt conveyors at intervals not to exceed 91.4 m (300 ft).

11.2.5.3 At least 152.4 m (500 ft) of fire hose shall be provided for each belt flight and strategically positioned within that belt flight.

11.2.5.4 The threads on the hose and hydrants shall be protected against dirt and rock grit.

11.2.5.5* Multiple hydrant assemblies, with the tools needed for their installation, shall be provided as part of each cache of emergency materials.

11.2.5.6 Fire hose shall be lined with a material having flame-resistant qualities meeting requirements for hose in the U.S. Bureau of Mines' Schedule 2G.

11.2.5.6.1 The covers of the fire hose shall be polyester or other material with flame-spread qualities and mildew resistance equal or superior to polyester.

11.2.5.6.2 The bursting pressure shall be at least four times the water pressure at the valve to the hose inlet with the valve closed.

11.2.5.6.3 The maximum water pressure in the hose nozzle shall not exceed a gauge pressure of 689.5 kPa (100 psi).

11.2.6 Emergency Materials. In addition to specific area equipment, the following equipment shall be readily available at locations not exceeding 3.2 km (2 mi) from each working section:

(1) 304.8 m (1000 ft) of brattice boards
(2) Two rolls of brattice cloth
(3) Two hand saws
(4) 11.3 kg (25 lb) of 8d nails
(5) 11.3 kg (25 lb) of 10d nails
(6) 11.3 kg (25 lb) of 16d nails
(7) Three claw hammers
(8) 25 bags of wood fiber plaster or 10 bags of cement (or equivalent material)
(9) 4536 kg (5 tons) of rock dust

11.3 Surface Operations.

11.3.1* Surface mines shall meet the same requirements for fire-fighting teams listed in 11.2.2 unless public fire fighters are available within 30 minutes with the capability to fight the most difficult fire at the mine site.

11.3.2 Fire extinguishers shall be provided in accordance with NFPA 10.

11.3.3 If fire hydrants are provided, they shall be installed in accordance with NFPA 24.

11.3.4 If fire hydrants are not provided, water trucks shall be the fire-fighting water source.

11.3.4.1 Water trucks shall be equipped with a pump, fire hose, nozzles, and appropriate fittings.

11.3.4.2 The water truck shall be equipped with a water cannon (turret).

11.3.4.3 The water truck shall be equipped with a connection to enable the fire department to take suction from the tank.

11.3.5 Fire hose and couplings shall be listed or approved. Cotton- or cotton-polyester-jacketed hose shall be treated in accordance with the U.S. Department of Agriculture Forest Service Specification 182 for mildew resistance.

11.3.6 Water lines shall be capable of delivering at least 378.5 L/min (100 gpm) at a hose nozzle pressure of 689.5 kPa (100 psi).

11.3.7 The water pressure at the hose nozzle shall not be excessively high so as to present a hazard to the hose operator.

11.3.8 The hose connections shall have threads compatible with the local fire department's hoses, or a supply of adapters shall be available to adapt the hose connections to the fire department hoses. The local fire department shall be consulted to ensure thread compatibility for hose connections.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 In the development of this document, the data in NIOSH Information Circular 9470, "Analysis of Mine Fires for All Underground and Surface Coal Mining Categories: 1990–1999," were examined. Table A.1.1.1 shows the number of fires for underground coal mines, surface fires at underground coal mines, at surface coal mines, and at coal preparation plants, as well as the number of fire injuries and coal production for the time period from 1990 to 1999.

Analysis of the data shows a general decrease in the number of fires over the 10-year period, particularly from 1996 to 1999, while coal production increased slightly. The largest number of fires over the 10-year period, as well as for each 2-year time period, occurred at surface coal mines. There were 164 injuries due to fire during the 10-year period, with the number decreasing significantly over the last 4 years. There were two fatalities in 1991.

A.1.3 Because of the uniqueness of coal mining, provisions in this standard can differ from commonly accepted fire protection standards and guides for other types of occupancies.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Table A.1.1.1 Number of Coal Mine and Preparation Plant Fires, Injuries Due to Fire, and Coal Production from 1990 to 1999

	Number of Fires*					
Years	Underground Coal Mines	Surface at Underground Coal Mines	Surface Coal Mines	Coal Preparation Plants	Number of Fire Injuries*	Coal Production† (10^6 short tons)
1990–1991	25	17	67	23	59	2,004
1992–1993	18	14	37	22	29	1,928
1994–1995	23	16	47	18	39	2,059
1996–1997	6	7	40	8	19	2,155
1998–1999	15	11	24	20	18	2,218
1990–1999 Total	87	65	215	91	164	10,364

*Derived from MSHA "Fire Accident Abstract" and "Fire Accident Report" publications.
†Derived from MSHA "Injury Experience in Coal Mining" publications.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.33 Mobile Equipment. Mobile equipment includes, but is not limited to, wheeled, skid-mounted, track-mounted, or rail-mounted equipment capable of moving or being moved.

A.4.2 Potential sources of ignition include, but are not limited to, the following:

(1) Smoking
(2) Open flames
(3) Cutting and welding
(4) Hot surfaces
(5) Frictional heat
(6) Static, electrical, and mechanical sparks
(7) Spontaneous ignition, including heat-producing chemical reactions
(8) Radiant heat

A.4.2.5.1 Automatic-closing doors provide a higher level of fire protection and are therefore recommended.

A.4.2.6 Belt fires originating away from the drive area usually have been caused by idlers with defective or stuck bearings. Tests have shown that such idlers can become moderately hot [93.3°C to 149°C (200°F to 300°F)]. The coal task group has been unable to find reliable evidence that idlers can become hot enough to ignite fire-retardant belting directly.

It appears that a warm or hot idler can cause fine coal dust accumulated around the idler to ignite. Then, when the belt has been stopped, coal burning beneath the belt ignites the belting.

The key to avoiding belt fires is to prevent the accumulation of fine coal dust around idlers. If a metal deck is provided between the carrying strand and the return strand of the belt, coal dust accumulates around the troughing idlers. Where possible, return idlers should be supported at a substantial height above the bottom so that coal dust is not likely to build up around return idlers. With proper clearance beneath these idlers, accumulations of coal dust can be cleaned up more easily.

Slat-type, self-cleaning tail pulleys are recommended. Coal dust discharged by such pulleys should be cleaned up frequently. Both good maintenance and good fire prevention necessitate that noisy bearings, which might indicate probable failure, be changed promptly before they become hot.

Conveyor belt fires have been caused by belts that lose proper alignment, with the edge of the moving belt then contacting combustible material. Loss of alignment can result from a number of factors, including displacement of idlers or pulleys and movement of supporting structure, spillage of conveyed material, and failure of a bearing (typically on a pulley). Where alignment is affected significantly, the edge of the belt can rub abrasively on the structure and objects near the edge of the belt. If the object on which the belt rubs is metal, the metal can become worn and heated. The edge of the belt can be damaged extensively, but the belt probably will not ignite because a point on the edge of the moving belt is in contact with the metal for only a very short period and will cool before it returns to the point of contact. The metal can become quite warm, but because it is a good conductor of heat, it will not become hot enough to ignite the belt if the belt stops. Nevertheless, if the material contacted is wood or another combustible, the combustible material could be heated by the friction of the edge of the moving belt until it ignites. Keeping combustible material away from the edge of the belt and use of alignment switches should prevent such fires.

A.4.2.11 Spontaneous combustion potential of coal depends on a number of factors, including mining practices, mining conditions, geology, and reactivity of the coal. The contributions of these factors can be determined by using a number of methods, including a NIOSH computer program named SPONCOM, which is available from the NIOSH web page.

A.4.2.11.2 Means to reduce the risk of spontaneous combustion include but are not limited to monitoring and trending of combustible gases, sealing, inerting, and using ventilation controls.

A.4.3 For further information see NIOSH Information Circular 9452, *An Underground Coal Mine Fire Preparedness and Response Checklist: The Instrument.*

A.4.3.1.1.1 Routing of water lines has caused severe problems in fighting fires at some large mines. These mines had multiple intake shafts spaced apart at considerable distances. Such ventilation can create a neutral point between the shafts, with fresh air moving from each shaft toward the neutral point. At the original opening of one mine, a water source was established and the water line was extended as the mining developed farther away from the original opening. With the water line extended to each new intake shaft and passing through each neutral point, a condition of opposite direction of flow of air and water existed beyond each neutral point.

If a fire occurs in an area of opposite flow, the fire has to be approached in the same direction as the airflow, but the water flow is moving through the fire area. Usually water lines in a fire area are damaged or broken by falling sections of burning roof. When a water line breaks in such a situation, the fire fighters are without water, and direct fire fighting is no longer possible. The fire then can be controlled only by sealing. At least one large coal mining company now provides an additional water source at each new intake shaft to ensure the ability to fight such fires.

The likelihood of this problem appears to be increasing as more mines are ventilating belt entries with air moving outby, while the water flow is inby. In some cases, mine management has recognized the problem and has developed procedures to change the direction of airflow in the event of a fire. Reversing the airflow should be done at a point close to and outby the fire to avoid pushing smoke-laden air back onto the fire. After the belt entry outby the fire has been cleared of smoke, the airflow can be reversed for the full length of the entry if desired.

Mines that obtain their water supply from an underground source also can have this problem of opposite directions of air flow and water flow. Usually there is no sure solution except to provide an alternative source of water or a large storage of water on the surface. If the power for the pumps is fed from the high-voltage system that feeds the mine and the fire damages the high-voltage cable anywhere on the system, the power can trip the entire system and shut down the pumps. Coordination of the electrical protective equipment or even a separate power supply might be needed to ensure that the pumps continue to supply water for fire fighting.

Even in situations where air and water are flowing in the same direction, management must recognize that water lines or hydrants in a burning entry are likely to be broken by the falling sections of burning roof. In such situations, a planned shutdown of the water line should be undertaken as soon as possible so a multiple hydrant can be installed in the water line at a convenient location close to the fire. With the multiple hydrant in place, at least three fire hose can be served effectively from the water line.

Because of the many factors that should guide the choice of location of water lines and hydrants, management should be properly qualified to select these locations, but management also should be able to justify its choice. Reliability of the water supply and ability of fire hose streams to reach a fire at any location or entry served by the water line should be the criteria by which the location is chosen.

A.4.3.1.1.9 Shutoff valve intervals of 305 m (1000 ft) are recommended. Indicator-type shutoff valves with labels specifying the normal operating position are recommended.

A.4.3.1.2.1 Water distribution lines generally cannot meet the capacity requirements of 4.3.1.2.1 unless 127 mm (5 in.) or 152.4 mm (6 in.) pipe is used for main water lines and 101.6 mm (4 in.) pipe is used for branch lines to producing areas. Higher nozzle pressures are recommended.

A.4.3.1.2.2 The required hose stream water demand equals a minimum supply of 817,650 L (216,000 gal).

A.4.3.1.3.1 Hydrants in a coal mine normally are only a valve screwed onto a tee that is installed on the water line. For the female coupling of a fire hose to be connected to a male thread, a pipe nipple usually is screwed into the discharge side of the valve. Because the threads of steel pipe nipples generally corrode if left exposed, brass nipples often are used instead of steel nipples. Many mines have begun to use Schedule 80 plastic nipples instead of steel. Regardless of the nipple material, the threads of the nipple should be protected against physical damage.

A properly designed system of hydrants and fire hose should make a good connection of fire hose lines to the hydrants without the need for tools.

The choice of locations for hydrants should be made to ensure that fire hose lines can be laid quickly from hydrants located on the water line through crosscuts to a fire located in any parallel entry or crosscut, rather than to provide convenience for use in the entry where the water line is located.

A.4.3.1.3.2 Hydrants should preferably be located in crosscuts, and stoppings in such crosscuts should be fitted with a man door.

A.4.3.2 Automatic detection systems and automatic sprinkler systems in mining facilities need to be specifically addressed for the following reasons:

(1) The contents of a mine occupancy are continually changing. Most items are not fixed and are designed to be moved with the mining operation. A mine operates as a heavy-duty excavation construction site and, thus, has the same transitory nature as a construction site.
(2) Unlike aboveground industrial occupancies, great distances are not unusual within an underground mine. Mines covering 64.75 km^2 (25 mi^2) or more are common.
(3) Mines have extremely harsh and unusual environments compared to aboveground industrial occupancies. Heavy concentrations of combustible dusts, the presence of explosive gases, temperature extremes, saturated humidity conditions, standing water, unstable strata, roof-to-floor heights that vary from 710 mm to 6.1 m (28 in. to 20 ft), and complex ventilation systems are all commonplace. The possibility of abuse from heavy machinery is a common hazard.
(4) Mining occupancies exhibit unique physical characteristics not found in any other type of occupancy. One example is the extreme pressures that can occur in a water line.
(5) Mines employ specialized facilities, equipment, and production processes not utilized in other industries. Fire protection efforts that fail to consider the unusual operating characteristics and fire protection requirements of underground coal mining systems could result in nonoptimal protection or the inadvertent introduction of hazards.

30 CFR 75.1103-4 provides requirements for installing fire detection systems in underground coal mines in the United States.

A.4.3.2.1.1 An automatic fire detector is a device designed to detect the presence of fire and initiate action. For the purpose of this standard, automatic fire detectors are classified as follows:

(1) *Heat detector*: a device that detects an abnormally high temperature or rate of temperature rise
(2) *Smoke detector*: a device that detects the visible or invisible particles of combustion
(3) *Flame detector*: a device that detects the infrared, ultraviolet, or visible radiation produced by a fire
(4) *Fire-gas detector*: a device that detects gases produced by a fire
(5) *Other fire detectors*: devices that detect a phenomenon other than heat, smoke, flame, or gases produced by a fire

Fire detectors should be installed as follows:

(1) *Vertical Placement.* Because the hot gases from a fire will rise owing to buoyancy forces, combustion products initially will be stratified near the roof of an entry. As the stratified gas layer moves away from the fire, the resultant cooling and dilution eventually will produce a well-mixed flow of combustion products. Data from full-scale fires indicate that some degree of stratification can exist at distances of hundreds of feet from the source of the fire.

    Because of this effect, fire detectors should be located at a vertical distance from the entry roof that does not exceed 25 percent of the average entry height. For example, in an entry with a height of 1.8 m (6 ft), the maximum distance from the roof at which a sensor should be located is 0.5 m (1½ ft). The maximum distance refers to the location of the actual sampling intake of the detector used.
(2) *Lateral Placement.* In general, the point of origin of a fire is unpredictable. It can occur along the floor, ribs, or roof of the entry. To provide optimum protection, it is recommended that the fire detectors be located within 0.6 m (2 ft) of the approximate midpoint of the entry.

    For entries in which the point of origin of the fire can be better estimated (such as a belt entry), the detectors should be located in such a manner that they provide for the estimated best coverage of that entry.

A.4.3.2.1.3 Batteries charged by the mine power system should indicate the condition of the batteries upon either manual or automatic activation of a battery check circuit.

For further information see *NFPA 72*.

A.4.3.2.1.4 Electrical equipment classified as "permissible" or "intrinsically safe" is certified as meeting the requirements of 30 CFR, Part 18, Chapter 1.

A.4.3.2.2.1 Based on U.S. Bureau of Mines Report of Investigation 9570, "Hazards of Conveyor Belt Fires," CO and smoke detectors provide a significant improvement over point type heat detectors in warning of a potential fire on conveyor belts.

A.4.3.2.2.2 U.S. Bureau of Mines Report of Investigation 9380, "Fire Detection for Conveyor Belt Entries," provides information on smoke and CO sensor alarm levels and sensor spacing as a function of belt entry cross-sectional area and belt entry air velocity.

A.4.3.3.1.1(3) Depending on the size of the equipment, additional manual actuators could be needed to provide quick access for activation of the system.

A.4.3.3.1.1(4) For further information on flame resistance, see 30 CFR 18.65.

A.4.3.3.1.1(6) Open-head deluge and water spray systems can be kept free of blockage by regular flow of water through the system. For example, fire suppression on continuous miners can be flowed once per shift to keep the nozzles clean. Deluge water spray systems at belt drives can be flowed weekly to keep the nozzles clean.

A.4.3.3.1.4 For criteria of equivalent protection, see 30 CFR 75.1107-13.

A.4.3.3.2.1 Wet-pipe automatic sprinkler systems have been found to be the preferred fire suppression systems for underground coal mines for the following reasons:

(1) They are the simplest systems available.
(2) They are the most reliable systems available.
(3) They provide selective operation, because only sprinklers close to the fire operate.
(4) They have the best performance record, especially on fires of Class A materials and of Class IIIB combustible liquids.
(5) They need minimal maintenance.
(6) They are nonelectrical.
(7) They use a limited quantity of water.
(8) The initial investment is low.

The major problem associated with automatic sprinkler systems in underground coal mines is the possibility of exposure to freezing conditions during cold weather. Another problem that can exist in very deep mines is that some of the listed components for automatic sprinkler systems might be unable to withstand the very high water pressure encountered (see U.S. Bureau of Mines Report of Investigation 9451, "Effect of Pressure on Leakage of Automatic Sprinklers"). It is not uncommon to encounter pressures above a gauge pressure of 3448 kPa (500 psi). The committee recommends testing sprinkler system components under anticipated maximum pressures. If sprinkler components are found to be unable to withstand the maximum pressure of the water line, the use of pressure regulators might be necessary. Experience has shown that pressure regulators can require considerable maintenance. Also, if the pressure regulating valve should leak, it might be necessary to provide a small relief valve on the discharge side of the regulating valve to prevent overpressure.

A.4.3.3.2.1(1) Under Report No. H0122086, "Suppression of Fires on Underground Coal Mine Conveyor Belts," the Department of the Interior, U.S. Bureau of Mines (USBM), conducted a series of full-scale fire tests.

The tests demonstrated that standard, 12.7 mm (½ in.) orifice, nominal 100°C (212°F) automatic sprinklers, located over the belt on 3 m (10 ft) centers, effectively controlled every test fire while opening only two sprinklers, with residual pressure held to a constant a gauge pressure of 69 kPa (10 psi).

From the time that the USBM tests were conducted, underground belts have tended to become wider to carry increased tonnage; therefore, belt fire suppression systems should be designed to supply more sprinklers than indicated by these tests. Because many conveyor belts stretch a long distance in a straight line, a fire scenario would involve only a portion of the belt, regardless of the overall length of the belt. Because the actual incidence of belt fires is low in underground coal mines, and most of those are in the area of the belt drive and the belt takeup, protection of only the area from the discharge pulley to the end of the takeup is needed. If the belt structure contains a deck between upper and lower strands of the belt, automatic sprinklers should be located beneath the deck, virtually doubling the size of the sprinkler system.

If the sprinkler system is extended to cover a distance greater than 30.5 m (100 ft) in one direction from the point where the pipe holding the automatic sprinklers along the roof is fed, then a hydraulic calculation of the system is recommended. Long runs of pipe should be flow tested as required by 4.3.3.5.5.1, with the eight open sprinklers installed at the distant end of the pipe run. Branch piping intended to protect limited areas should be piped with adequately sized pipe to carry the required water flow. Table A.4.3.3.2.1(1) should be used to determine the minimum size of pipe.

Larger systems should be separately flow tested as required by 4.3.3.5.5.1.

Table A.4.3.3.2.1(1) Minimum Pipe Sizes per Number of Sprinklers

Pipe Size	Maximum Number of Sprinklers on Pipe
1 in.	2
1¼ in.	3
1½ in.	5
2 in	10
2½ in.	20
3 in.	40
3½ in.	65
4 in.	100

For SI units, 1 in. = 25.4 mm.

A.4.3.3.2.2 Because many air compressors are moved frequently, the fire suppression system needs to be equally portable. Some compressors that have a deck or lid over the compressor have been fitted with piping and sprinklers attached to the underside of the deck. Other compressors without a deck have suitable piping with at least two sprinklers 3 m (10 ft) apart. The piping is made to be attached to roof bolts or otherwise suitably supported over the centerline of the compressor. The piping needs to be equipped with a pressure switch that prevents the operation of the compressor unless the piping is under pressure and with a flow switch that shuts the compressor down if water flows. If a fire hose is used to connect the piping to a water line, the connection point of the hose to the sprinkler piping should be located so that a fire on the compressor will not damage the fire hose.

A.4.3.3.3.1 NFPA 13 requires a minimum 140 kPa (20 psi) residual pressure for ordinary hazard pipe schedule sprinkler systems.

A.4.3.3.3.2.1 Pipe and fittings that permit limited motion of the pipe are recommended, as they allow the pipe to be held closer to the roof. If threaded fittings are used, steel pipe with extra-strength threaded fittings is recommended. Copper, aluminum, or other approved materials could be permitted if they are adequate for the pressure.

A number of mines use aluminum pipe or tubing with groove-type couplings and fittings. Where water pressure does not exceed 3448 kPa (500 psi), grooved couplings that have a 12.7 mm (½ in.) female national pipe thread (FNPT) outlet are used to provide connections for sprinklers. Piping put together in this manner can be located closer to an undulating roof, especially if the pipe lengths are short enough to put the couplings (and the automatic sprinklers) on 3 m (10 ft) centers. Mines that use groove-type couplings can have most of the piping precut and grooved in the shop, which simplifies installation underground. Rolled grooves are recommended because they do not reduce the strength of the pipe as much as the cut grooves do. If cut grooves are used, Schedule 40 or heavier pipe should be used.

A.4.3.3.3.2.5 Some automatic sprinklers might not withstand the water pressure that can be encountered in deep mines. Information on the effect of high water pressure on automatic sprinklers can be found in U.S. Bureau of Mines Report of Investigation 9451, "Effect of Pressure on Leakage of Automatic Sprinklers."

Under U.S. Bureau of Mines Report of Investigation 9538, "Performance of Automatic Sprinkler Systems for Extinguishing Incipient and Propagating Conveyor Belt Fires Under Ventilated Conditions," NIOSH conducted a series of full-scale fire tests under ventilated conditions of 1.1 and 4.0 m/s (225 and 800 ft/min) for fires up to 10.8 MW. The tests demonstrated that pendent and horizontal sidewall types were both able to extinguish incipient belt fires. Directional sprinklers showed a slightly improved performance in terms of maximum heat release rate at the lower airflow. Both pendent and horizontal sidewall sprinkler types were able to extinguish propagating fires. Horizontal sidewall sprinklers showed an increased effectiveness compared to the pendent sprinklers because of the increased upstream coverage area of the water discharge in terms of maximum heat release rate.

A.4.3.3.3.2.6 The restrictions on sprinkler spacing apply to sprinklers on the same line and those located between sprinklers on adjacent lines.

A.4.3.3.3.2.7 Where sprinkler positioning is such that full coverage can be impaired, such as where a single line of sprinklers protects a belt conveyor with little clearance, a flow test should be conducted to determine if adequate wetting of surface areas is achieved. Additional sprinklers should be provided in the event that adequate coverage is not achieved, or alternative arrangements such as rotated lines or sidewall sprinklers should be considered. Consideration also should be given to the need for noncombustible baffles to protect sprinklers from the discharge of adjacent sprinklers located within 1.8 m (6 ft).

A.4.3.3.3.5 Dry-pipe automatic sprinkler systems are more complex and more difficult to design and install than wet-pipe systems. The committee recommends that all systems be designed and installed by skilled and experienced personnel.

A pressure relief valve, set to relieve at a pressure below the maximum pressure rating of the dry-pipe valve, should be installed between the pressure regulating valve and the dry-pipe valve. The reclosing pressure of the relief valve should be higher than the set pressure of the regulating valve.

A.4.3.3.3.6.1 Underground shaft mines that use diesel-powered equipment generally employ underground diesel fuel storage areas to facilitate equipment refueling. Adit-type mines in the western United States might initially locate diesel fuel storage and refueling facilities on the surface; however, as the active mine workings progress farther from the adit portal(s), these facilities will likely be moved underground.

A common means of fire protection in many underground diesel fuel storage areas is the use of fixed water sprinkler systems. However, this situation represents a significant safety hazard. According to the NFPA *Fire Protection Handbook*, water sprinklers can be permitted to be used on diesel fuel for control but not for extinguishment.

In "The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," a report by an interagency task group prepared for MSHA in 1985, the simple conclusion was that "water spray or fog usually will not extinguish diesel fuel fires."

In an underground coal mine, fire control is not sufficient; fire extinguishment is essential for the following reasons:

(1) Unlike an underground metal or nonmetal mine, the mineral in a coal mine is combustible. All fire prevention and protection provisions in an underground coal mine are aimed at preventing the ignition of the coal. In a metal or nonmetal mine, if fire control efforts are unsuccessful in extinguishing a fire on a piece of diesel equipment or a diesel fuel fire, personnel can be evacuated and the fire can be allowed to consume all available fuel materials, thereby self-extinguishing. In an underground coal mine, this practice would almost certainly result in the ignition of the coal and the consequent loss of part or all of the mine.
(2) Even if a fire does not grow in intensity or spread to the coal, toxic smoke and fire gases are produced as long as it burns, which can endanger persons within the mine.
(3) According to the NFPA *Fire Protection Handbook*, overpressure failure of containers exposed to fire is considered the principal hazard of closed-container flammable and combustible liquid storage.
(4) Even a "controlled" fire can cause such container failure, producing a fire so intense that the sprinkler system is unable to control it, much less extinguish it.
(5) Water sprays are not effective in extinguishing pressure fires, running fuel fires, and obstructed spill fires, all of which could occur in a diesel refueling area.
(6) Water supplies are limited in many underground mines. Fire "control" should be considered temporary, because when the water supply is depleted, the fire will grow immediately to the maximum intensity.
(7) The vapor pressure of diesel fuel increases with elevation, due to reduced barometric pressure. As a result, even fuels without flash point–reducing additives can become flammable, depending on the altitude at which they are used. This reduction in flash point can result in reclassification of

the diesel fuel to a Class IC flammable liquid. There is no clear consensus in the literature and industry practice as to the effectiveness of fixed water sprays in controlling and extinguishing fires involving Class IC flammable liquids. Although industry practice strongly favors fixed water sprays for such applications, the literature and available research results clearly indicate the ineffectiveness of fixed sprays on Class IC liquids, especially in the case of pressure fires, running fuel fires, and obstructed spill fires.

Therefore, water sprinkler systems installed for the protection of diesel fuel storage areas are considered inadequate; foam–water systems should be utilized. See the applicable sections of NFPA 16.

A.4.3.3.3.6.2 The alarm system that serves sprinklers protecting the drive area of a belt conveyor also should be permitted to serve as the fire detection system installed over that portion of the belt conveyor.

A.4.3.3.4.3.3 The clapper of a differential-type dry-pipe valve should be held off its seat during any test in excess of 345 kPa (50 psi), to prevent damaging the valve.

A.4.3.3.5.4 The special suppression system manufacturer is a good source for training regarding their equipment. Other acceptable training resources can be available.

A.4.3.3.5.5.2 The system could have several end-of-line drains if parts of the system dead end.

A.4.3.3.5.5.3 Deluge sprinklers might need to be flowed more frequently than monthly to keep the sprinkler systems clean. If caps are not used on water spray systems, they also might need to be flowed more frequently than monthly to keep the nozzles clean.

A.4.3.3.6.1 The actuation of a fire suppression system on self-propelled equipment should cause shutdown of the protected equipment.

A.4.3.3.6.1(11) Because exposure to some agents or their decomposition products could be hazardous to personnel, it is recommended that the appropriate NFPA standard for the agent under consideration be consulted to determine the agent's use and limitations, recognizing that the mine environment can make prompt evacuation difficult.

A.4.3.3.6.1(12) A dry chemical system should be inspected every 6 months in accordance with NFPA 17.

A.4.3.3.6.2 Pipe or hose supplying open spray nozzles should be sized to avoid excessive pressure loss. Open nozzles provide a good spray pattern with 6.9 kPa to 137.9 kPa (10 psi to 20 psi) of water pressure at the nozzles. If nozzle pressure exceeds 172.4 kPa (25 psi), additional or larger orifice nozzles can be permitted to be used to increase the water flow. If nozzle pressure is less than 137.9 Pa (20 psi), smaller orifice nozzles should be used to increase the pressure. The objective is to obtain the maximum flow of water at a pressure high enough to provide a reasonable spray pattern.

The water spray should be directed upward to wet the roof over the machine. This prevents the fire from spreading to the coal, which should be the primary objective of the fire protection system. Also, water will fall back down onto the machine, cooling and possibly extinguishing the flames. Alternatively, the nozzles can be directed at the fire hazard areas of the machine. The risk of this method is that the fire could be in an area not covered by the sprays and could spread to the coal.

A.4.3.4.1.1.1 Larger capacity extinguishers that provide more agent and longer discharge time are recommended.

A.4.3.4.1.2.3 It is not the intent of 4.3.4.1.2.3 to allow two lower rated fire extinguishers to be used to achieve a higher overall rating.

A.4.3.4.1.3.2 Visual inspections require documentation only at 6-month intervals.

A.4.3.4.2.1.1 Hydrants should be located to ensure that fire hose can be laid quickly from hydrants, which are located on the water line in any of the entries, through crosscuts to a fire located in parallel entries or crosscuts, rather than being located for convenient use in the entry where the water line is located.

A.4.3.4.2.1.4 Fire hose should be purchased as an entire unit that consists of the hose and couplings. The pressure rating should include both the hose and the couplings.

A.4.3.4.2.1.6 These threads are also referred to as National Pipe Straight Hose (NPSH). National Hose (NH) is also known as National Standard Thread (NST) and National Standard (NS).

Threads of 38 mm (1½ in.) or 50 mm (2 in.) hose couplings should be straight, iron pipe thread, now labeled NPSH. While it is always preferable to use fire hose adapters, NPSH couplings can be attached to standard male pipe threads. This is especially important because of the large number of hydrants needed on water lines.

Where the gasket of a fire hose coupling is in good condition, the coupling should be tightened with bare-hand pressure only. It usually will not leak. Hose wrenches are needed to uncouple hose only. Overtightening couplings with hose wrenches harms the gaskets.

Rocker lug couplings are preferred to pin-type couplings.

Most mines use NPSH threads because the couplings will attach to male pipe threads of the same size.

A.4.3.4.2.1.9 In many fires, fire hose has to be carried to the fire. If manual transport is necessary, the hose should be coiled into "bundles" or "doughnuts," with the male coupling at the center. In this manner, the hose is in proper orientation for use, and the exposed threads of the male coupling are protected. Hose lengths should be limited to 30.5 m (100 ft) or less, because greater lengths make the hose bundle too large and heavy.

It is sometimes preferable to coil bundles or doughnuts of fire hose starting with the approximate center point of the hose at the center of the bundle. A coil made in this manner positions the hose couplings on the outside so the hose can be laid starting at the hydrant moving toward the nozzle or from the nozzle back to the hydrant with equal efficiency.

Where high pressures are a concern, pressure relief devices can be used. The devices can be stored with the hose cache.

A.4.3.4.2.1.11 Consideration should be given to providing caches at intervals of less than 1524 m (5000 ft) where conditions warrant. A single hose cache might satisfy more than one of the required locations.

A.4.3.4.2.2 Fire hose requires special consideration at coal mines. Cotton- or linen-jacketed hose should not be used, as it is subject to mildew attack. Even mildew-treated hose does not endure. Rubber-lined and rubber-jacketed hose resists mildew attack, but this type of hose is heavy, stiff, and expensive. Neoprene-lined, polyester hose with rocker lug couplings is probably the best hose for mine use. The use of pin-type couplings should be avoided because the pins are easily broken or knocked off.

In low coal and where the water supply can deliver about 3.2 L/sec (50 gpm) at proper pressure, 38 mm (1½ in.) hose should be used. Where the water supply is able to provide 378 L/min to 460 L/min (100 gpm to 120 gpm) at proper pressure, 50 mm (2 in.) hose is preferable. Hose of 64 mm (2½ in.) has no advantage over 50 mm (2 in.) hose, and the extra weight and cost of 64 mm (2½ in.) hose is considerable.

Many mines have standardized on 38 mm (1½ in.) fire hose, even though their water lines can supply substantially more water than is required to get proper discharge from a 38 mm (1½ in.) hose nozzle. Some of these mines provide at least two valved connections (hydrants) in operating areas so that more than a single 38 mm (1½ in.) hose line can be used if needed. In some cases, short lengths of pipe with two or more hydrants are available for use at other points along the water lines. These multiple hydrants can be put in the line at joints where the water line is joined with grooved couplings.

While the total water flow of two 38 mm (1½ in.) hose lines is about the same as one 50 mm (2 in.) hose line, in the opinion of many experienced mine fire fighters, two 38 mm (1½ in.) hose lines provide greater flexibility during a fire-fighting operation.

A.4.3.4.6 While regulatory agencies have legal powers and responsibilities in a mine fire situation, the mine operator should have a preplanned organization capable of managing an effective fire-fighting effort. This organization has to be prepared, resolute, and capable. As part of periodic training, the organization should conduct fire drills that involve all levels of mine management. The regulatory agencies also should be invited to participate in fire drills. Training develops management capability and promotes cooperation between concerned agencies and mine management.

A.5.2 Fires adversely affect all types of self-propelled and mobile surface mining equipment, including, but not limited to, trucks, front-end loaders, crawlers, drills, shovels, and draglines. Most fires occur on or near engine exhaust systems, high-speed drive lines, malfunctioning high-pressure–high-temperature hydraulic systems, or faulty electrical components.

Total elimination of fire hazards is impossible, because sources of ignition and fuel for fires are inherent in the basic equipment design. The problem is further complicated by the collection of environmental debris. Therefore, efforts to reduce fire losses must be aimed at fire prevention and fire suppression.

To improve fire protection and prevention on surface mining equipment, some manufacturers of mining equipment emphasize the reduction of the fire potential of specific items in the original design of their equipment. Such items include turbochargers, exhaust manifolds and exhaust pipe shielding and insulation, location of combustible and flammable liquid reservoirs, and hydraulic and fuel-line routing.

Most surface mining equipment is required to have at least one hand-portable extinguisher mounted in a readily accessible location. Extinguishers are most effective when used by trained operators. However, considering the size and configuration of machines found at a mine, fires can be difficult or impossible to fight with a hand-held extinguisher. For this reason, fire suppression systems have been developed to aid in suppressing those fires that are hard to access and thereby to reduce “off-road” equipment fire losses.

The key to operator protection is early detection of fires to provide a warning to the operator, fuel shutoff to minimize fuel for the fire, and fire suppression during its earliest stages. Specialized systems to perform these functions can be required to protect the operator and the machines. To be totally effective, however, system operation must be fully understood by owners and operators, and provisions must be made for periodic inspection and maintenance.

Fire suppression systems, including hand-portable extinguishers, offer the mining industry a cost-effective tool by which personnel and investments in mining equipment can be protected.

A.5.3.4.1 This paragraph is not intended to include the boom of a dragline or shovel.

A.5.3.4.8(8) The same record tag or label can also indicate if recharging was performed.

A.5.3.5.2.1 A dry-chemical system is the preferred system for these areas.

A.5.3.5.2.2 Smoke detectors are not recommended because of the harsh environment.

A.5.3.5.3.1 Automatic systems are not necessary if the area is easily accessible for manual fire fighting.

A.5.3.5.4.2 Carbon dioxide would not be the best choice for fighting this type of fire due to the potential for the gas to be dispersed before the oxygen concentration is reduced enough to affect the fire.

For transformers over 5000 kVA, a fixed fire suppression system is recommended.

A.5.3.5.5.4 Based on the condition of the equipment, a higher frequency than annual scanning might be needed.

A.5.3.6.6 Equipment in this category is generally a vehicle weight of 90,720 kg (200,000 lb) or more and the size of a Hitachi 1800, Caterpillar 5230, Komatsu PC1000-6, Liebherr R984, DeMag H95, and Hitachi 1100.

A.5.3.8.1.1 Depending on the size of the vehicle and size of the fire, a 9.1 kg (20 lb) fire extinguisher could be more effective.

A.5.3.8.2.5 NFPA and manufacturers require 6-month inspections.

A.5.3.8.3.2 The following are examples of large equipment:

(1) Track dozer of 300 horsepower or more or 31,752 kg (70,000 lb) weight or more (e.g., Caterpillar D8R)
(2) Front-end loader of 400 horsepower or more and vehicle weight of 45,360 kg (100,000 lb) (e.g., Caterpillar 988)
(3) Wheel dozer of 300 horsepower or more and vehicle weight of 27,216 kg (60,000 lb) or more (e.g., Caterpillar 824G)
(4) Grader of 275 horsepower or more and vehicle weight of 24,948 kg (55,000 lb) or more (e.g., Caterpillar 16H)
(5) Pull-type scraper of 450 horsepower or more and vehicle weight of 44,453 kg (98,000 lb) or more (e.g., Caterpillar 631E)
(6) Scraper with push/pull twin engine of 450 horsepower and 490 horsepower or more and vehicle weight of 51,257 kg (113,000 lb) or more (e.g., Caterpillar 637E)

(7) Blast hole drill of 360 horsepower or more and weight of 30,845 kg (68,000 lb) or more (e.g., Ingersol-Rand DM-30)

A.5.3.8.3.3(4) Depending on the size of the equipment, additional ground-level manual actuators could be needed to provide quick access for manual activation of the system.

A.5.3.8.3.7 Six months is required by NFPA standards and manufacturers. The fire suppression system manufacturer is a good source for proper training regarding their equipment. Other acceptable training resources might be available.

A.6.1.2.2 Pneumatic coal-cleaning systems employ low-pressure air, usually pulsed, to effect a separation between relatively dry coal and mechanically associated impurities. The coal is usually 19 mm (¾ in.) and smaller, with up to 4 percent surface moisture. The pickup of fines from the feed coal in the process air stream creates a potentially explosive mixture. However, approximately 2 m/sec (400 ft/min) air velocity dissipates methane from the coal and, in practice, reduces explosion and fire hazards to very low proportions inside the equipment. Nonetheless, in the area surrounding the equipment, a potential fire hazard exists from unintentionally vented fine coal, and the potential for all hazards increases where the cleaners are preceded by thermal dryers.

A.6.2.1.4 Electrical components of ventilation equipment installed in the open and separated from the ventilation air being pulled from the hazardous area can be permitted to be considered nonhazardous.

A.6.2.1.4.1 Electrical equipment classified as "permissible" is certified as meeting the requirements of 30 CFR Part 18, Chapter 1.

A.6.2.1.6 Approved, intrinsically safe electrical equipment can be permitted to be used in any areas classified as "hazardous."

A.6.2.1.7 The intent of this requirement is the avoidance of arcing ignition sources resulting from differing electrical potentials between metal structural elements or between any such element and ground. The metal building elements might include the building frame (beams, columns, etc.), roof panels, building or control room panels, building utilities such as piping, ducts, or conduit, or other items. The objective of connecting metal parts to a ground is recognized as the best means of avoiding arcing between building elements or between those elements and ground or other grounded items. Any arrangement that provides both a good ground and a system of metal continuity from the ground to all metal elements achieves the intent. Where construction provides solid, secure metal-to-metal contact, the necessary continuity normally is provided. In cases where grounding is in question, resistance measurements should be made between the most remote elements or the most suspected elements or both and ground. If tests show less than 0.1 ohm resistance to ground, the arrangement can be permitted to be considered satisfactory. Testing should be done during dry weather when ground moisture is at a minimum. If lightning protection is provided, additional bonding of major building members to lightning system conductors might be required. Such bonding, however, can be permitted to serve the grounding needs covered by this requirement.

A.6.2.2.3.1 For further information, see NFPA 68.

A.6.2.2.5 Round ducts should be used wherever possible. All ducts should limit the number of bends and irregularities that could interfere with free airflow. Rectangular ducts should be used only where clearance prevents the use of round ducts. Rectangular ducts should be made as nearly square as possible to minimize the deposit of combustible materials.

A.6.2.3.1 Provision of 0.1 m^2 (1 ft^2) of building vent for each 2.3 m^3 (80 ft^3) of volume or space in which an explosion might occur generally is considered adequate for coal preparation plants, although the amount of venting needed to minimize structural damage that might be caused by a dust explosion varies according to the strength of the building, extent of the hazard, location and distribution of vents, properties of the coal dust, and other factors. Reference should be made to NFPA 68 in the sizing of explosion vents.

A.6.2.4 Bulk storage of Class II combustible liquids should be located outside the preparation plant and should be appropriate for the nature of the liquids and the quantities being stored. Tanks within the preparation plant should be of limited size, holding no more than the quantities needed for one and one-half shifts of operation. Each tank should be fitted with an overflow pipe of ample size to return the full volume of the transfer pump to the bulk storage tank. Tanks within the preparation plant should be isolated from the rest of the plant. The isolated area containing the tanks should be protected with an automatic sprinkler system that can provide a density of 6.1 L/min · m^2 (0.15 gpm/ft^2) over the entire area with all heads flowing. The floors beneath these tanks should have curbs, adequate slope, and floor drains able to handle the liquid from the tanks as well as the discharge from all automatic sprinklers.

A.6.3 A typical coal preparation plant process begins with raw coal entering a breaker where coal and undesirables, such as rocks, are separated. From the breaker, the coal is crushed and screened to size and then transferred, usually by belt conveyor, to the washing process. During the washing process, the dirty coal is separated from clay and rock by water washing or by chemical flotation. From the washing process, the clean, wet coal is conveyed to a drying process whereby surface moisture is reduced. A variety of dryers can be used, such as centrifugal, fluidized bed, or thermal disk processors. From the drying process, the clean, dry coal is conveyed to storage facilities, such as bins, silos, and coal barns, and then loaded out for transport or shipment by rail, surface, or conveyor for downstream use. *(See Figure A.6.3.)*

A.6.3.1.10 Phosphorescent exit signs can be used to identify building exits.

A.6.3.1.12.1 Refer to NFPA 850 for guidance on spacing transformers from buildings.

A.6.3.1.12.2 *NFPA 70* requires a 3-hour fire-rated room for transformers with combustible oil. This can be decreased to a 1-hour rated room if automatic fire suppression is provided.

A.6.3.1.12.3 Refer to NFPA 850 for guidance on fire barriers and spill containment for transformers.

A.6.3.2.2.1 Examples of where fixed protection might be needed in coal preparation include conveyor belts, galleries, tunnels, beneath bins, transfer houses, silo head houses, dust collectors, rotary compressors, and other areas such as switch gear rooms, control rooms, change houses, and combustible and flammable liquids storage or process areas. These areas should be considered ordinary hazards. Areas with noncombustible construction or noncombustible contents are areas where fixed protection might not be needed.

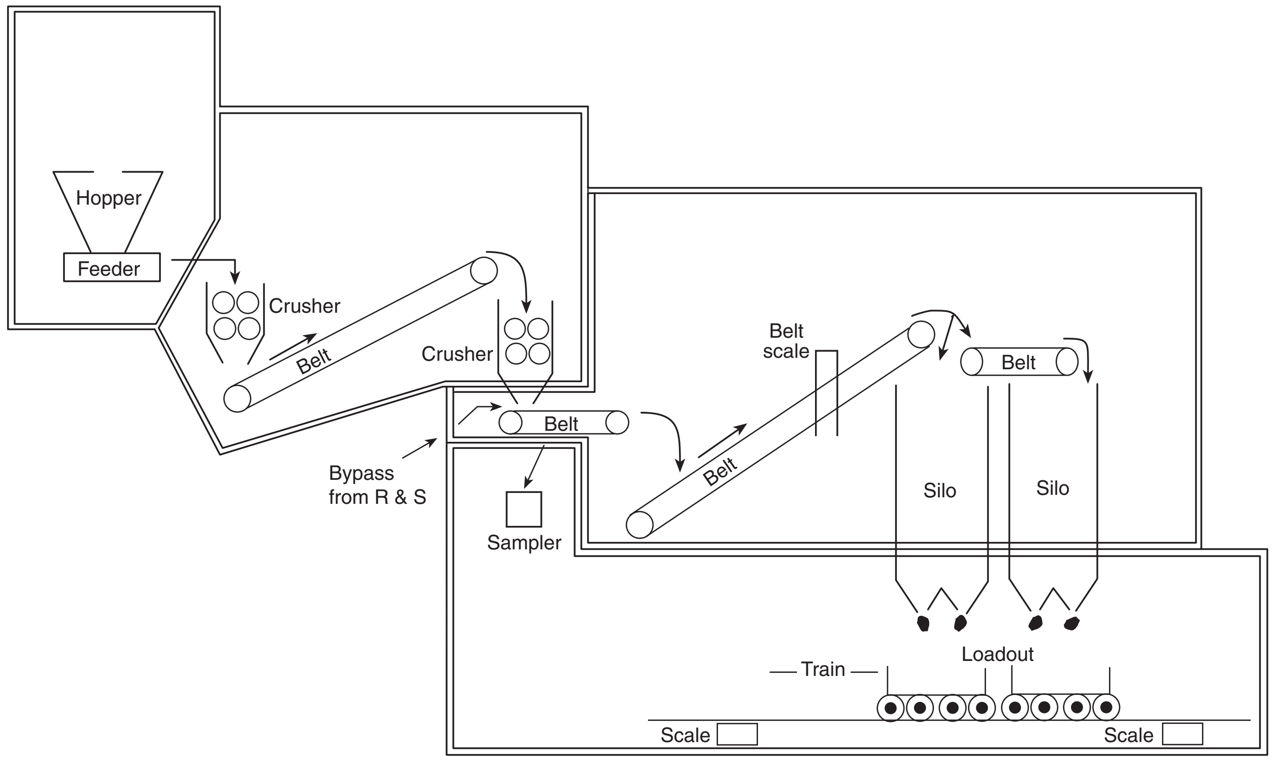

FIGURE A.6.3 Typical Coal Preparation Plant.

A.6.3.2.3.1 Standpipes should be located in exterior stairways. Where exterior stairways are not provided, standpipes should be located as close to stairways as practicable. This arrangement will provide fire fighters with ready access to fire-fighting water. Ideally, plants should have exterior stairways with standpipes on opposite ends of the plant. These stairways will provide fire fighters with two angles of attack.

When applying water, fire fighters should exercise care to avoid the use of solid hose streams in locations where the streams could create explosions by disturbing dust deposits.

Fire hose should not be used for washdown purposes.

In plants where the vibration anticipated is sufficient to cause movement of the fire protection system resulting in the wear of water piping at the hangers, it might be necessary to install vibration absorbers.

A.6.3.2.4.1 A readily available supply can include a dedicated fire protection water supply, a pond or other large body of water, an industrial process water system, or large water trucks (tankers). If water trucks (tankers) are used, they should be of a capacity and quantity to deliver a continuous source of water for the duration of the fire-fighting effort. Personnel should be trained in emergency vehicle operation and mobile water supply shuttle procedures. If an impounded body of water is provided, it should be close and accessible enough to the protected property to allow fire fighters a quick response.

A.6.3.2.4.4 Chapter 8 and Appendix G of NFPA 1142 outline suggested methods for determining the estimated water supply (fire flow) that can be necessary for fire-fighting purposes.

A.6.3.2.6.3 A gaseous fire suppression system can also be considered for important motor control center (MCC) rooms or for rooms that contain input/output (I/O) cabinets. A gaseous fire suppression system or smoke detector system can also be considered for the preparation plant control room.

A.6.4.1 Thermal coal dryers can be of any type that conforms to the requirements of Section 6.4, including rotary dryers, continuous carrier dryers, vertical tray and cascade dryers, multilouver dryers, suspension or flash dryers, and fluidized bed dryers. These direct-fired convection-type dryers constitute the majority of currently operational units. Almost all these units utilize special direct-fired air heater–type furnaces, usually coal fired by stokers or by pulverized fuel systems.

A.6.4.2.5 For further information, see NFPA 68.

A.6.4.2.7 Thermal oil systems are used in coal preparation plants to indirectly dry coal in thermal disk processors. Severe losses have occurred due to lack of inadequate sprinkler protection, poor siting and confinement of expansion and storage tanks and heaters, improper piping arrangement, and inadequate interlocks and controls. Even though the woodworking industry has unique equipment that needs hot oil applications, the hot oil heating and distribution systems are similar, and the concepts provided in NFPA 664 can be utilized for the coal preparation industry.

Chapter 8 of NFPA 664 is the primary reference in NFPA standards for thermal oil systems used in industrial processes. While NFPA 664 addresses loss prevention in a specified occupancy (wood products), other standards might be applicable to any industrial process featuring thermal oil systems.

A.6.4.5 Guidance for design of vent ducts is provided in NFPA 68.

A.7.1 Gas and electric welding or cutting procedures should be in accordance with NFPA 51B.

A.7.1.2.1 For additional information, see NFPA 326 and AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting Containers and Piping That Have Held Hazardous Substances.*

A.7.1.2.5 If the coal is susceptible to spontaneous combustion, water should not be used to wet down the area. Rock dust should be used.

A.7.1.4.1 For information on labeling of compressed and liquefied gas cylinders, see CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers.*

A.7.1.5.9 For information on labeling of compressed and liquefied gas cylinders, see CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers.*

A.7.3.1 Buried tanks do not create a fire hazard but preferably should be at least 1.5 m (5 ft) from all buildings.

A.7.3.1.2 Information on the design and construction of atmospheric tanks can be found in API 650, *Standard for Welded Steel Tanks for Oil Storage*; UL 142, *Standard for Steel Above-Ground Tanks for Flammable and Combustible Liquids*; or UL 80, *Standard for Steel Inside Tanks for Oil Burner Fuels or Other Combustible Liquids.*

Low pressure tanks and pressure vessels can be permitted to be used as atmospheric tanks.

A.7.3.2 This can be accomplished by diking or drainage with remote impounding. See 22.11.2 of NFPA 30 for additional details.

A.7.3.3.4 For additional information see Annex B of NFPA 30.

A.7.3.3.6 For additional information see Section 27.8 of NFPA 30.

A.7.4.5 Combustible liquid storage in drums or totes preferably should be stored outside.

A.7.5.1.1 Electrical equipment classified as "permissible" is certified as meeting the requirements of 30 CFR Part 18, Chapter 1.

A.7.6.2.2 Containers and portable tanks for combustible liquids authorized by the U.S. Department of Transportation should be acceptable as storage containers.

A.7.6.2.10 Information on the design and construction of pressure vessels can be found in the ASME *Boiler and Pressure Vessel Code*, "Code for Unfired Pressure Vessels," Section VIII, Division I.

A.7.6.2.13 Information on venting can be found in API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks.*

A.7.6.3 The terms *transfer* and *transport* are used synonymously to mean movement of combustible liquid in closed containers, tanks, safety cans, or pipelines between underground locations.

A.7.6.3.10 The greatest risk of fire involving substantial quantities of combustible liquids exists when rail supply cars are being moved, especially on a trolley wire–powered rail system. In contrast, cars parked where trolley and feed wire are absent or de-energized represent a distinctly lower risk. Limiting the storage of lubricants in operating areas to a 3-day rather than a 1-day supply reduces the frequency of transport and, as a result, the overall risk of fire.

A.7.6.3.12 Where pressurized pipeline systems are used for combustible liquid transfer, consideration should be given to providing a pressure-sensing interlock downstream of the transfer pump discharge. This interlock should be suitable for Class I, Division 2 locations and should be arranged to shut down the pump immediately upon loss of line pressure.

A.7.6.5 The principal Class II combustible liquid used in a coal mine is diesel fuel.

A.7.6.5.2.7 There are no listed doors for storage areas in underground mines.

A.7.6.5.2.10 Information on tank foundations can be found in Appendix E of API 650, *Standard for Welded Steel Tanks for Oil Storage*, and Appendix B of API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks.*

A.7.6.8 No requirements for bonding or grounding to dissipate static electricity are included in NFPA 30, which does not require bonding or grounding for combustible liquids handled at temperatures below their flash points.

It is recognized, however, that certain conditions can exist that could necessitate bonding or grounding, such as those of temperature and altitude, which can reduce the flash point of diesel fuel.

For additional information on static electricity, see NFPA 77.

A.8.5 A manifold system should be considered for all new installations in shop buildings.

A.8.6.2 Automatic sprinkler protection provides the most affordable fire protection. Where water supplies are adequate, sprinkler protection should be strongly considered for office and warehouse occupancies.

A.8.6.3 If an adequate water supply is available, a fire hydrant should be installed within 15.2 m (50 ft) of the warehouse, shop, and office building.

A.8.6.6 For office buildings, a minimum of one 4.6 kg (10 lb) extinguisher should be provided for every 279 m^2 (3000 ft^2) of building area. Travel distance from any point to the nearest extinguisher should not exceed 22.9 m (75 ft). For shop and warehouse areas, a minimum 9.1 kg (20 lb) extinguisher should be provided for every 22.9 m (75 ft) travel distance within the building.

Large-wheeled, dry-chemical or foam extinguishers should be considered for shop and warehouse areas. The type of fires that can occur in these areas can be too large to be handled by a hand-held extinguisher.

A.9.1 Unless the conveyor is very long, burning coal on a moving belt is not likely to ignite the belt. Also, if the belt should ignite, the burning of the belt is likely to be extinguished after the burning coal has been discharged and the belt continues to run. No reports of running conveyor belts in and around preparation plants that have caught fire and burned have been located. Every reported case of belts catching fire and burning has occurred after the belts have been stopped.

Some preparation plants use the froth flotation process to separate impurities from fine coal. The agents typically used in froth flotation are Class II combustible liquids. The coal recovered from the froth cells is coated minimally with these agents. It has been found that frothed coal carried on conveyor belts will coat the belting with the agents, causing the coated belting to ignite easily and the flame spread to become significantly more rapid than usual. It is recommended that belts that carry frothed coal be protected with automatic sprinklers. While the froth flotation process operates as a water slurry and presents no risk of fire, the reagents normally used are No. 2 fuel oil and methyl isobutyl carbinol (MIBC), which are Class II combustible liquids.

Fortunately, evidence of heating is easy to detect. During the early stage of heating, the odor is unmistakable. When heating is more advanced, smoke and steam also might be apparent. If the hot coal is in an exposed storage pile, the hot material can be dug out and wetted. If the hot material has to be loaded onto a conveyor belt, the loading areas should be hosed down, and water should be applied to the hot material before or as it is loaded onto the belt.

Tunnels under silos or storage piles should be ventilated adequately and should be protected with a system of automatic sprinklers. Separate hose for fire fighting should be provided. The main tunnel should have exit routes at opposite ends of the tunnel.

A.9.1.1 The U.S. Mine Safety and Health Administration standards found in 30 CFR for fire-retardant conveyor belt materials should be used as a guide. Fire-retardant belt materials will burn and, therefore, might require additional fire protection.

Stockpile conveyors, reclaim conveyors, and conveyors going to loadout silos or bins should be fire-resistant belt.

Rip detection also can be considered for long runs or critical belt systems. Critical factors to be considered should be the impact on production if the belt is lost, the cost of the belt itself, availability of spare belting, length of time to repair the belt, and alternatives to bypass the belt if it is lost.

A.9.1.2 A steel deck, which often is placed between the top and bottom strands of a belt conveyor, should not be used. It is recommended that existing decks be removed.

Belt galleries that use supporting trusses with substantial length of span should be set entirely beneath the belt so that, in the event of a fire, the loaded structural members of the truss are not seriously exposed to the heat of the burning belt. The supports for the troughing and return idlers should not be structural parts of the truss. The covering for the belt should be partially open on the walkway side, allowing access to the belt and to the belt idlers for maintenance and fire fighting.

Belts that are located entirely within relatively long-span supporting trusses should be protected by a fixed fire protection system.

Provision for removing burning coal to a safe area utilizing conveyors should be considered. These conveyors might require manual water spray to cool smoldering coal. Flanged openings can be used for removing burning coal if adequate planning and equipment have been provided.

A.9.4.3 To minimize potential frictional ignition, alignment switches can be permitted to be provided at intervals sufficient to prevent the belt from contacting such materials.

A.9.4.6.3.1.3 The flexible hose should be attached at a point where it is least exposed to a fire ignition source, such as the drive rollers.

A.9.4.6.3.2(8) Pipe hangers should be designed to support five times the weight of the water-filled pipe plus 114 kg (250 lb) at each point of piping support. Hanger rods should be at least 9.5 mm (3⁄8 in.) thick for pipe up to 102 mm (4 in.). U hooks should be at least 8 mm (5⁄16 in.) thick for pipes up to 50.8 mm (2 in.). Eye rods should be at least 9.5 mm (3⁄8 in.) thick for pipe up to 102 mm (4 in.). This information is taken from Section 9.1 of NFPA 13.

A.9.4.7.4 Adjustable fog nozzles should be provided for all hoses.

A.9.4.8 Transfer points can also require dust suppression.

A.9.5 The key concept in coal storage is to prevent spontaneous combustion. Preventing spontaneous combustion requires all of the following:

(1) Eliminating air entrainment in the coal
(2) Eliminating heat sources near the storage
(3) Preventing moisture in the coal

A.10.2.2 This process can be accomplished by pressurization, sealing the room, or air filtration. Housekeeping and coal-wetting agents also can be used to reduce the coal dust in the room. Coal dust should not be allowed to accumulate inside electrical cabinets.

A.10.4.2 CO_2 systems are not recommended for occupied areas. If a CO_2 system is used, it should have a maintenance lockout.

A.10.5.1 If the building has a standpipe system, a fire hose can be used as a substitute for a fire extinguisher as detailed in NFPA 10.

A.11.1 For mines where the response time of the public fire department is in excess of 30 minutes, an emergency organization that is trained in basic fire-fighting techniques should be developed. Training should consist of the use of large extinguishers and small hose streams 38 mm (1½ in.) to provide immediate fire-fighting efforts until the local fire department arrives. This training would also include procedures for using fire hose off a water truck or any other nearby sources of water. A crew consisting of at least five members for each shift should be trained in fire-fighting operations. Detailed fire-fighting procedures should be developed for each type of potential fire, for example, dragline, shovel, mobile equipment, warehouse, and office. Training should be conducted based on those scenarios.

A.11.2.5.1 Two portable water cars, readily available, can be used in place of the water lines prescribed in 11.2.5.1.

A.11.2.5.5 A multiple hydrant is a short length of 76.2 mm (3 in.) or 102 mm (4 in.) pipe, usually with three valved outlets (hydrants) to which fire hose lines can be connected. If the mine is equipped with a foam generator for fighting fires, there should be an additional outlet to feed the generator. An alternative is to assemble the hydrants from grooved pipe fittings that also have threaded tee connections to which the valved outlets are connected. The multiple hydrants should have adapters that allow them to be connected to any of the pipe sizes in use at the mine.

A.11.3.1 Surface fire-fighting teams should be trained and equipped in accordance with 11.2.2.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2015 edition.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems*, 2013 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2014 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.

NFPA 70®, *National Electrical Code®*, 2014 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 2015 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2012 edition.

NFPA 850, *Recommended Practice for Fire Protection for Electric Generating Plants and High Voltage Direct Current Converter Stations*, 2015 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, 2012 edition.

NFPA *Fire Protection Handbook*, 20th edition, 2008.

B.1.2 Other Publications.

B.1.2.1 API Publications. American Petroleum Institute, 1220 L Street NW, Washington, DC 20005-4070.

API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, 2008.

API 650, *Standard for Welded Steel Tanks for Oil Storage*, 2012.

API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks*, 2009.

B.1.2.2 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, 2013.

B.1.2.3 AWS Publications. American Welding Society, 550 NW LeJeune Road, Miami, FL 33126.

AWS F4.1, *Recommended Safe Practices for the Preparation for Welding and Cutting Containers and Piping That Have Held Hazardous Substances*, 2007.

B.1.2.4 CGA Publications. Compressed Gas Association, 14501 George Carter Way, Suite 103, Chantilly, VA 20151-2923.

CGA C-7, *Guide to the Preparation of Precautionary Labeling and Marking of Compressed Gas Containers*, 2007.

B.1.2.5 MSHA Publications. Mine Safety and Health Administration, National Mine Health and Safety Academy, 1301 Airport Road, Beaver, WV 25813-9426.

"Fire Accident Abstract."

"Fire Accident Report."

"The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," report prepared by an interagency task group for MSHA, 1985.

"Injury Experience in Coal Mining."

B.1.2.6 NIOSH Publications. National Institute for Occupational Safety and Health, 1600 Clifton Road, Atlanta, GA 30333.

NIOSH IC 9452, *An Underground Coal Mine Fire Preparedness and Response Checklist: The Instrument*, 2000.

NIOSH IC 9470, "Analysis of Mine Fires for All Underground and Surface Coal Mining Categories: 1990–1999," 2000.

B.1.2.7 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 80, *Standard for Steel Tanks for Oil Burner Fuels or Other Combustible Liquids*, 2007, revised 2009.

UL 142, *Standard for Steel Above-Ground Tanks for Flammable and Combustible Liquids*, 2006, revised 2010.

B.1.2.8 USBM Publications. U.S. Bureau of Mines, Publications, National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

Report No. H0122086, "Suppression of Fires on Underground Coal Mine Conveyor Belts."

RI 9380, "Fire Detection for Conveyor Belt Entries," 1991.

RI 9451, "Effect of Pressure on Leakage of Automatic Sprinklers," 1993.

RI 9538, "Performance of Automatic Sprinkler Systems for Extinguishing Incipient and Propagating Conveyor Belt Fires Under Ventilated Conditions," 1995.

RI 9570, "Hazards of Conveyor Belt Fires," 1995.

B.1.2.9 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 30, Code of Federal Regulations, Part 18, Chapter 1.

Title 30, Code of Federal Regulations, Part 18.65.

Title 30, Code of Federal Regulations, Part 75, 1103-4.

Title 30, Code of Federal Regulations, Part 75, 1107-13.

B.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

B.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

Fire Protection Guide to Hazardous Materials, 2010.

NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*, 2015 edition.

NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*, 2015 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2012 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2013 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2013 edition.

NFPA 69, *Standard on Explosion Prevention Systems*, 2014 edition.

NFPA 385, *Standard for Tank Vehicles for Flammable and Combustible Liquids*, 2012 edition.

NFPA 505, *Fire Safety Standard for Powered Industrial Trucks Including Type Designations, Areas of Use, Conversions, Maintenance, and Operations*, 2013 edition.

NFPA 1963, *Standard for Fire Hose Connections*, 2014 edition.

B.2.2 Other Publications.

B.2.2.1 ACGIH Publications. American Conference of Governmental Industrial Hygienists, 1330 Kemper Meadow Drive, Cincinnati, OH 45240-1634.

Industrial Ventilation: A Manual of Recommended Practice for Design, 28th edition, 2013.

B.2.2.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI A92.2, *Vehicle-Mounted Elevating and Rotating Aerial Devices*, 2009.

ANSI A92.3, *Elevating Work Platforms, Manually Propelled*, 2006.

ANSI B30.5, *Mobile and Locomotive Cranes*, 2011.

B.2.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester*, 2010.

ASTM D86, *Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure*, 2012.

ASTM D93, *Standard Method of Test for Flash Point by the Pensky-Martens Closed Tester*, 2012.

ASTM D323, *Standard Method of Test for Vapor Pressure of Petroleum Products (Reid Method)*, 2008.

ASTM D3278, *Standard Test Methods for Flash Point of Liquids by Small Scale Closed-Cup Apparatus*, 2011.

ASTM E136, *Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

B.2.2.4 IEEE Publications. IEEE, Inc., Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE Standard 446, *Recommended Practice for Emergency and Standby Power Systems for Industrial and Commercial Applications*, 1995.

B.2.2.5 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J53, *Minimum Performance Criteria for Emergency Steering of Wheeled Earthmoving Construction Machines, Standard*, 1993.

SAE J185, *Access Systems for Off-Road Machines, Standard*, 2003.

SAE J925, *Minimum Access Dimensions for Construction and Industrial Equipment*, 1993.

deLime, T. L., "Improved Fire Protection for Off-Highway Equipment," Society of Automotive Engineers Off-Highway Vehicle Meeting, Milwaukee, Sept. 1979, SAE 790882.

Jewett, J., "Fire Suppression Systems," Society of Automotive Engineers Off-Highway Vehicle Meeting, Milwaukee, Sept. 1979, SAE 790779.

Johnson, G. A., "Improved Fire Protection Systems for Surface Coal Equipment," Society of Automotive Engineers Off-Highway Vehicle Meeting, Sept. 1977, SAE 770744.

Pomroy, W. H., "Improved Automatic Fire Protection Systems for Off-Highway Mine Vehicles," Society of Automotive Engineers Off-Highway Vehicle Meeting, Milwaukee, Sept. 1979, SAE 790880.

B.2.2.6 Former U.S. Department of Interior Bureau of Mines Publications. The following former Bureau of Mines reports and articles are available for Open File (OFR) inspection at the following locations: National Institute for Occupational Safety & Health (NIOSH) Facilities, P.O. Box 18070, Pittsburgh, PA 15326; U.S. Geological Survey, Reston, VA; and the National Mine Health and Safety Academy, Beaver, WV. They also may be obtained directly from the National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

Note: Publications marked with an asterisk provide information on fire risk assessment.

Report No. H0122086, "Suppression of Fires on Underground Coal Mine Conveyor Belts."

Report No. J0275008, "Annotated Bibliography of Coal Mine Fire Reports."

Baker, R. M., "An Annotated Bibliography of Metal and Nonmetal Mine Fire Reports," 1980. U.S. BuMines OFR 68 (1)-(3)-81. NTIS PB 81-223711.

*Kasten, A. E., "Develop and Test an Automatic Fire Control System for Surface Mining Machinery, Volume I, Systems Development," 1977. U.S. BuMines OFR 119-78. NTIS PB 293 983.

Lease, W., "Development and Testing of a Fire Protection System for Coal Augers," 1975. U.S. BuMines OFR 25-76. NTIS PB 249-865.

Lease, W., "Development, Installation, and Testing Services for an Automatic, Point-Type Thermal Sensor Fire Protection System on a Mining Dozer," 1976. U.S. BuMines OFR 71-77. NTIS PB 266075/AS.

*Lease, W. D., "Development of an Automatic Fire Protection System for Surface Vehicles," 1981. U.S. BuMines OFR 73-82. NTIS PB 82-215765.

*McDonald, L. A., "Development and Test of an Automatic Fire Control System for Surface Mining Machinery, Volume II, Reliability Testing," 1981.

*McDonald, L. A., "Improved Fire Protection System for AN-FO Haulers and Loaders," 1982. U.S. BuMines OFR 46-83.

*Stevens, R. B., "Improved Sensors and Fire Control System for Mining Equipment," 1972. U.S. BuMines OFR 25 (1)-(2)-74. NTIS PB 232405 and NTIS PB 232406.

Stevens, R. B., "Automatic Fire Sensing and Suppression System for Mobile Mining Equipment," 1978. U.S. BuMines OFR 34-79. NTIS PB 294 731.

The following Bureau of Mines reports are available from the Section of Publications, Bureau of Mines, 4800 Forbes Avenue, Pittsburgh, PA 15213.

Johnson, G. A., "Automatic Fire Protection Systems for Large Haulage Vehicles; Prototype Development and In-Mine Testing," 1978. U.S. BuMines IC 8683.

*Pomroy, W. H., "Automatic Fire Protection Systems for Surface Mining Equipment," 1980. U.S. BuMines IC 8832.

Pomroy, W. H., "A Statistical Analysis of Coal Mine Fire Incidents in the United States from 1950 to 1977," 1980. U.S. BuMines IC 8830.

*Pomroy, W. H., "Economic Analysis of Surface Mining Mobile Equipment Fire Protection Systems," 1982. U.S. BuMines RI 8698.

U.S. BuMines Mining Research Staff, "Metal Mine Fire Protection Research," 1977. BuMines IC 8752.

U.S. Mines Technology News, No. 27, "Automatic Fire Protection for Surface Coal Augers," 1976.

U.S. BuMines Technology News, No. 50, "Bulldozer Fire Protection," 1978.

U.S. BuMines Technology News, No. 70, "Fire Protection for Blasthole Drill," 1979.

U.S. BuMines Technology News, No. 74, "Fire Protection for Front-End Loaders," 1979.

U.S. BuMines Technology News, No. 77, "Loading Shovel Fire Protection," 1980.

U.S. BuMines Technology News, No. 78, "Fire Protection for Hydraulic Excavators," 1980.

U.S. BuMines Technology News, No. 79, "Automatic Fire Protection for Mining Trucks," 1980.

U.S. BuMines Technology News, No. 106, "Dragline Fire Protection," 1981.

U.S. BuMines Technology News, No. 107, "An-Fo Hauler Fire Protection," 1981.

B.2.2.7 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 30, Code of Federal Regulations, Part 75, 1101-14.

B.2.2.8 Other Publications. *Accident Prevention Manual for Industrial Operations*, National Safety Council, 425 North Michigan Avenue, Chicago, IL 60611.

Jenson, R., ed., "Fire Protection for the Design Professional," 1975. Cahners Books, 89 Franklin Street, Boston, MA 02110.

B.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 122

Standard for

Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities

2015 Edition

This edition of NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, was prepared by the Technical Committee on Mining Facilities. It was issued by the Standards Council on November 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 122 was approved as an American National Standard on December 1, 2014.

Origin and Development of NFPA 122

In 1978 the Technical Committee on Mining Facilities, through its membership and current Mine Safety and Health Administration regulations, identified the need for guidance in storage and handling of flammable and combustible liquids in underground nonmetal mines. The first edition of NFPA 122 was approved in 1986 as a result and was titled NFPA 122, *Storage of Flammable and Combustible Liquids Within Underground Metal and Nonmetal Mines (Other than Coal).* The second edition was issued in 1990 and included a variety of minor editorial changes to provide consistency with the other NFPA Mining Facilities documents.

The 1995 edition was a complete revision that focused the document on the overall fire protection of metal and nonmetal mines, as indicated by the document's new title, NFPA 122, *Standard for Fire Prevention and Control in Underground Metal and Nonmetal Mines.* Furthermore, this edition incorporated the requirements that were previously included in NFPA 124, *Standard for Fire Protection of Diesel Fuel and Diesel Equipment in Underground Mines*, which was withdrawn. Further changes included editorial corrections and revisions that provided consistency with other NFPA mining-related standards.

The 2000 edition of the standard was reconfirmed by the technical committee. There were no technical changes made. The fire risk assessment material in Appendix A was editorially moved to Appendix B.

In 2004, the Technical Committee reorganized the mining standards and combined NFPA 121, *Standard on Fire Protection for Self-Propelled and Mobile Surface Mining Equipment*, with NFPA 122. The committee also added a new Chapter 13, Fire Protection of Surface Metal Mineral Processing Plants. The committee incorporated the concept of conducting a fire risk assessment throughout the standard.

For the 2010 edition, the technical committee assigned a task group the responsibility of revising NFPA 122 to update the existing fire protection requirements that were included in portions of existing Sections 4.3 and 7.4 to improve operator safety and the reliability of the required suppression systems. Similarly, Chapter 12, Fire Prevention and Fire Protection of Surface Mining Equipment, was completely revised to make it consistent with fire protection industry practices and the updated provisions in NFPA 120, *Standard for Fire Prevention and Control in Coal Mines.*

Concurrently, another task group was assigned the responsibility of revising NFPA 122 to include fire protection requirements for hydro-metallurgical solvent extraction (SX) plants. This resulted in two new sections being added into Chapter 13, Section 13.18 for new and existing hydro-metallurgical solvent extraction (SX) plants and Section 13.19 for new hydro-metallurgical solvent extraction (SX) plants. Sections 13.18 and 13.19 include a fire risk assessment of the facility and requirements for fixed fire suppression systems. To support these new sections on hydro-metallurgical solvent extraction (SX) plants, additional references and definitions were added to Chapters 2 and 3, respectively.

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The Metal/Nonmetal Mining Task Group for the 2010 edition consisted of the following members: Larry Moore, Chair, FM Global; Steve Behrens, Swiss Re; Dennis Brohmer, Tyco Fire Suppression & Building Products; J. J. Kenny, Marsh; L. Harvey Kirk, MSHA; Mario Orozco, Zurich; Pierre Tousignant, QIT Quebec; and Mark Yarbro, Freeport MacMoran Mining.

The 2014 edition of NFPA includes various technical and editorial updates. The committee has established a common definition and a protection scheme for *self-propelled*, *mobile equipment*, and *portable equipment*.

Technical Committee on Mining Facilities

Matthew J. Bujewski, *Chair*
MJB Risk Consulting, MO [SE]

David G. Aden, State of Alaska Department of Public Safety, AK [E]
Steven M. Behrens, XL Global Asset Protection Services, CT [I]
J. Emmett Bevins, Amerex Corporation, AL [M]
Dennis D. Brohmer, Tyco Fire Protection Products, WI [M]
Jack Douglas Conaway, Arch Coal, Inc., MO [U]
Thomas A. Delorie, Jr., Marsh Risk Consulting, PA [I]
L. Harvey Kirk III, U.S. Department of Labor, VA [E]
James M. Kohl, Cintas Fire Protection, IL [IM]
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Larry J. Moore, FM Global, CO [I]
Mario G. Orozco, Zurich Services Corporation, IL [I]
Rob Rosovich, FireIce Inc., FL [M]
Steven A. Sheldon, Fisher Engineering, Inc., AZ [SE]
Alex C. Smith, National Institute for Occupational Safety & Health, PA [RT]
Thomas D. Stilwell, Xtralis, Inc., MA [M]
Brent Sullivan, North American Coal Corporation, ND [U]
Bruce Watzman, National Mining Association, DC [U]
Rick Wells, Peabody Energy, MO [U]
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Dennis M. Phillips, Tyco Fire Protection Products, TN [M]
(Alt. to D. D. Brohmer)
Scott C. Strickling, FM Global, Chile [I]
(Alt. to L. J. Moore)

Susan Bershad, NFPA Staff Liaison

This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on safeguarding life and property against fire, explosion, and related hazards associated with underground and surface coal and metal and nonmetal mining facilities and equipment.

NFPA 122

Standard for

Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities

2015 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard covers minimum requirements for safeguarding life and property against fire and related hazards associated with metal and nonmetal underground and surface mining and metal mineral processing plants.

1.1.2 As applies to underground mining, this standard shall cover only the following:

(1) Diesel-powered equipment
(2) Storage and handling of flammable and combustible liquids

1.1.3 As applies to underground mining, this standard shall not cover flammable and combustible liquids produced in underground mines, such as shale oil mines.

1.1.4 As applies to surface mining, this standard shall cover only the following:

(1) Mobile equipment in use without its own motive power train and normally moved by self-propelled equipment
(2) Self-propelled equipment that contains a motive power train as an integral part of the unit and is not rail-mounted

1.1.5 This standard shall not cover buildings or employee housing and support facilities for a mining operation, or preparation or use of explosives.

1.1.6* As applies to metal mineral processing, this standard shall cover fire and related hazards associated with metal mineral processing plants — whether underground or on the surface — including but not limited to conveying, crushing, fine milling, beneficiation, flotation, hydro-metallurgical solvent extraction, drying, filtering, ore and concentrate storage, and support facilities for the mineral processing activity.

1.1.7* As applies to surface metal mineral processing plants, this standard shall not cover the following:

(1) Solvent extraction plants
(2) Pressure-leaching processes
(3) Alumina refineries
(4) Nonmetal mineral processing plants
(5) Metal smelters including roasting, sintering, and calcining
(6) Metal refineries such as electrowinning or electrorefining processes
(7) Gas, liquid, or solid waste handling or storage systems

1.1.8 Nothing in this standard is intended to prohibit the use of new methods or devices, provided sufficient technical data are submitted to the authority having jurisdiction to demonstrate that the new method or device is equivalent in quality, effectiveness, durability, and safety to that specified by this standard.

1.2 Purpose. This standard shall be intended for use by those charged with fire prevention and fire protection or with responsibility for purchasing, designing, installing, testing, inspecting, approving, listing, operating, or maintaining the following:

(1) Facilities and equipment for the storage and handling of flammable and combustible liquids within underground metal and nonmetal mines
(2) Diesel-powered equipment in underground metal and nonmetal mines, mobile and self-propelled surface mining equipment in metal and nonmetal mines, and metal mineral processing plants

1.3 Application. Only those skilled in fire protection shall be permitted to design and supervise the installation of fire protection systems.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.
NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam,* 2010 edition.
NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems,* 2015 edition.
NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems,* 2015 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.
NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.
NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection,* 2012 edition.
NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems,* 2015 edition.
NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2013 edition.
NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2013 edition.
NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances,* 2013 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.
NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.
NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2013 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.
NFPA 55, *Compressed Gases and Cryogenic Fluids Code,* 2013 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.
NFPA 70®, *National Electrical Code*®, 2014 edition.
NFPA 72®, *National Fire Alarm and Signaling Code,* 2013 edition.
NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2015 edition.
NFPA *101*®, *Life Safety Code*®, 2015 edition.
NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.
NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting,* 2012 edition.
NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems,* 2015 edition.

2.3 Other Publications.

2.3.1 ANSI/NETA Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor New York, NY 10036.

Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems, 2011.

2.3.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code,* Section VIII, X, 2013.

2.3.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*, 2008.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2012.

2.3.4 CSA Publications. Canadian Standards Association, 5060 Spectrum Way, Mississauga, ON, L4W 5N6, Canada.

CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code,* 2009.

2.3.5 Other Publication.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 17, *Standard for Dry Chemical Extinguishing Systems,* 2013 edition.
NFPA 17A, *Standard for Wet Chemical Extinguishing Systems,* 2013 edition.
NFPA 30, *Flammable and Combustible Liquids Code,* 2015 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.
NFPA 52, *Vehicular Gaseous Fuel Systems Code,* 2013 edition.
NFPA 80, *Standard for Fire Doors and Other Opening Protectives,* 2013 edition.
NFPA 120, *Standard for Fire Prevention and Control in Coal Mines,* 2015 edition.
NFPA 750, *Standard on Water Mist Fire Protection Systems,* 2015 edition.
NFPA 5000®, *Building Construction and Safety Code*®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Boiling Point. The temperature at which the vapor pressure of a liquid equals the surrounding atmospheric pressure. [**30,** 2015]

3.3.2 Closed Container. A container, as herein defined, so sealed by means of a lid or other device that neither liquid nor vapor will escape from it at ordinary temperatures. [**30,** 2015]

3.3.3 Combustible. Capable of undergoing combustion.

3.3.4 Combustible Liquid Storage Area.

3.3.4.1 ***Combustible Liquid Storage Area — Fixed.*** An area used for storage of Class II and Class III combustible liquids that is infrequently moved, and where the aggregate quantity present shall not exceed 18,925 L (5000 gal) . Handling of liquids incidental to transfer can take place within a storage area. [**120,** 2015]

3.3.4.2 ***Small Combustible Liquid Storage Area — Portable.*** An area used for storage of Class II and Class III combustible liquids that is periodically moved, and where the aggregate quantity present does not exceed 3785 L (1000 gal). Handling of liquids incidental to transfer can take place within a storage area. [**120,** 2015]

3.3.5 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame. [**5000,** 2015]

3.3.6 Container. Any vessel of 450 L (119 gal) or less capacity used for transporting or storing liquids. [**30,** 2015]

3.3.7 Cutoff Room. A room within a building and having at least one exterior wall.

3.3.8 Diesel-Powered Equipment. Any device powered by a diesel engine.

3.3.9* Emergency Egress.

3.3.10 Equipment Operator. The authorized person who starts, controls, or stops mining equipment.

3.3.11 Fire Detector. An automatic device designed to detect the presence of fire and initiate action.

3.3.12 Fire Risk Assessment. The evaluation of the relative danger of the start and spread of fire; the generation of smoke, gases, or toxic fumes; and the possibility of explosion or other occurrence endangering the lives and safety of personnel or causing significant damage to property.

3.3.13 Fixed Diesel Fuel Storage Area. A designated location used to facilitate fuel dispensing for the storage of diesel fuel in containers, tanks, or both, exceeding an aggregate quantity of 2498 L (660 gal), from which tanks or containers are not moved or transported within the mine.

3.3.14 Fixed Fire-Suppression System. An engineered or pre-engineered total flooding or local application system consisting of a fixed supply of extinguishing agent permanently connected for fixed agent distribution to fixed nozzles that are arranged to discharge an extinguishing agent into an enclosure (total flooding), directly onto a hazard (local application), or a combination of both; or an automatic sprinkler system.

3.3.14.1 ***Engineered Systems.*** Those systems requiring individual calculation and design to determine the flow rates, nozzle pressures, pipe size, area, volume protected by each nozzle, quantity of suppression agent, number and types of nozzles, and their placement in a specific system.

3.3.14.2 ***Pre-Engineered Systems.*** Those systems having predetermined flow rates, nozzle pressures, and quantities of extinguishing agent and having specific pipe size, maximum and minimum pipe lengths, flexible-hose specifications, number of fittings, and number and types of nozzles. [**17,** 2013]

3.3.15 Flammable Liquid Storage Area. Area used for storage of Class I liquids. [**120,** 2015]

3.3.15.1 ***Large Flammable Liquid Storage Area.*** An area used for storage of Class I liquids where the aggregate quantity present is greater than 37.8 L (10 gal).

3.3.15.2 ***Small Flammable Liquid Storage Area.*** An area used for storage of Class I liquids where the aggregate quantity present is 37.8 L (10 gal) or less.

3.3.16* Flash Point. The minimum temperature of a liquid at which sufficient vapor is given off to form an ignitible mixture with the air, near the surface of the liquid or within the vessel used, as determined by the appropriate test procedure and apparatus specified in Section 4.4 of NFPA 30. [**30,** 2015]

3.3.17 Hand Hose Line System. A hose and nozzle assembly connected by fixed piping or connected directly to a supply of extinguishing agent.

3.3.18 Hot Work. Work involving burning, welding, or a similar operation that is capable of initiating fires or explosions. [**51B,** 2014]

3.3.19 Inherent Safety. A protection layer that relies on the reduction or elimination of hazardous conditions, materials, or processes through changes in the chemistry, physics, and physical design of a process.

3.3.20 Liquid.

3.3.20.1 ***Combustible Liquid.*** Any liquid that has a closed-cup flash point at or above 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30. Combustible liquids are classified according to Section 4.3 of NFPA 30. [**30,** 2015]

3.3.20.2 ***Flammable Liquid.*** Any liquid that has a closed-cup flash point below 37.8°C (100°F), as determined by the test procedures and apparatus set forth in Section 4.4 of NFPA 30, and a Reid vapor pressure that does not exceed an absolute pressure of 40 psi (276 kPa) at 37.8°C (100°F), as determined by ASTM D323, *Standard Test Method for Vapor Pressure of Petroleum Products (Reid Method)*. Flammable liquids are classified according to Section 4.3 of NFPA 30. [**30,** 2015]

3.3.21 Metal and Nonmetal. Minerals other than coal.

3.3.22 Metal Mineral. Belonging to the class of inorganic metal compounds occurring in the earth's crust that are transformed into pure metals by metallurgical refining, including gold, silver, lead, zinc, nickel, and copper.

3.3.23* Metal Mineral Processing Plant. A surface processing facility used to size, separate, and concentrate valuable metals from raw ore.

3.3.24 Mine Operator. Any owner, lessee, or other person who operates, controls, or supervises a mine.

3.3.25* Mineral. A naturally formed inorganic substance occurring in the earth's crust and having a consistent and distinct set of physical properties and a composition that can be expressed by a chemical formula.

3.3.26 Mobile Equipment. Wheeled, skid-mounted, track-mounted, or rail-mounted equipment capable of moving or being moved.

3.3.27* Noncombustible Material. Material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors when subjected to fire or heat.

3.3.28 Nonmetal Mineral. Belonging to the class of inorganic structural and industrial minerals that do not become metals through metallurgical refining, such as potash, asbestos, sulfur, granite, and rock aggregates.

3.3.29 Ore. A mixture of valuable metal mineral and waste rock.

3.3.30 Pipeline System. An arrangement of piping, valves, connections, and allied equipment installed in a mine for the purpose of transporting, transferring, or dispensing flammable or combustible liquids.

3.3.31 Portable Extinguisher. An extinguisher of the hand-held or wheeled type that is capable of being carried or moved about; or a transportable system consisting of a hose reel or rack, hose, and discharge nozzle assembly connected to a supply of suppressant.

3.3.32 Pressure Vessel. A container or other component designed in accordance with the ASME *Boiler and Pressure Vessel Code*, or CSA B51, *Boiler, Pressure Vessel and Pressure Piping Code.* [**52**, 2013]

3.3.33* Safe Area. An area where hot work such as cutting and welding, burning, or grinding is done routinely and frequently and has been identified, inspected, and designated as being safe for hot work operations.

3.3.34 Safety Can. A listed container of not more than 20 L (5.3 gal) capacity having a screen or strainer in each fill and pour opening and having a spring-closing lid and a spout cover designed to safely relieve internal pressure when exposed to fire. [**30,** 2015]

3.3.35 Self-Closing Doors. Doors that, when opened and released, return to the closed position. [**80,** 2013]

3.3.36 Self-Igniting Ore. See 3.3.37, Self-Igniting Rock.

3.3.37* Self-Igniting Rock. Rock containing minerals prone to self-heating and ignition due to chemical oxidation and spontaneous combustion, if such minerals are present in sufficient amounts and occur in a form known to present a spontaneous combustion hazard.

3.3.38 Self-Propelled Equipment. Any unit that contains a motive power train as an integral part of the unit.

3.3.39* Solvent Extraction (SX) Facility. Within this standard, a solvent extraction (SX) facility is a hydro-metallurgical processing facility associated with a mining or mineral refining facility that uses organic or alcohol-based solvents to extract desirable metals.

3.3.40 Suitable. That which is appropriate and has the qualities or qualifications to meet a given purpose, occasion, condition, function, or circumstance.

3.3.41 Tank. A closed vessel having a liquid capacity in excess of 227 L (60 U.S. gal).

3.3.41.1 ***Atmospheric Tank.*** A storage tank that has been designed to operate at pressures from atmospheric through a gauge pressure of 6.9 kPa (1.0 psi) (i.e., 760 mm Hg through 812 mm Hg) measured at the top of the tank. [**30,** 2015]

3.3.41.2 ***Low Pressure Tank.*** A storage tank designed to withstand an internal gauge pressure above 3.5 kPa (0.5 psi) but not more than 103.4 kPa (15 psi).

3.3.41.3 ***Portable Tank.*** Any closed vessel having a liquid capacity over 227 L (60 gal) and not intended for fixed installation. [**30,** 2015]

Chapter 4 General

4.1 General. Provisions in Chapter 4 shall apply to all underground and surface metal and nonmetal mines and to surface metal mineral processing plants, subject to scope limitations.

4.2 Housekeeping.

4.2.1 Spills, leaks, excess lubricants, and combustible materials such as oil-soaked wastes, rubbish, and accumulations of environmental debris shall not be allowed to accumulate in quantities that could create a fire hazard, as determined by a fire risk assessment.

4.2.2 Approved metal receptacles shall be provided where oil-soaked wastes or rubbish are not immediately removed to a safe place for disposal.

4.2.3 Maintenance operations shall include written procedures and practices to identify and prevent leakage and accidental escape of flammable or combustible liquids.

4.2.4 Spillage of flammable or combustible liquids shall be cleaned up.

4.2.5 Where flammable or combustible liquids are used or handled, means shall be provided to dispose of leakage or spills.

4.2.6 Access routes shall be kept clear of obstructions to allow access and use of fire protection equipment.

4.3 Ignition Source Control.

4.3.1 Smoking and open flames shall be prohibited in areas or locations where fire or explosion hazards exist.

4.3.2 Signs warning against smoking and open flames shall be posted conspicuously.

4.4 Hot Work.

4.4.1 Hot work shall be in accordance with NFPA 51B.

4.4.2 Compressed gases used for hot work shall be stored in accordance with Chapter 4 of NFPA 51.

4.4.3 A hot work permit system shall be developed for all areas of the mine and surface metal processing facilities where hot work is conducted outside of designated safe areas.

4.4.4 Hot work shall be performed only by personnel who have been trained in precautions and procedures for safety in these operations.

4.4.5 Before hot work is performed, prior approval shall be granted by the plant/mine superintendent or designated agent.

4.4.6 All hot work equipment shall be maintained to ensure it is in proper condition.

4.4.7 A flashback arrester shall be installed at the outlet of each pressure regulator on compressed flammable gas cylinders.

4.4.8 When not in use, the compressed gas cylinder valve shall be closed.

4.4.9 Appropriate personal protective equipment, including gloves, goggles, and welding hoods, shall be worn by personnel during hot work operations.

4.4.10 Combustible materials such as oil, grease, wood, or cardboard boxes and rags within 4.6 m (15 ft) of hot work shall be removed, covered, or wetted down before hot work is started.

4.4.11 Hot work shall not be performed within 15.24 m (50 ft) of explosives, blasting agents, or mine fuel storage areas, unless separated by a suitable noncombustible barrier.

4.4.12 Open gear cases or other exposed machinery components containing lubricants located within 4.6 m (15 ft) shall be covered with noncombustible material before hot work is started.

4.4.13 Noncombustible barriers shall be installed below hot work operations that are being performed in or over shafts, silos, or bins, and similar openings that are constructed of or contain combustible materials or flammable gases.

4.4.14 Openings or cracks in walls, partitions, floor decks, or ducts shall be covered tightly to prevent the passage of sparks to adjacent areas.

4.4.15 Where hot work is done on a metal wall, partition, ceiling, or roof, precautions shall be taken to prevent ignition of combustibles on the other side due to conduction or radiation.

4.4.16 Noncombustible barriers shall be installed below hot work operations that are being performed over empty open-topped tanks or process equipment that are lined with rubber, plastic, or other combustible linings.

4.4.17 As an alternative to providing barriers over open-topped lined equipment in 4.4.16, the equipment shall be filled with water or an ore-water slurry (pulp).

4.4.18 Rubber or plastic lined or constructed vessels, process equipment, or piping shall be clearly labeled using placards or stencils warning of hot work fire hazard.

4.4.19 The hot work permit system shall include explicit wording warning of rubber and plastic lined or constructed equipment hazards and special precautions to be taken.

4.4.20 Hot work shall not be performed in the presence of atmospheres containing flammable mixtures of gases, vapors, or liquids with air, or combustible mixtures of dust in suspension with air.

4.4.21* Hot work shall not be performed on or within containers that have contained combustible or flammable materials until such containers or tanks have been thoroughly purged and cleaned or inerted.

4.4.22 A charged water hose line or a multipurpose dry chemical portable extinguisher having a minimum nominal capacity of 9.1 kg (20 lb) shall be available at the work site before hot work is started.

4.4.23 Inspection for sparks, smoldering material, and fire shall be made during hot work operations.

4.4.24 Where hot work is performed near combustible materials that cannot be removed or protected, a trained fire watch person equipped with extinguishing devices shall be present to guard against fire during and after hot work operations.

4.4.25 Where a fire watch is required, a search of the area, including all levels or floors above and below, shall be made and the fire watch shall be maintained for a minimum of 30 minutes after completion of hot work operations to detect and extinguish smoldering combustibles.

4.4.26 Fire watchers shall be familiar with alarm location and procedures for sounding an alarm in the event of a fire.

4.4.27 Tests for methane and other flammable gases shall be made before hot work in any area where flammable gas could be present.

4.4.28 Cutting or welding shall not be allowed to begin or continue unless the concentration of flammable gas is less than 25 percent of the lower explosive limit.

4.5 Maintenance.

4.5.1 The operator shall establish a maintenance program that ensures that equipment is in proper working order.

4.5.2 All ore handling and concentrating equipment and machinery shall be maintained in accordance with the manufacturers' recommendations.

4.6 Fire Protection Equipment Inspection, Maintenance, and Testing.

4.6.1 Portable extinguishers shall be inspected, tested, and maintained in accordance with NFPA 10.

4.6.2 Any fire suppression system shall be inspected, tested, and maintained in accordance with the manufacturer's listed installation and maintenance manual or owner's manual (inspection) and the applicable NFPA standard for the type of system.

4.6.2.1 A fire suppression system, approved for use on mobile and self-propelled equipment, shall be inspected on a monthly basis in accordance with the fire suppression system manufacturer's listed installation and maintenance manual or owner's manual.

4.6.2.2 A fire suppression system, approved for use on mobile and self-propelled equipment, shall be serviced/maintained at least semiannually in accordance with the fire suppression system manufacturer's listed installation and maintenance manual.

4.7 Training.

4.7.1 All site personnel shall receive annual instruction on the different classes of fires and types of fire-fighting equipment, fire prevention, and emergency procedures to be followed during a fire.

4.7.2 All site personnel shall receive annual training in the use or operation of fire suppression and detection devices in their work areas or on the equipment they operate, supervise, or maintain.

4.7.3 All site personnel who inspect, test, and maintain a fire suppression system shall be trained to perform their intended tasks.

4.7.4 All site personnel shall receive annual instruction on emergency evacuation procedures.

4.8 Flammable and Combustible Liquid Handling and Storage.

4.8.1 Fixed, unburied flammable or combustible liquid storage tanks shall be provided with containment or drainage in accordance with NFPA 30.

4.8.2 Flammable or combustible liquids shall not be stored or processed underneath cable trays or inside cable-spreading rooms or tunnels.

4.8.3 Subsection 4.8.1 shall not apply to underground mines.

4.8.4 Ignition.

4.8.4.1 Precautions shall be taken to prevent the ignition of flammable and combustible liquid vapors.

4.8.4.2 Possible sources of ignition shall include, but are not limited to, the following:

(1) Open flames
(2) Smoking
(3) Cutting and welding
(4) Hot surfaces
(5) Frictional heat
(6) Static, electrical, and mechanical sparks
(7) Spontaneous ignition, including heat-producing chemical reactions
(8) Radiant heat

4.8.5 Where a fire risk assessment determines the need, ventilation air volume and velocity shall be designed to dilute and carry away flammable or explosive concentrations of vapors before they reach 25 percent of the lower explosive limit.

4.9 Vehicle Refueling.

4.9.1 Vehicles using liquid fuels shall be refueled only at locations designated for that purpose and from approved dispensing pumps and nozzles.

4.9.2 While fueling, vehicles, regardless of fuel type, shall be constantly attended.

4.9.3 Engines, except diesel engines, shall be shut off during refueling.

Chapter 5 Fire Risk Assessment and Risk Reduction

5.1* Fire Risk Assessment.

5.1.1 A documented fire risk assessment shall be performed for all diesel-powered underground mining equipment, all self-propelled and mobile surface mining equipment, storage and handling of flammable and combustible liquids, and surface metal mineral processing facilities.

5.1.2 Only those skilled in fire risk assessment techniques shall be permitted to conduct a fire risk assessment.

5.1.3 The fire risk assessment shall be kept on file at the mine site.

5.1.4* The fire risk assessment shall determine whether mobile or other equipment, fuel depots, and surface buildings and metal mineral processing facilities require a fixed fire suppression system.

5.1.5 The fire risk assessment shall determine whether an on-site fire fighting organization is required, based on the distance to the nearest local public fire department and response time.

5.1.6 Where required by the authority having jurisdiction, fixed fire protection systems shall be provided.

5.1.7 The fire risk assessment shall include evaluation of the risk potential for the start and spread of a fire and the generation of smoke, gases, or toxic fumes that could endanger the lives and safety of personnel or cause damage to property.

5.1.8 A separate fire risk assessment for each piece of mobile or self-propelled mining equipment — whether underground or on the surface — shall be required when variations in design, use, condition, and environment could change the fire potential.

5.1.9 If the fire risk assessment identifies unacceptable risks, further assessment shall include an evaluation of each of the following:

(1) Methods for reducing or eliminating existing hazardous fire conditions
(2) Use of detection and early fire-warning devices
(3) Use of fixed fire suppression systems
(4) Requirements for on-site fire water availability and capacity
(5) Normal and emergency means of egress from equipment or workplaces and evacuation to a safe location, such location to be determined by the fire risk assessment

(6) Compartmentalization of equipment, isolation of areas, or provision of barriers or enclosures to prevent or contain the spread of fire
(7) Availability of fire-fighting personnel and fire suppression equipment
(8) Spread of fire to combustible materials in proximity
(9) Ventilation control structures to contain or redirect products of combustion (underground mines only)
(10) Any other devices or procedures necessary to protect life and property

5.1.10 Modifications affecting the fire risk of mobile, self-propelled, or other mining equipment or buildings shall be analyzed to determine whether such modifications decrease or increase fire risks.

5.1.11 Working plans for fixed fire protection systems shall be submitted for approval to the authority having jurisdiction.

5.2 Risk Reduction.

5.2.1 Risk reduction practices shall follow the principles of minimizing ignition sources, reducing exposure of combustible materials to ignition sources, and control or suppression of fire spread.

5.2.2 For purposes of this standard, fire protection shall include fire prevention, fire detection, and fire suppression.

Chapter 6 Fire Detection and Suppression Equipment

6.1 Portable Fire Extinguishers.

6.1.1 General Requirements. All areas or process equipment in underground and surface mines and metal mineral processing plants where combustible materials are present, processed, or handled shall be provided with approved portable multipurpose fire extinguishers that comply with NFPA 10.

6.1.2 The number of such extinguishers, their type, size, and distribution shall be in accordance with NFPA 10, except that the extinguishers shall have a nominal capacity of 4.5 kg (10 lb) or greater of agent and a minimum rating of 4-A:10-B:C.

6.1.3 Extinguishers employing agents having a B:C rating shall be permitted to be used on electrical hazards.

6.1.4 At least one hand-portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) or greater and a minimum rating of 10-A:60-B:C shall be located outside of, but not more than 3 m (10 ft) from, the opening into each flammable and combustible liquid storage or dispensing area and maintenance shop.

6.1.5 Where portable fire extinguishers are provided within flammable and combustible liquid storage or dispensing areas and maintenance shops, travel distance to a portable extinguisher shall not exceed 9.1 m (30 ft).

6.2 Hand Hose Line Systems.

6.2.1 All areas or process equipment in underground and surface mines and metal mineral processing plants where combustible materials, liquids, or other fire hazards exist, as determined by the fire risk assessment, shall be provided with approved hand hose line systems.

6.2.2 Hand hose line systems shall be installed in accordance with NFPA 14, and shall be a minimum of either 38 mm (1½ in.) lined or 25 mm (1 in.) hard rubber.

6.2.3 When automatic sprinkler systems are supplied through the hand hose line standpipe system, hydraulic calculations shall be used to ensure that the piping and water supply will supply the hose and automatic sprinkler demands simultaneously.

6.2.4 Hose stations in conveyor galleries shall be provided with hoses that are of length equal to the distance between water supply connections.

6.3 Fire Detection.

6.3.1 Fire detectors shall be permitted to be used to initiate audible or visual warning, automatic actuation of a fire suppression system, equipment shutdown, or any combination thereof.

6.3.2 Fire detection systems and applicable equipment in surface mineral concentrating plants shall be installed and tested in accordance with *NFPA 72*.

6.3.3 Fire detection systems in underground mines and on surface mobile and self-propelled equipment shall be tested in accordance with *NFPA 72*.

6.3.4 Fire detectors shall be listed for their application.

6.3.5 Equipment compartment and room sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area shall determine the placement, type, sensitivity, durability, and, where applicable, the number of detectors.

6.3.6 Detector testing shall not require the discharge of the fire suppression system on underground diesel-powered or surface mobile or self-propelled equipment.

6.3.7 Any equipment found deficient shall be repaired or replaced and the system retested for operation in accordance with the manufacturer's instructions.

6.3.8 The mine operator, plant superintendent, or a designee shall have a copy of the manufacturer's installation and maintenance manual or owner's manual that describes detection system operation and required maintenance.

6.4 Fire Suppression Equipment.

6.4.1 Fire suppression systems shall be designed, installed, and tested in accordance with the following NFPA standards:

(1) NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*
(2) NFPA 12, *Standard on Carbon Dioxide Extinguishing Systems*
(3) NFPA 12A, *Standard on Halon 1301 Fire Extinguishing Systems*
(4) NFPA 13, *Standard for the Installation of Sprinkler Systems*
(5) NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*
(6) NFPA 17, *Standard for Dry Chemical Extinguishing Systems*
(7) NFPA 17A, *Standard for Wet Chemical Extinguishing Systems*
(8) NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*
(9) NFPA 750, *Standard on Water Mist Fire Protection Systems*
(10) NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*

6.4.1.1 A pre-engineered fire suppression system shall be approved for use and shall be designed, installed, and tested in accordance with the fire suppression system manufacturer's listed installation and maintenance manual.

6.4.2 Testing shall not require the discharge of suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system can be verified.

6.4.3 The mine operator, plant superintendent, or a designee shall have a copy of the manufacturer's installation and maintenance manual or owner's manual that describes suppression system operation, required maintenance, and recharging.

6.4.4 Where inadvertent discharge of the fire suppression system during servicing could result in injury to personnel, provisions shall be made to safeguard against accidental actuation of the system.

Chapter 7 Fire Protection for Diesel-Powered Equipment in Underground Mines

7.1 Equipment Modification.

7.1.1* All diesel-powered mining equipment shall be analyzed to determine whether fire risks can be reduced through equipment modification.

7.1.2* Modifications affecting the fire risk of diesel-powered mining equipment shall be analyzed to determine whether such modifications decrease or increase the fire risk.

7.2 Equipment Inspection and Maintenance. Hydraulic fluid, coolant, lubrication and fuel lines, electrical wiring, mechanical components, and fire prevention devices shall be inspected and maintained in accordance with the manufacturers' recommendations.

7.3 Portable Fire Extinguishers.

7.3.1 All self-propelled, diesel-powered underground equipment shall be equipped with at least one portable, multipurpose (ABC) dry chemical extinguisher having a nominal capacity of 4.6 kg (10 lb) of extinguishing agent and a minimum rating of 4-A:10-B:C.

7.3.2 The risk assessment shall determine whether larger or additional extinguishers are needed.

7.4 Fixed Suppression Systems. Diesel-powered equipment shall be protected by a fixed fire suppression system to suppress the largest anticipated fires in the protected areas, and that system shall have the following characteristics:

(1) Be listed or approved for the purpose
(2) Be automatically actuated by a fire detection system
(3)*Have one manual actuator in the operator's compartment and at least one additional actuator accessible from the ground
(4) Be provided with an agent container and a network of agent distribution hoses or pipes with discharge nozzles
(5) Be provided with discharge nozzle blowoff caps or other suitable devices or materials to prevent the entrance of moisture, dirt, or other material into the piping
(6) Have all system components secured and protected against damage, including abrasion and corrosion
(7) Be installed so that the system actuation causes shutdown of the protected equipment
(8) Permit up to a 30-second agent discharge delay
(9) Include a standby source of power if electrical power is the only means of actuation
(10) Have an installation and maintenance manual or owner's manual

7.4.1 Post-installation testing shall be in accordance with the manufacturer's or designer's recommendations.

7.4.2 Testing shall not require the discharge of suppressant unless there is no other satisfactory manner in which the reliability and integrity of the system can be verified.

Chapter 8 Transfer of Flammable or Combustible Liquids in Underground Mines

8.1 Fire Risk Assessment. The fire risk assessment for surface flammable or combustible liquid storage areas located near underground mines shall include the following:

(1) The potential for the generation of smoke, gases, or toxic fumes that could contaminate the mine intake air
(2) The topography and relative elevation of storage tanks and mine openings
(3) Air currents
(4) Vegetation

8.2 Proximity of Surface Flammable and Combustible Liquid Storage to Underground Openings.

8.2.1 Surface flammable or combustible liquid storage areas shall be located away from any mine opening to prevent contamination of mine intake air, but in no case shall they be closer than 30.5 m (100 ft) unless the boreholes are drilled specifically for the transfer of combustible liquids to the underground mine.

8.2.2 Drainage from flammable or combustible liquid storage areas shall be designed and maintained to prevent liquid flow toward any mine opening.

8.3 Surface-to-Underground Transfer.

8.3.1 Flammable or combustible liquid shall be permitted to be transferred into the mine by pipeline, portable tank, closed container, or safety can.

8.3.2 Persons shall not be transported on conveyances with flammable or combustible liquids unless the items are secured or are small and can be carried safely by hand.

8.3.3 Where flammable or combustible liquid is transferred into the mine, it shall be transferred directly to a storage area or a location where it will be used.

8.3.4* Pipeline systems used for flammable or combustible liquid transfer shall be permitted to be either wet or dry pipe installations.

8.3.5 Piping, valves, and fittings used for flammable or combustible liquid transfer shall be suitable for the expected working pressures and structural stresses.

8.3.6 Piping, valve, and fitting burst strengths shall be at least four times the static pressure.

8.3.7 The mechanical and thermal stresses of the pipeline caused by exposure to fire shall be considered in the selection of components and the design of the pipeline system.

8.3.8 A manual shutoff valve shall be installed in the pipeline at the surface storage tank and at the point of underground discharge.

8.3.9 An additional shutoff valve shall be installed in each branch line where the branch line joins the main line.

8.3.10 The pipeline system shall be guarded by location or other acceptable practice so as to be protected against physical damage.

8.3.11 Flammable or combustible liquid pipeline transfer systems shall be maintained to function as designed.

8.3.12 A fire risk assessment shall be conducted for the location(s) intended for installation of flammable or combustible liquid pipeline systems.

8.4 Underground Transfer.

8.4.1 Persons shall not be transported on conveyances with flammable or combustible liquids unless the items can be carried by hand.

8.4.2 Flammable or combustible liquid containers or tanks loaded on rail or trackless vehicles shall be secured against shifting and damage during transit.

8.4.3 Flammable or combustible liquid containers or tanks shall be at least 305 mm (12 in.) below energized trolley wires or protected from contacting the wire by insulation while being transported by trolley wire-powered systems.

8.4.4 Vehicles transporting flammable or combustible liquids shall be kept clear of accumulations of oil, grease, and other combustible material.

8.4.5 Vehicles transporting flammable or combustible liquids shall not be stored under an energized trolley wire.

8.4.6 Unless in a single tank or container, the quantity of flammable or combustible liquids in containers or tanks off-loaded from transport vehicles and stored in an operating area shall not exceed a three-day supply for equipment normally operating in that area.

Chapter 9 Flammable Liquid Storage in Underground Mines

9.1* General.

9.1.1* Electrical equipment in large flammable liquid storage areas shall be Class I, Division 1, as specified in *NFPA 70*, or shall be classified as "permissible" electrical equipment.

9.1.2 Flammable liquids in storage shall be kept in closed containers.

9.1.3 Flammable liquids shall be permitted to be used only where there are no open flames or other sources of ignition within the possible path of vapor travel in flammable concentrations.

9.1.4 Flammable liquid containers shall be returned to a flammable liquid storage area after use.

9.1.5 Other than Class IA liquids in aerosol cans, flammable liquids with flash points below −18°C (0°F), such as gasoline, shall not be permitted.

9.2 Flammable Liquid Containers.

9.2.1 Safety cans or containers for flammable liquids authorized by the U.S. Department of Transportation (DOT) shall be acceptable as storage containers.

9.2.2 Containers for flammable liquids shall conform to the capacity limitations specified in Table 9.2.2.

9.2.3 All flammable liquid containers shall be labeled clearly with the word "flammable."

9.2.4 Flammable liquid containers shall be stored to prevent overturning or toppling.

9.3 Small Flammable Liquid Storage Areas.

9.3.1 Small flammable liquid storage areas shall be separated from other small flammable or combustible liquid storage areas by at least 15.24 m (50 ft) or from large flammable liquid storage areas by a distance of at least 30.5 m (100 ft), or they shall be separated by unexcavated rock or masonry bulkheads.

9.3.2 Storage of flammable liquids in small flammable liquid storage areas shall be in cabinets specifically designed and constructed for such purpose.

9.4 Large Flammable Liquid Storage Areas.

9.4.1 The total aggregate quantity of flammable liquids to be stored in any one storage area shall not exceed 624 L (165 gal).

9.4.2 Large flammable liquid storage areas shall be separated from other flammable or combustible liquid storage areas by at least 30.5 m (100 ft) or separated by an unexcavated rock or masonry bulkhead and shall be located a minimum of 30.5 m (100 ft) from any shaft station or explosives magazine or electrical substation and transformers.

9.4.2.1* Electrical equipment within 15.2 m (50 ft) from the storage area shall be Class I, Division 1, as specified in *NFPA 70*, or shall be classified as "permissible" electrical equipment.

9.4.2.2 Large flammable liquid storage areas shall be located a minimum of 30.5 m (100 ft) from any working face and out of the line of sight of blasting, or they shall be located a minimum of 152.4 m (500 ft) within the line of sight of any working face.

9.4.2.3 Large flammable liquid storage areas shall not be constructed in an area bounded at any point by self-igniting rock.

9.4.3 Large flammable liquid storage areas shall be enclosed and of noncombustible construction.

9.4.3.1 The enclosure shall be tightly sealed and have a minimum 2-hour fire resistance rating.

9.4.3.2 Each opening into a large flammable liquid storage area shall be limited to a maximum area of 9.2 m^2 (100 ft^2).

9.4.3.3 Openings shall be equipped with self-closing fire doors with a minimum 1½-hour fire resistance rating.

9.4.3.4 The entire storage area below the sill shall be capable of containing the total amount of flammable liquids stored, or means shall be provided to remove the spilled flammable liquid safely.

9.4.3.5 Large flammable liquid storage areas shall have exhaust directed to an exhaust ventilating system with air movement with a velocity to maintain flammable vapors at less than 25 percent of the lower explosive limit.

9.4.4 Noncombustible storage cabinets meeting the requirements specified in NFPA 30, Section 9.5, shall be considered as complying with the construction requirements for large flammable liquid storage areas.

Table 9.2.2 Maximum Allowable Size of Containers for Flammable Liquids

	Class IA		Class IB		Class IC	
Container Type	**L**	**gal**	**L**	**gal**	**L**	**gal**
Original metal containers (other than DOT containers) or approved plastic containers	3.79	1	18.93	5	18.93	5
Safety cans	7.57	2	18.93	5	18.93	5
Containers, other than safety cans, complying with 9.2.1		Not allowed	227.12	60	227.12	60

9.4.4.1 Combustible rock shall be covered with noncombustible material, such as gunite, shotcrete, or preformed masonry units.

9.5 Dispensing Flammable Liquids.

9.5.1 Flammable liquids shall be drawn from or transferred into containers within a storage area using only the following methods:

(1) From safety cans
(2) From a container by means of a device drawn through an opening in the top of the container
(3) By gravity through a listed or approved self-closing valve or self-closing faucet

9.5.2 Transfer.

9.5.2.1 Transfer of flammable liquids by means of pressurizing a container with air shall be prohibited.

9.5.2.2 Transfer of flammable liquids by pressure of inert gas shall be permitted only if controls, including pressure-relief devices, are provided to limit the pressure so it cannot exceed the design pressure of the container.

9.5.3 Where electrically powered pumps are used to transfer flammable liquids, a clearly identified and accessible switch or circuit breaker shall be provided at a suitably remote location, as determined by a fire risk assessment, to shut off the power to all dispensing and pumping devices in the event of an emergency.

9.5.4 Where flammable liquids are dispensed from containers, the containers shall be provided with approved vents, bonding, and flame arresters.

9.5.5 At least one portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) or greater with a minimum rating of 4-A:60-B:C shall be located not more than 9.1 m (30 ft) from any area where flammable liquid is dispensed.

Chapter 10 Combustible Liquid Storage in Underground Mines

10.1 General.

10.1.1 Chapter 10 shall apply to the storage and handling of combustible liquids in containers, portable tanks, and tanks intended for fixed installations.

10.1.2 Combustible liquids in use shall not be covered in this chapter.

10.1.3 Combustible liquids in approved tanks or containers meeting the following requirements shall not require any special consideration and shall be permitted to be exempt from the requirements for storage areas if the containers or tanks are located at least 15.24 m (50 ft) from a working face, explosives magazines, electrical substations, shafts, other exempt containers or tanks, or any storage area and if they are located out of the line of sight of blasting and out of the way of vehicular traffic:

(1) Class II combustible liquids stored in containers meeting the requirements of this chapter and not exceeding an aggregate of 227 L (60 gal) in any single location
(2) Class III combustible liquids stored in containers or approved tanks as specified in this chapter and not exceeding an aggregate of 2498 L (660 gal) in any single location

10.1.4 Ventilation shall be provided to prevent the accumulation of ignitible vapors.

10.2 Combustible Liquid Containers and Tanks.

10.2.1 Shipping containers and portable tanks of combustible liquids authorized by the U.S. Department of Transportation shall be acceptable as storage containers.

10.2.1.1 Shipping containers larger than 18.9 L (5 gal) shall be provided with vacuum and pressure relief.

10.2.1.2 Containers and portable tanks for combustible liquids shall conform to the capacity limitations defined in Chapter 3.

10.2.2 Combustible liquid storage tanks intended for fixed installation and engineered portable tanks shall be of materials compatible with the liquid stored and shall be designed and built in accordance with good engineering practices.

10.3* Atmospheric Tanks. Atmospheric tanks shall not be used for storage of a combustible liquid at a temperature above its boiling point.

10.4* Low-Pressure Tanks. The operating pressure of the tanks shall not exceed the design working pressure.

10.5* Pressure Vessels. The operating pressure of the vessel shall not exceed the design working pressure.

10.6 Venting Atmospheric and Low-Pressure Combustible Liquid Storage Tanks.

10.6.1 Storage tanks shall be vented to prevent the development of a vacuum or pressure that could distort the shell or roof of the tank as a result of filling or emptying and atmospheric temperature changes.

10.6.2 Protection also shall be provided to prevent overpressure from any filling source exceeding the design pressure of the tank.

10.6.2.1* Vents shall be at least as large as the filling or withdrawing lines but not less than 32 mm (1¼ in.) nominal inside diameter.

10.6.3 If more than one fill or withdraw line can be used simultaneously, the vent capacity shall be based on the maximum anticipated simultaneous flow.

10.6.3.1 Vent pipes shall be constructed to drain toward the tank without sags or traps to collect liquid.

10.7 Additional Considerations.

10.7.1 Connections for all tank openings shall be liquidtight.

10.7.2 Each connection to a tank through which liquid normally can flow shall be provided with a valve located at the flange nearest the shell of the tank.

10.7.3 Tanks containing combustible liquids shall be provided with a means, such as a remote manual or automatically actuated valve, for quick cutoff of flow in the event of fire in the vicinity of the tank.

10.7.4 Openings for manual gauging, if independent of the fill pipe, shall be kept closed when not gauging.

10.7.5 Each such opening for any liquid shall be protected against liquid overflow and possible vapor release by means of a spring-loaded check valve or other device.

10.7.6 Substitutes for manual gauging shall be permitted.

10.8 Small Combustible Liquid Storage Areas.

10.8.1 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from explosives magazines, electrical substations, working faces, or other combustible liquid storage areas or shall be separated by unexcavated rock or masonry bulkheads.

10.8.2 The storage area, unless equipped with an approved fire protection system, shall be located a minimum of 30.5 m (100 ft) from any shaft station.

10.8.3 A combustible liquid storage area shall be recessed or otherwise located and protected from accidental damage by mobile equipment or blasting.

10.8.4 Combustible liquid storage areas shall not be constructed in an area bounded at any point by self-igniting ore.

10.8.5 Where combustible liquid storage areas are constructed of combustible materials or are located where there is rock capable of self-propagating combustion, the material or rock shall be covered with noncombustible material such as gunite, shotcrete, or preformed masonry units.

10.8.6 Where tanks are used, a means shall be provided to confine within or remove from the combustible liquid storage area the contents of the largest tank in the event of a tank rupture.

10.9 Large Combustible Liquid Storage Areas.

10.9.1 The total quantity of combustible liquids in storage tanks intended for fixed installation shall not be restricted.

10.9.2 In areas not protected by automatic fire suppression systems, the total quantity of combustible liquids in containers and portable tanks shall be restricted in accordance with Table 10.9.2, but in no case shall the aggregate quantity exceed 190,000 L (50,000 gal) in any single storage area.

Table 10.9.2 Unprotected Storage of Combustible Liquids in Containers and Portable Tanks

	Maximum Pile Height		Maximum Quantity per Pile		Maximum Total Quantity	
Class	m	ft	L	gal	L	gal
Container Storage						
II	2.1	7	7,570	2,000	15,100	4,000
IIIA	2.1	7	26,500	7,000	53,000	14,000
IIIB	2.1	7	26,500	7,000	106,000	28,000
Portable Tank Storage						
II	3.0	10	11,360	3,000	22,700	6,000
IIIA	3.0	10	41,640	11,000	83,300	22,000
IIIB	3.0	10	41,640	11,000	166,600	44,000

10.9.3 The use of racks shall not be permitted in unprotected areas.

10.9.3.1 Where combustible liquid storage areas are protected by automatic fire suppression systems, the total quantity of combustible liquids in containers and portable tanks shall not be restricted.

10.9.4 Within a combustible liquid storage area, the quantity stored in a single pile shall be in accordance with Table 10.9.4.

Table 10.9.4 Storage Arrangements for Protected Palletized or Solid Pile Storage of Combustible Liquids in Containers and Portable Tanks

	Maximum Storage Height				Maximum Quantity per Pile			
	Containers		Portable Tanks		Containers		Portable Tanks	
Class	m	ft	m	ft	L	gal	L	gal
II	2.1	7	3.0	10	28,400	7,500	75,700	20,000
III	3.0	10	4.6	15	37,850	10,000	75,700	20,000

10.9.4.1 For mixed storage of Class II and Class III liquids in a single pile or rack, the maximum quantity and maximum height in that pile or rack shall be as specified for Class II liquids *(see Table 10.9.4 and Table 10.9.5.1)*, as applicable.

10.9.5 Individual piles *(see Table 10.9.2 and Table 10.9.4)* shall be arranged so that piles are separated from each other by at least 1.2 m (4 ft).

10.9.5.1 Where racks are used, the heights and quantities per rack shall be in accordance with Table 10.9.5.1.

Table 10.9.5.1 Storage Arrangements for Protected Rack Storage of Combustible Liquids in Containers

		Maximum Storage Height		Maximum Quantity per Rack	
Class	Rack Type	m	ft	L	gal
II	Double row or single row	4.6	15	34,000	9,000
III	Multirow, double row, or single row	6.1	20	90,850	24,000

10.9.6 Single-row or double-row rack storage *(see Table 10.9.5.1)* shall be separated by minimum 2.4 m (8 ft) aisles from other rows of rack storage or other pile storage.

10.9.7 Empty or idle combustible pallet storage within the combustible liquid storage area shall be limited to a maximum pile size of 23.2 m^2 (250 ft^2) and a maximum storage height of 2.1 m (7 ft).

10.9.8 Idle pallet storage shall be separated from combustible liquids by at least 1.2 m (4 ft).

10.9.8.1 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from explosives magazines or electrical substations.

10.9.9 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from any shaft station, unless equipped with an approved fire protection system.

10.9.10 Combustible liquid storage areas shall be located a minimum of 30.5 m (100 ft) from any working face and out of the line of sight of blasting, or they shall be located a minimum of 152 m (500 ft) within the line of sight of any working face to avoid damage from fly rock.

10.9.11 Combustible liquid storage areas shall be separated from other flammable or combustible liquid storage areas by a distance of at least 30.5 m (100 ft), or they shall be separated by unexcavated rock or masonry bulkheads.

10.9.12 The masonry bulkhead shall have a minimum thickness of 102 mm (4 in.) of block or 51 mm (2 in.) of reinforced gunite.

10.9.12.1 Combustible liquid storage areas that are enclosed shall be built of noncombustible materials.

10.9.13 Combustible rock within all large combustible liquid storage areas shall be covered with noncombustible material such as gunite, shotcrete, or preformed masonry.

10.9.13.1 If enclosed, each opening into a combustible liquid storage area shall be equipped with a self-closing metal door.

10.9.14 Bulkheads, if used, shall be sealed tightly and shall be built or covered with noncombustible materials.

10.9.14.1 No storage areas shall be constructed in a location bounded at any point by self-igniting ore.

10.9.15* Tanks shall rest on the ground or on foundations made of concrete, masonry, piling, or steel.

10.9.16 Tank foundations shall be designed to minimize the possibility of uneven settling of the tank and to minimize corrosion in any part of the tank resting on the foundation.

10.9.16.1 The entire combustible liquid storage area below the door sill shall be capable of containing the total amount of combustible liquid, or means shall be provided to remove the combustible liquid.

10.9.17 All piping, valves, and fittings shall be designed for the expected working pressures and structural stresses.

10.9.18 Combustible liquid storage areas not buried or equipped with automatic fire suppression systems shall have exhaust directed to an exhaust ventilating system.

10.10* Dispensing Combustible Liquids.

10.10.1 Dispensing combustible liquid from containers or tanks shall be permitted to be accomplished by transfer pump or gravity flow.

10.10.2 Means shall be provided to control the flow and prevent leakage and accidental discharge.

10.10.2.1 Combustible liquids shall be permitted to be dispensed through the application of positive pressure to containers or tanks only if they are certified as pressure vessels.

10.10.3 Manual dispensing valves, if used, shall be of the self-closing type.

10.10.3.1 Where electrically powered pumps are used to dispense combustible liquids, a clearly identified and accessible switch or circuit breaker shall be provided at a suitably remote location, as determined by a fire risk assessment, to shut off the power to all dispensing and pumping devices in the event of an emergency.

10.10.4 Dispensing nozzles shall be of the self-closing type without a latch-open device.

10.10.5 Combustible liquids shall not be dispensed within 15.24 m (50 ft) of cutting or welding operations.

10.10.6 At least one portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 4-A:60-B:C shall be located not more than 9.1 m (30 ft) from any area where combustible liquid is dispensed.

10.10.7 Spillage shall be cleaned up.

Chapter 11 Fire Suppression for Flammable or Combustible Liquid Storage Areas in Underground Mines

11.1 Portable Fire Extinguishers.

11.1.1 At least one hand portable fire extinguisher having a nominal capacity of 9.1 kg (20 lb) with a minimum rating of 4-A:60-B:C shall be located outside of, but not more than 3.0 m (10 ft) from, the opening into each storage area.

11.1.2 The installation of manual or automatic fire suppression systems shall not exempt the requirements for a portable fire extinguisher.

11.1.2.1 Where portable fire extinguishers are provided within storage areas, travel distance to a portable extinguisher shall not exceed 9.1 m (30 ft).

11.2 Hand Hose Line Systems. Hand hose lines designated for fire fighting and accessible to flammable and combustible storage areas shall be equipped to discharge a foam-water solution and shall be in accordance with NFPA 11.

11.3 Fire Suppression Systems.

11.3.1* Where provided, automatic sprinkler systems installed for the protection of flammable liquid or diesel fuel storage areas shall be of the foam-water type.

11.3.2 Where provided, automatic sprinkler systems used for the protection of other underground mine combustible liquid storage areas shall be installed in accordance with NFPA 13.

11.3.3 Where the fire suppression requirements of this standard are met by means other than an automatic sprinkler system but an automatic sprinkler system is installed to supplement such means, the water supply provisions for automatic sprinkler systems of NFPA 13 shall not be required.

11.3.4 Fire suppression systems other than automatic foam-water sprinkler systems in underground mines shall be in accordance with NFPA 11, NFPA 12, NFPA 12A, NFPA 16, NFPA 17, and NFPA 2001.

Chapter 12 Fire Prevention and Fire Protection of Surface Mining Equipment

12.1 General. This chapter shall cover haul trucks, front end loaders, bulldozers, graders, scrapers, blast hole drills, shovels, hydraulic and bucket wheel excavators, draglines, and other mobile and self-propelled equipment.

12.2* Fire Prevention. Risk reduction practices shall follow the principles of minimizing ignition sources and reducing exposure of combustible materials to ignition sources.

12.2.1 Housekeeping.

12.2.1.1 Spills, leaks, excess lubricants, and combustible materials such as oil-soaked wastes, rubbish, and accumulations of environmental debris shall not be allowed to accumulate in quantities that could create a fire hazard.

12.2.1.2 Approved metal receptacles shall be provided where oil-soaked wastes or rubbish are not immediately removed to a safe place for disposal.

12.2.1.3 The storage and handling of flammable or combustible liquids on or within equipment shall be in accordance with Chapter 17 of NFPA 30.

12.2.1.4 Access to fire protection equipment on mining equipment shall be kept clear of obstructions.

12.2.2 Inspection and Maintenance of Equipment. Hydraulic, coolant, lubrication and fuel lines, electrical wiring, and fire prevention devices shall be inspected and maintained in accordance with the manufacturers' recommendations.

12.2.3 Flammable and Combustible Liquid Storage on Equipment. Flammable and combustible liquid storage and usage shall be in accordance with Section 4.8.

12.2.4 Compressed Gas Storage and Usage. Compressed gas storage and usage shall be in accordance with Section 4.4.

12.3 Fire Protection.

12.3.1 Fire protection for the purposes of this standard shall be defined in the broad sense to include fire detection and fire suppression.

12.3.2 Fire suppression systems shall include dry chemical, wet chemical, gaseous, water mist, foam, or sprinklers.

12.3.3 Fire suppression systems and fire alarm systems shall be installed in accordance with applicable NFPA standards.

12.3.4 Portable Fire Extinguishers.

12.3.4.1* All self-propelled and mobile diesel and electrical equipment shall be equipped with at least one listed portable multipurpose (ABC) dry chemical extinguisher having a minimum rating of 4-A:60-B:C and a nominal capacity of 4.6 kg (10 lb) or greater of extinguishing agent.

12.3.4.2 The fire risk assessment shall be used to determine whether larger or additional extinguishers are needed.

12.3.4.3 The fire-extinguishing agent applied by hand-portable extinguishers to hazards involving energized electrical equipment shall be nonconductive.

12.3.4.4 Portable fire extinguishers shall be maintained in accordance with NFPA 10 and kept in their designated places at all times.

12.3.4.5 Portable fire extinguishers shall be located on each vehicle and shall be accessible.

12.3.4.6 In areas where obstruction to visual observation cannot be completely avoided, visible markings shall be provided to indicate the location of the portable fire extinguishers.

12.3.4.7 Extinguishers installed under conditions where they can be subject to physical damage shall be guarded to protect against damage.

12.3.4.8 The installation of an automatic or manually operated fire suppression system shall not eliminate the portable fire extinguisher requirement.

12.3.4.9 Portable fire extinguishers shall be inspected, maintained, and recharged as specified in NFPA 10, Chapter 7, and the following:

(1) Portable fire extinguishers shall be inspected visually at least monthly.
(2) The visual inspection shall ensure the following:
    (a) The extinguisher is in its designated place.
    (b) The tamper seals are intact.
    (c) The extinguisher gauge is in the operable range (if the extinguisher is the stored-pressure type).
    (d) There is no obvious physical damage or condition that will prevent proper operation.
(3) Extinguishers found to be defective or deficient by visual inspection shall be replaced.
(4) Extinguishers shall be subjected to a maintenance examination at least once every year.
(5) Maintenance procedures shall include a thorough examination of the extinguishers, including mechanical parts, extinguishing agent, and expellant.

(6) Any troubles or impairments shall be corrected.
(7) All extinguishers shall be recharged after use in accordance with the manufacturer's recommendations.
(8)*Each extinguisher shall have a permanent tag attached on which the inspection date shall be recorded.

12.3.4.10 Portable extinguishers shall be tested hydrostatically at intervals not exceeding those specified in NFPA 10, Chapter 8.

12.3.5 Draglines, Bucket Wheel Excavators, Electric Shovels, and Hydraulic/Electric Excavators.

12.3.5.1 Center Pin/Collector Ring Area.

12.3.5.1.1 An automatic fire suppression system shall be installed in the center pin/collector ring area. If an electrical spark cannot communicate from the collector ring (e.g., a sealed ring) to the grease around the center pin, a fire suppression system is not required.

12.3.5.1.2 An automatic fire suppression system shall be installed in the ring gear area.

12.3.5.1.3 An audible and visual suppression system alarm shall be transmitted to the operator's cab.

12.3.5.1.4 A manual actuator shall be provided just outside the center pin/collector ring area.

12.3.5.2 Hydraulics.

12.3.5.2.1* An automatic fire suppression system shall be installed to protect the hydraulic pump(s), hydraulic control valves, and associated lines and equipment in the hydraulic pump area and other areas where fires can spread.

12.3.5.2.2* The system shall send audible and visual alarms to the operator's cab.

12.3.5.2.3 A manual actuator shall be located just outside the hydraulic compartment area.

12.3.5.3 Lube Oil Pumping and Storage.

12.3.5.3.1* Automatic lube oil systems that are located in a segregated room shall be provided with an automatic fire suppression system.

12.3.5.3.2 The system shall send an audible and visual alarm to the operator's cab.

12.3.5.3.3 A manual actuator shall be located just outside the lube oil room.

12.3.5.3.4 Lube oil rooms shall have automatic door closers or shall have the door interlocked to shut upon actuation of the fire suppression system.

12.3.5.4 Transformers.

12.3.5.4.1 Oil-filled transformers located in the tail section, enclosed rooms, or other inaccessible locations shall be provided with an automatic fire suppression system.

12.3.5.4.1.1 The system shall transmit an audible and visual alarm to the operator's cab.

12.3.5.4.1.2 A manual actuator shall be located just outside the transformer area.

12.3.5.4.2* Transformers located in areas other than those listed in 12.3.5.4.1 shall be protected with a Class B:C, minimum 45.4 kg (100 lb) fire extinguisher.

12.3.5.4.3 Oil analysis, including dissolved gas, shall be conducted on combustible oil-filled transformers based upon manufacturer's recommendations or the ANSI/NETA MTS, *Standard for Maintenance Testing Specifications for Electrical Power Distribution Equipment and Systems*, whichever is more stringent.

12.3.5.4.4 Thermographic scanning shall be performed on transformers on an annual basis.

12.3.5.5 Electrical Room or Cabinet.

12.3.5.5.1 Enclosed electrical rooms shall be protected with a total flooding gaseous extinguishing agent or equivalent fire suppression system.

12.3.5.5.1.1 The gaseous extinguishing system shall be installed in accordance with NFPA 2001.

12.3.5.5.1.2 The gaseous extinguishing system shall be actuated by a smoke, ultraviolet/infrared (UV/IR), or heat detector system and send an audible and visual alarm to the operator's cab.

12.3.5.5.1.3 The ventilation system shall be interlocked to the gaseous extinguishing system to shut down upon first detection.

12.3.5.5.1.4 The room shall be sealed to maintain the design gaseous extinguishing concentration.

12.3.5.5.2 Electrical rooms shall be maintained at a positive pressure to reduce the chances of dust entering the room.

12.3.5.5.3 Electrical cabinets shall be protected with a gaseous fire suppression system.

12.3.5.5.3.1 The system shall be installed in accordance with NFPA 2001.

12.3.5.5.3.2 The system shall be actuated by a smoke, UV/IR, or heat detector system and send an audible and visual alarm to the operator's cab.

12.3.5.6 Manual Extinguishing Equipment.

12.3.5.6.1 Minimum 45.4 kg (100 lb) ABC-type extinguishers shall be accessible to persons on the main deck of the dragline.

12.3.5.6.2 The location and number of extinguishers shall be determined by what is practical for the machine.

12.3.6 Hydraulic/Diesel Excavators.

12.3.6.1 An automatic fire suppression system shall be provided to protect the engine compartment, hydraulic pumps, and associated equipment.

12.3.6.1.1* For diesel-powered generators with hydraulic systems containing more than 567.8 L (150 gal) in the lines, a dual agent system shall be provided.

12.3.6.1.2 A manual actuator shall be located in the operator's cab and at the means of egress from the machine.

12.3.6.2 The machine shall be interlocked to shut down upon discharge of the extinguishing system.

12.3.6.3 A means shall be provided to automatically relieve the hydraulic pressure upon discharge of the extinguishing system.

12.3.6.4 Adequate fire resistance shielding shall be provided between the hydraulic hoses and the turbocharger and engine manifold to prevent hydraulic fluid from being sprayed on hot mechanical parts.

12.3.6.5 The fire detection electrical wiring within fire hazard areas, such as battery compartments, engine compartments, and so forth, shall be outfitted with a fire-resistant sleeve.

12.3.6.6 Fire suppression system manual actuation lines shall not be routed near high heat surfaces and shall not be routed within fire hazard areas unless fitted with fire-resistant sleeves.

12.3.7 Mobile Equipment.

12.3.7.1 Fire Protection. Portable extinguishers installed on mobile mining equipment, including but not limited to mobile generators and compressors, shall have a minimum rating of 2-A:10-B:C and a nominal capacity of 2.3 kg (5 lb) of extinguishing agent.

12.3.8 Self-Propelled Equipment.

12.3.8.1 Portable Fire Extinguishers.

12.3.8.1.1* All self-propelled surface mining equipment, including but not limited to bulldozers, front-end loaders, haulage trucks, cranes, graders, scrapers, draglines, drills, shovels, and diesel and electrical equipment, shall be equipped with at least one listed, portable, multipurpose (ABC), dry-chemical extinguisher having a nominal capacity of 4.5 kg (10 lb) or greater of agent.

12.3.8.1.2 Portable extinguishers installed on small units of self-propelled mining equipment, including but not limited to miniature loaders and individual personnel transports, shall have a minimum rating of 2-A:10-B:C and a nominal capacity of 2.3 kg (5 lb) of extinguishing agent.

12.3.8.2 Fire Detection.

12.3.8.2.1 Fire detectors shall be permitted to be used to initiate audible or visual warning, automatic actuation of a fire suppression system, or equipment shutdown.

12.3.8.2.2 Fire detectors shall be tested and listed for the application.

12.3.8.2.3 Compartment sizes and contours, airflow patterns, obstructions, and other characteristics of the protected area shall determine the placement, type, sensitivity, durability, and, where applicable, number of detectors.

12.3.8.2.4 All fire detection systems and applicable equipment shall be tested after installation in accordance with *NFPA 72* and fire suppression systems standards.

12.3.8.2.4.1 It shall not be necessary for testing to require the discharge of any associated fire suppression system.

12.3.8.2.5* At least every 6 months, all fire detection systems, including alarms, shutdowns, and other associated equipment, shall be thoroughly examined and checked for proper operation in accordance with the manufacturer's recommendations.

12.3.8.2.5.1 Any equipment found deficient shall be repaired or replaced, and the system retested for operation in accordance with the manufacturer's instructions.

12.3.8.2.6 Between the maintenance examinations or tests, the detection system shall be inspected visually, in accordance with an approved schedule necessitated by conditions as determined by the mine operator.

12.3.8.3 Fixed Suppression Systems.

12.3.8.3.1 Haul trucks with a capacity of over 77 metric tons (85 tons) shall have a fixed fire suppression system protecting the engine compartment and hydraulic pump and other hazard areas.

12.3.8.3.2* Other large mining equipment such as but not limited to bulldozers, endloaders, drills, graders, and scrapers shall have a fixed fire suppression system protecting the engine compartment and hydraulic pump and other hazard areas.

12.3.8.3.3 Mining equipment requiring a fire suppression system shall be protected by a system to suppress potential fires in the protected areas and shall comply with the following:

(1) The fire suppression system shall be listed or approved for the purpose.
(2) Where installed, the equipment shall be located or guarded so as to be protected against physical damage.
(3) Fire suppression systems shall be automatically actuated.
(4)*Automatically actuated systems shall also have a manual actuator capable of being activated from the operator's compartment or other location.
(5) Agent distribution hose or pipe shall be secured and protected against damage, including abrasion and corrosion.
(6) Except for automatic sprinkler systems, discharge nozzles shall be protected against entrance of environmental debris, including moisture, dust, dirt, or insects, by blowoff caps or other similar devices or materials.
(7) Except for automatic sprinkler systems, the nozzle cover shall open or blow off upon discharge of the system.
(8) The automatic fire suppression system shall be installed so that system actuation causes shutdown of the protected equipment.
(9) Up to a 30-second delay shall be included in the design of the interlock system for the operator to maintain control of the equipment.

12.3.8.3.4 A standby source of power shall be provided where electrical power is the only means of fire suppression system actuation.

12.3.8.3.5 All fire suppression equipment and systems shall be tested after installation in accordance with the manufacturer's or designer's recommendations.

12.3.8.3.5.1 Testing shall not require the discharge of suppressant unless there is no other manner in which the reliability and integrity of the system can be verified.

12.3.8.3.6 An installation-and-maintenance or owner's manual that describes system operation and maintenance requirements shall be provided for all fire suppression equipment.

12.3.8.3.7* In accordance with the manufacturers' or designers' recommended inspection and maintenance procedures and schedules, but not to exceed every 6 months, all fire suppression systems, including alarms, shutdowns, and other associated equipment, shall be thoroughly examined and checked for proper operation by trained and competent personnel.

12.3.8.3.7.1 Any equipment found deficient shall be repaired or replaced, and the system retested for proper operation.

12.3.8.3.7.2 Between regular maintenance examinations or tests, the system shall be inspected visually, in accordance with the manufacturer's or designer's recommended schedule.

12.3.8.3.7.3 Testing shall be in accordance with the applicable NFPA standards.

12.3.8.3.8 Fire suppression systems shall be maintained in operating condition at all times.

12.3.8.3.9 Use, impairment, and restoration of the system shall be reported to the mine operator.

12.3.8.3.10 All persons who can be expected to inspect, test, maintain, or operate a fire suppression system shall be trained to perform their intended tasks.

12.3.8.3.11 Where inadvertent discharge of the fire suppression system during servicing could result in injury to personnel, provisions shall be made to safeguard against accidental actuation of the system.

12.3.8.3.12 All operators, supervisors, and maintenance personnel of self-propelled and mobile equipment shall be trained in the use of fire suppression equipment.

Chapter 13 Fire Protection of Surface Metal Mineral Processing Plants

13.1 General. Chapter 13 shall include the following:

(1) Mill (concentrator) processing buildings
(2) Crushers and crushing buildings
(3) Conveyor systems
(4) Combustible and flammable liquids mixing buildings and tank farms
(5) Other ore processing facilities such as filter rooms, process pump houses, and thickeners
(6) Electrical substations, transformers, control rooms, cable-spreading rooms and tunnels, and motor control center (MCC) rooms
(7) Offices, shops, laboratories, warehouses, fuel depots, maintenance garages, and other ancillary nonproduction buildings on the site of and supporting the operation of the mineral processing plant

13.2 Emergency Response and Manual Fire Fighting.

13.2.1 Based on the fire risk assessment, an on-site fire fighting organization shall be developed.

13.2.2 Detailed and documented fire fighting procedures shall be developed for site- and process-specific fire scenarios.

13.2.3 Training of the fire fighting organization shall be based upon specific fire scenarios.

13.2.4 Emergency procedures shall include a documented plan for rapid assembly, transportation of emergency personnel and equipment to the fire scene, and operation of the fire suppression equipment available at the facility.

13.3 Construction. Buildings and structures greater than 465 m^2 (5000 ft^2) shall be of noncombustible construction or protected by an automatic sprinkler system.

13.4 Lightning Protection. Where lightning protection is required, it shall be in accordance with NFPA 780.

13.5 Egress and Exiting.

13.5.1 Two means of egress in accordance with NFPA *101* shall be provided on every floor of all buildings.

13.5.2 Emergency lighting shall be provided at the means of egress stairways in accordance with NFPA *101*, Section 7.9.

13.5.3 Emergency exit signs shall be provided at the means of egress stairways in accordance with NFPA *101*, Section 7.10.

13.6 Yard Hydrant Systems.

13.6.1 The fire risk assessment shall be used to determine requirements for and location of yard hydrants.

13.6.2 Yard hydrants shall be in accordance with NFPA 24.

13.7* Water Supply and Water Distribution Systems.

13.7.1 The fire risk assessment shall be used to determine requirements for water supply and water distribution systems.

13.7.2 Where a fire water supply is required by the risk assessment, capacity and availability shall provide the water demand for fire-fighting purposes, including hose and sprinkler systems, for a minimum duration of 2 hours.

13.7.3* Where fire mains and hydrants are required by the risk assessment, the water supply system shall be installed and maintained in accordance with NFPA 24.

13.7.4 Where public or private fire mains are not provided, alternate water supplies shall comply with NFPA 1142.

13.7.5 Where allowed by the fire risk assessment, process water systems shall be permitted to supply fire mains.

13.8 Flammable and Combustible Liquids.

13.8.1 The storage, use, and handling of flammable and combustible liquids in and around metal mineral processing facilities and on or in equipment in such plants shall conform with NFPA 30.

13.8.2 Material Safety Data Sheets or equivalent listing the flammability characteristics and flash point of flammable and combustible materials shall be kept on site for review by employees and the authority having jurisdiction.

13.9 Compressed Gases. The storage, use, and handling of compressed gases shall be in accordance with NFPA 55 and NFPA 58.

13.10 Rubber and Plastic Lined Equipment.

13.10.1* The fire risk assessment shall be used to determine protection requirements of rubber and plastic lined equipment.

13.10.2 Equipment with internal combustible rubber or plastic linings shall be clearly labeled by placards or stenciling on the side of the lined equipment.

13.10.3 The label shall indicate that a combustible lining is present and shall state "Hot work such as cutting and welding should be avoided."

13.10.4 The label shall be clearly visible.

13.10.5 When hot work must be performed on lined equipment, guidelines in Section 4.4 shall be followed.

13.10.6 Repairs and modifications to rubber or plastic lined equipment using flammable solvents shall require ventilation during solvent use.

13.10.7 Electrical lights and other electrical appliances shall be rated for the hazard when used during repairs and modifications to rubber or plastic lined equipment using flammable solvents.

13.10.8 Equipment and personnel repairing internal liners using flammable solvents shall be grounded against static discharge.

13.10.9 A written pre-planned procedure for emergency response shall be developed for fighting an internal rubber or plastic lined equipment fire.

13.11 Plastic Equipment.

13.11.1* The fire risk assessment shall be used to determine protection requirements of equipment constructed from plastic.

13.11.2 Plastic equipment shall be clearly labeled by placards or stenciling on the side of the equipment.

13.11.3 The label shall indicate that combustible plastic is present and shall state "Hot work such as cutting and welding should be avoided."

13.11.4 The label shall be clearly visible.

13.11.5 When hot work must be performed on plastic equipment, guidelines in Section 4.4 shall be followed.

13.11.6 Repairs and modifications to plastic equipment using flammable solvents shall require ventilation during solvent use.

13.11.7 Electrical lights and other electrical appliances shall be listed for the hazard when used during repairs and modifications to plastic equipment using flammable solvents.

13.11.8 Equipment and personnel repairing plastic equipment using flammable solvents shall be grounded against static discharge.

13.11.9 A written pre-planned procedure for emergency response shall be developed for fighting a plastic equipment fire.

13.12 Belt Conveyors.

13.12.1 Belt alignment limit switches shall be provided on conveyors to shut down belts that are tracking improperly.

13.12.2 Motion-sensing switches shall be provided to detect a slipping or jammed belt and shall be interlocked to shut off driving power when the belt stops or slows down by more than 20 percent of its normal speed.

13.12.3 Sequence switches shall be provided on contributing conveyors to prevent any operating conveyor from discharging material to a stopped downstream conveyor.

13.12.4* Conveyor belt systems shall be inspected and maintained to prevent ignition sources.

13.12.5 Accumulations of rock shall be removed from areas where the rock could jam or contact a rotating part and cause ignition of the belt.

13.12.6* The fire risk assessment shall be used to determine protection requirements of conveyor belts.

13.13 Hydraulic Fluids and Lubricating Oil Systems.

13.13.1* The fire risk assessment shall be used to determine protection requirements of hydraulic fluid and lubrication oil systems.

13.13.2 The use of listed fire-retardant or resistive fluids shall be acceptable as an alternate protection solution for fixed suppression on hydraulic systems.

13.13.3 Hydraulic fluid systems shall be capable of being shut off by one of the following measures:

(1) Actuation of automatic fire suppression or detection systems
(2) Actuation of automatic reservoir low-level, loss-of-pressure, or flow switches
(3) Actuation of manual power shutoff located at least 15.24 m (50 ft) from the hydraulic system or in a separate cutoff area from the hydraulic system

13.13.4 Hydraulic fluid and lubrication oil tanks and pumps, of individual or aggregate quantity in excess of 1892 L (500 gal), shall be located in dedicated cutoff rooms of 1-hour fire resistance.

13.13.5 Individual hydraulic and lubricating oil systems shall be located in a curb or pan capable of containing the entire reservoir capacity.

13.14* Thermal Oil Heating Systems.

13.14.1* Fire protection of thermal oil heating systems shall include as a minimum the following:

(1) A cutoff room of 1-hour fire resistance for thermal oil heater, storage, and expansion tanks and pumps

    Exception: Heat exchangers or other appliances using thermal oil to dry the ore may be located in the general production area.

(2) Interlocks to shut off the thermal oil system upon actuation of a fixed suppression or detection systems
(3) Automatic fixed fire protection system inside the cutoff room

13.14.2 Acceptable fixed fire protection systems described in 13.14.1(3) shall include automatic sprinklers, water spray systems, or foam-water systems.

13.15 Fuel-Fired Equipment. Burner management systems for solid, gas, and liquid fuel delivery systems shall be in accordance with NFPA 85.

13.16* Electrical Equipment Spaces.

13.16.1 The fire risk assessment shall be used to determine fire protection requirements of switch rooms, cable-spreading spaces, cable distribution tunnel and control rooms with electrical switch panels, transformers, and grouped electrical cables.

13.16.2 Electrical equipment shall be installed, tested, inspected, and maintained in accordance with *NFPA 70*.

13.16.3 Control rooms, cable-spreading rooms, transformers, and electrical switch rooms shall be protected with an acceptable fire protection system, including but not limited to cutoffs and barriers, smoke or heat detection, fire-retardant coating, automatic sprinklers, water spray systems, water mist systems, foam water systems, gaseous suppression systems, dry chemical systems, and portable extinguishers.

13.16.4 MCCs shall be protected with an acceptable fire protection system, including but not limited to, 1-hour cutoffs and barriers, smoke or heat detection, fire suppression systems, and portable extinguishers. Acceptable fire suppression systems include automatic sprinklers, water spray systems, water mist systems, foam-water systems, gaseous suppression systems, and dry chemical systems. A fire risk assessment shall be used to determine if fire suppression is not required for MCCs.

13.17 Battery Charging Installations.

13.17.1 Battery charging installations shall have ventilation for the removal of generated gases from charging batteries.

13.17.2 Means shall be provided to flush spilled electrolyte.

13.18* Hydro-Metallurgical Solvent Extraction (SX) Facilities. Section 13.18 shall apply to both new and existing SX facilities.

13.18.1* The fire risk assessment as required in Section 5.1 shall include an evaluation of each of the following:

(1) Use of inherent safety in design of facilities
(2) Methods for reducing or eliminating hazardous fire conditions
(3) Impact of radiant heat, wind effects, and liquid drainage patterns
(4) Use of detection and early fire-warning devices
(5) Use of fixed fire suppression systems
(6) Requirements for on-site fire water availability, quality, and capacity
(7) Normal and emergency means of egress from equipment or workplaces and evacuation to a safe location, such location to be determined by the fire risk assessment
(8) Compartmentalization of equipment, isolation of areas, or provision of barriers or enclosures to prevent or contain the spread of fire
(9) Use of drainage systems to channel spilled solvents during a fire emergency
(10) Availability and accessibility of fire-fighting personnel and fire suppression equipment
(11) Spread of fire to combustible materials in proximity
(12) Any other devices or procedures necessary to protect life and property
(13) Use of combustible plastics in construction and process equipment
(14) Prevention of mist and aerosol generation
(15) Ignition source control
(16) Production and elimination of static electrical sources
(17) Impact of altitude on flash point of the solvents used

13.18.1.1 The fire risk assessment shall not preclude the need for the requirements of Section 13.18.

13.18.2 Yard hydrants shall be installed to cover the entire SX facility.

13.18.2.1 Water duration for yard hydrant systems shall be for 120 minutes.

13.18.2.2 Yard hydrants shall be provided with foam injection capability.

13.18.3 Hot work shall be controlled in SX facilities in accordance with Section 4.4.

13.18.4 Electrical equipment shall be designed in accordance with electrical hazard classification ratings in *NFPA 70*, based on the flammability and process conditions of the solvent.

13.18.5* To prevent static electrical charges, all metallic piping and vessels containing flammable or combustible liquids or vapors shall be bonded and grounded.

13.18.6 Where nonconductive plastic pipes, vessels or flanges are used and cannot be grounded, static charge shall be eliminated by other means.

13.18.7 Enclosed buildings containing flammable or combustible liquids shall be mechanically ventilated in accordance with NFPA 30.

13.18.8* Outdoor mixer-settler cells and other process equipment with covers shall not require mechanical ventilation.

13.18.9* Fire detection with alarm shall be provided where flammable or combustible liquids are present, including but not limited to over solvent tanks, in pipe trenches, over pumps, and inside mixer-settler buildings.

13.18.10* As part of the emergency response, provisions shall be made to shut off valves on pregnant liquor supply (PLS) lines and on organic solvent lines.

13.19* New Solvent Extraction (SX) Facilities. Section 13.19 shall apply to new SX facilities.

13.19.1 Fixed fire suppression shall be provided for the following SX facility areas and equipment:

(1) Buildings housing SX processes
(2) Interior of all mixer-settler vessels/cells
(3) Crud tanks that include treatment filters and centrifuges
(4) Coalescers
(5) Along launders and weirs outside of mixer-settler vessels
(6) Inside pipe trenches carrying solvents
(7) Inside organic solvent and diluent tanks
(8) Inside dikes enclosing organic solvent storage tanks
(9) Over organic solvent pumps
(10) Over elevated pipe racks carrying organic solvents in plastic pipes
(11) Other areas handling, processing, or exposed to flammable or combustible liquids

13.19.1.1* Fire suppression for applications in 13.19.1 shall be water, foam, dry chemical, or water mist.

13.19.1.2* Design of fire suppression systems in 13.19.1 shall be based on criteria set forth in NFPA 11, NFPA 15, NFPA 16, and NFPA 17.

13.19.1.3* Actuation of fire suppression systems in 13.19.1 shall be automatic.

13.19.2 As exposure protection, automatic water-only deluge (open-head) sprinkler systems shall be provided between mixer-settler trains if spaced closer than 15.24 m (50 ft) from each other.

13.19.3 As exposure protection, automatic water-only deluge sprinkler systems shall be provided around the exterior perimeter of organic solvent tanks if spaced closer than 15.24 m (50 ft) from each other.

13.19.4 As exposure protection, automatic fire suppression shall be provided over other critical equipment (i.e., transformers) or outside along important building walls [i.e., motor control center (MCC) rooms] that are within 15.24 m (50 ft) of a solvent fire area.

13.19.5 Hydraulic design of automatic fire suppression systems in 13.19.1 shall include the simultaneous operation of all fire protection systems associated with a single (multi-cell) train.

13.19.6 The total flow rate of foam application and water associated with the discharge of automatic fire extinguishing systems, fixed monitors, and hydrants shall determine the total volume of fire water required.

13.19.7 Solvent spills from the SX facility shall be drained to a safe area, such as a catchment area or pond, via buried or enclosed piping or channels.

13.19.7.1 The drainage system design shall consider both solvent flow as well as water flow from fire suppression systems.

13.19.7.2 Drainage piping or channeling systems shall be arranged to prevent burning solvents from flowing to the safe catchment area or pond.

13.19.7.3 Concrete, steel, or rigid thermoset plastics such as polyvinyl chloride (PVC) or glass fiber reinforced plastic (FRP) shall be permitted for drainage piping or channels.

13.19.7.4 When plastic materials are used for drainage pipes or channels, such pipes or channels shall be buried.

13.19.8 Bulk storage tanks of flammable or combustible solvent shall be located outdoors in a diked area in accordance with the requirements for flammable liquid tanks in NFPA 30.

13.19.9 Solvent extraction process areas shall be provided with minimum 150 mm (6 in.) high curbing to confine and channel solvent spills.

13.19.9.1 Individual curbed areas shall not exceed 465 m^2 (5000 ft^2).

13.19.10 Where trenches or plastic piping containing flammable or combustible organics enter a lower-grade tank farm or pumping area, a barrier wall shall be provided to prevent spilled liquids at the higher level from flowing into the lower area.

13.19.10.1 Where plastic piping containing flammable or combustible liquids passes through a barrier wall, a steel spool pipe of a minimum 1.5 m (5 ft) shall be provided on both sides of the wall.

13.19.10.2 An emergency, remotely actuated shutoff valve shall be provided on pipe lines containing flammable or combustible liquids that penetrate the barrier wall.

13.19.11 Shutoff valves on PLS lines shall be capable of being shut off remotely.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 Because of the uniqueness and often remoteness of metal and nonmetal mines and ore processing facilities, provisions in this standard could differ from commonly accepted fire protection standards and guides devised for other types of occupancies. The provisions of this document are considered necessary to provide a reasonable level of protection from loss of life and property from fire and explosions. They reflect situations and the state of the art at the time the standard was issued.

As of 2001, there were 12,479 metal/nonmetal mining and processing operation in the United States. In the most recent 12-year period, approximately 515 fires of all types were reported.

Fires and explosions in mines and mineral processing plants have caused major loss of property, production equipment, buildings, and business interruption. In the five-year period from 1994 to 1998, mines and quarries of all types averaged $12.3 million a year in direct damage in fires reported to U.S. local fire departments. In the same period, nonmetallic mineral processing and product manufacturing facilities averaged $16.1 million a year in direct damage in fires reported to U.S. local fire departments. *(For more information, see the NFPA Fire Protection Handbook, 2008 edition, Chapter 9, Section 9.16.)*

Fires adversely affect all areas of mining and mineral processing operations, including underground and surface self-propelled and mobile mining equipment, underground fuel storage areas, surface ore concentrating and processing buildings and equipment, and support facilities associated with these activities.

Fire and related hazards in metal ore processing facilities include but are not limited to conveyor belts; rubber lined equipment; combustible and flammable reagents; gaseous, liquid, or solid fuels; mineral extraction solvents and carriers; dielectric, thermal, and lubricating oils; hydraulic fluids; grouped plastic electric cables; and combustible construction. Significant fire and explosions have occurred in concentrator mills due to these hazards.

Ignition sources for these hazards are present and cannot always be controlled. The most common ignition source in this industry is uncontrolled hot work.

Control and awareness of combustible loading, including "hidden" combustibles like rubber or plastic lined equipment, is important to understanding these hazards. Automatic fire suppression systems coupled with effective emergency response have been effective in limiting fire damage in processing facilities.

Most fires involving mobile or self-propelled mining equipment — whether underground or surface— occur on or near engine exhaust systems, high-speed drive lines, malfunctioning high-pressure–high-temperature hydraulic systems, or faulty electrical components. Total elimination of fire hazards on equipment is impossible since sources of ignition and fuel for fires are inherent in the basic equipment design. The fire problem is further complicated by the collection of environmental debris. Therefore, efforts to reduce fire losses on mobile equipment must be aimed at fire prevention and fire suppression.

To improve fire protection and prevention on mining equipment, some manufacturers of mining equipment have placed emphasis on the reduction of the fire potential of specific items in the original design of their equipment. Such items include turbochargers, exhaust manifolds and exhaust pipe shielding and insulation, location of combustible and flammable liquid reservoirs, and hydraulic and fuel line routing.

Most mining equipment is required to have at least one hand-portable extinguisher mounted in a readily accessible location. Extinguishers are most effective where used by trained operators. However, considering the size and configuration of machines found at a mine, fires can be difficult or impossible to fight with a hand-held extinguisher. For this reason, fire suppression systems have been developed to aid in suppressing those fires that are hard to access and thereby to reduce "off-road" equipment fire losses.

The key to operator protection is early detection of fires to provide a warning to the operator, fuel shutoff to minimize fuel for the fire, and fire suppression during its earliest stages. Specialized systems to perform these functions can be required to protect the operator and the machines. To be totally effective, however, system operation must be fully understood by owners and operators, and provisions must be made for periodic inspection and maintenance.

Fire suppression systems, including hand-portable extinguishers, offer the mining industry a cost-effective tool by which personnel and investments in mining equipment can be protected.

It could be necessary for those charged with purchasing, testing, approving, and maintaining fire protection equipment for the mining industry to consult an experienced fire protection specialist.

A.1.1.6 A typical metal mineral processing plant — also called a concentrating or dressing mill — is physically separated from the mining operation, although it can be connected by conveyor systems. Typical metals produced using concentrator plants are gold, silver, platinum, nickel, zinc, lead, molybdenum, and copper. Essentially any metal can be concentrated in this manner. Some concentrating mills are located on floating dredges, such as those used in titanium mining.

The general purpose of the processing plant is to receive crushed ore, further reduce it in size by additional crushing, milling, and screening, and separate waste materials (gangue) from desirable metal mineral values. Most metal mineral mills are similar in that they have large semi-autogenous, ball, or roll mills for fine grinding the ore into a pulp or slurry. Once ground, the slurry is processed by flotation or beneficiation using reagents. After flotation, the concentrate — which can be in the 20 percent to 30 percent metals value range — is filtered or thermally dried and stored. Some metals, like molybdenum, feature combustible thermal oils in the drying process. Concentrate is sent to metallurgical refineries to recover the final pure product. The refinery might be adjacent to the mill but is usually separate.

By-products produced in a typical metal concentrator mill include tailings, which consist of waste gangue and entrained water and process chemicals. This waste is sent to a tailings disposal facility.

A.1.1.7 There are number of processes associated with concentration or refining of metal ores that are not applicable to this standard but deserve mention due to their hazards and integration with the concentration process. These include solvent extraction–electrowinning (SX–EW); pressure leaching processes (using high-pressure autoclave reactors); alumina refineries; metal smelters, including flash furnaces; roasting, sintering, calcining, and electro-refining processes; and gas, liquid, or solid waste handling systems. There are also nonmetal mineral processing plants such as those used for recovering phosphates, nitrates, potash, and soda ash. All of these processes are chemical in nature, and all have serious fire and explosion hazards.

Of particular mention and importance from a potential fire hazard standpoint are solvent extraction (SX) plants, which are covered in Section 13.18 (for new and existing facilities) and Section 13.19 (for new facilities).

An SX plant is a separations process using combustible solvents like kerosene or alcohol for separating valuable metal minerals. An SX process facility often features thousands of gallons of solvent in plastic tanks using plastic piping and can be located outdoors or inside buildings. SX plants are common at copper mines where the oxide content of the ore body allows acid leaching in heaps. They are also common for uranium, nickel, and cobalt.

While kerosene is usually a Class II combustible liquid and in a cold state is relatively difficult to ignite, once ignited it burns similar to other lower flash point hydrocarbons. At high elevations, the flash point can render the material a Class I flammable liquid. In very hot climates, the material can be above its flash point and the potential for heating is increased when the solution is carried in black plastic piping subject to solar heating.

Protection of SX plants needs to consider response time of fire fighters and types of fire fighting appliances and suppression agents. Because of the large quantities of combustible liquids and use of plastic piping and process systems — which can fail prematurely due to fire impingement and rapidly release additional combustible liquids — a well-developed and large area fire could occur in minutes, and responding fire fighters could be faced with protecting exposures rather than suppression of the incipient event. For this reason the use of fast-acting automatic detection and suppression systems is advised. Foam-water systems have proven effective in suppressing combustible liquid fires. If used, consideration needs to be given to providing protection over and under mixer-settlers and tanks, in tunnels with plastic piping, under pipe racks, over pumps, and inside mixer-settlers.

Provision of drainage, confinement, control of static electricity by bonding and grounding, and selection of stout piping systems, such as stainless steel or structural fiberglass reinforced plastic instead of less robust polyethylene, is advised.

A mineral SX plant should not be confused with an agricultural SX plant that uses low flash point flammable solvents, like hexane, for recovering oils from soybeans, canola, and corn, and that has a higher hazard. NFPA 36 applies to protection of agricultural solvent extraction plants but does not apply to protection of mineral solvent extraction plants. There currently are no NFPA standards on mineral SX plants.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.9 Emergency Egress. See NFPA *101* for the use of the term.

A.3.3.16 Flash Point. The flash point of a liquid having a viscosity less than 45 SUS at 37.8°C (100°F) or a flash point of 93.4°C (200°F) or higher shall be determined in accordance with ASTM D56, *Standard Method of Test for Flash Point by the Tag Closed Cup Tester.*

The flash point of a liquid having a viscosity of 45 SUS or more at 37.8°C (100°F) or a flash point of 93.4°C (200°F) or higher shall be determined in accordance with ASTM D93, *Standard Test Methods for Flash Point by the Pensky-Martens Closed-Cup Tester.*

As an alternative, ASTM D3278, *Standard Method of Tests for Flash Point of Liquids by Small-Scale Closed-Cup Apparatus*, shall be permitted to be used for paints, enamels, lacquers, varnishes, and related products and their components having flash points between 0°C to 110°C (32°F to 230°F), and having a viscosity lower than 150 stokes at 25°C (77°F).

A.3.3.23 Metal Mineral Processing Plant. A mineral processing plant, also called a concentrator mill or a dressing plant, can have crushers; grinding mills; fuel-fired dryers; separation circuits featuring flammable, combustible, or toxic liquid reagents in flotation cells; and possibly special hazard circuits using thermal oils and solvent extraction. A mineral processing plant is usually located close to the mine due to cost of shipping raw ore long distances.

A.3.3.25 Mineral. *Mineral* in this document refers only to metal or nonmetal ores and not to coal.

A.3.3.27 Noncombustible Material. Materials that are reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, are considered noncombustible materials.

A.3.3.33 Safe Area. Examples are designated welding shops.

A.3.3.37 Self-Igniting Rock. In metal/nonmetal mines this usually pertains to sulfide ores or coal deposits.

A.3.3.39 Solvent Extraction (SX) Facility. A hydrometallurgical solvent extraction facility is not to be confused with an agricultural solvent extraction plant that uses hexane or other low flash point flammable or combustible liquid to recover edible oils such as soy, palm, or corn oil. Agricultural solvent extraction plants are covered by NFPA 36. NFPA 36 is not to be used for protection requirements of hydrometallurgical solvent extraction facilities.

A.4.4.21 For additional information, see NFPA 326 and AWS F4.1, *Safe Practices for the Preparation of Containers and Piping for Welding and Cutting*.

A.5.1 See Annex B for suggested procedure to conduct a fire risk assessment.

A.5.1.4 Examples of where fixed protection might be needed in mineral processing plants include conveyor belts, galleries, tunnels, over rubber and plastic constructed or lined equipment, switch gear rooms, control rooms, change houses, and combustible and flammable liquids storage or process areas. Areas with noncombustible construction or noncombustible contents are areas where fixed protection might not be needed.

A.7.1.1 Some examples of equipment modifications that can favorably reduce risk of fire include physical barrier between fuel and ignition sources, thermal shields over hot surfaces, hydraulic hose and electrical wiring harness rerouting, and power shutoffs.

A.7.1.2 Modifications could affect the life expectancy and certification of diesel-powered equipment and diesel-powered equipment components. It is possible that such a modified machine would not be covered by the manufacturer's warranty or certification. Questions concerning the effect of a proposed modification should be discussed with the diesel-powered equipment manufacturer or the manufacturer's representative.

A.7.4(3) Depending upon the size of the equipment, additional ground-level manual actuators could be needed to provide quick access for manual activation of the system.

A.8.3.4 Where pressurized pipeline systems are used for combustible liquid transfer, consideration should be given to providing a pressure-sensing interlock downstream of the transfer pump discharge. This interlock should be suitable for Class I, Division 2 locations and should be arranged to shut down the pump immediately upon loss of line pressure.

A.9.1 Because of the inherent hazards associated with flammable liquids, the underground storage of flammable liquids should be avoided.

A.9.1.1 Electrical equipment classified as "permissible" is certified as meeting the requirements of 18 CFR, Chapter 1.

A.9.4.2.1 Electrical equipment classified as "permissible" is certified as meeting the requirements of 18 CFR, Chapter 1.

A.10.3 Atmospheric tanks should be built in accordance with good engineering practices.

Information on the design and construction of tanks can be found in API 650, *Standard for Welded Steel Tanks for Oil Storage*; UL 80, *Standard for Steel Tanks for Oil Burner Fuels or Other Combustible Liquids*; or UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*.

Low-pressure tanks and pressure vessels can be permitted to be used as atmospheric tanks.

A.10.4 Low-pressure tanks should be built in accordance with good engineering practices.

A.10.5 Pressure vessels should be built in accordance with good engineering practices.

Information on the design and construction of pressure vessels can be found in the *Code for Unfired Pressure Vessels*, Section VIII, Division I, of the ASME *Boiler and Pressure Vessel Code*.

A.10.6.2.1 Information on venting can be found in API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks*.

A.10.9.15 Information on tank foundations can be found in API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks*, Appendix B, and API 650, *Standard for Welded Steel Tanks for Oil Storage*, Appendix E.

A.10.10 No requirements for bonding or grounding to dissipate static electricity are included in this standard for combustible liquids, based upon the fact that NFPA 30 does not require bonding or grounding for combustible liquids handled at temperatures below their flash points.

However, it is recognized that certain conditions can exist that could necessitate bonding or grounding, such as temperature and altitude, which can reduce the flash point of diesel fuel.

For additional information on static electricity, see NFPA 77.

A.11.3.1 Underground shaft mines that use diesel-powered equipment generally employ underground diesel fuel storage areas to facilitate equipment refueling. Adit-type mines in the western United States can initially locate diesel fuel storage and refueling facilities on the surface; however, as the active mine workings progress further from the adit portal(s), these facilities usually are moved underground.

A common means of fire protection currently found in many underground diesel fuel storage areas is a fixed water sprinkler system. The federal Mine Safety and Health Administration (MSHA) currently approves such systems for this application. The consensus of the committee is that this situation represents a significant safety hazard. According to the NFPA *Fire Protection Handbook*, water sprinklers can be used on diesel fuel for control but not for extinguishment.

"The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," a report by an interagency task group prepared for MSHA in 1985, concludes that "water spray or fog usually will not extinguish diesel fuel fires."

In an underground mine, fire control is not sufficient; fire extinguishment is essential for the following reasons:

(1) As long as a fire burns, even if it does not grow in intensity or area and appears to be responsive to fire control, toxic smoke and fire gases are produced that can endanger persons in the mine.
(2) According to the NFPA *Fire Protection Handbook*, overpressure failure of containers when exposed to fire is considered the principal hazard of closed-container flammable and combustible liquid storage.
(3) Even a "controlled" fire can cause container failure, producing a fire so intense that the sprinkler system is unable to control it, much less extinguish it.
(4) Water sprays are not effective in extinguishing pressure fires, running fuel fires, and obstructed spill fires, all of which can occur in a diesel refueling area.
(5) Water supplies are limited in many underground mines. Fire control, therefore, should be considered temporary, because the fire will grow immediately to maximum intensity when the water supply is depleted.
(6) The vapor pressure of diesel fuel increases with elevation due to reduced barometric pressure. As a result, even fuels without flash point–reducing additives can become flammable, depending on the altitude at which they are used. This reduction in flash point could result in reclassification of the diesel fuel to a Class IC flammable liquid. There is no clear consensus in the literature and industry practice as to the effectiveness of fixed water sprays in controlling and extinguishing fires involving Class IC flammable liquids. Although industry practice strongly favors fixed water sprays for such applications, the literature and available research results clearly indicate the ineffectiveness of fixed sprays on Class IC liquids, especially on pressure fires, running fuel fires, and obstructed spill fires.

Water sprinkler systems installed for the protection of diesel fuel storage areas might not be effective in suppression even though they do provide good control through cooling; foam-water systems can provide suppression.

For further information on foam-water systems, see NFPA 16.

A.12.2 Fires adversely affect all types of self-propelled and mobile surface mining equipment, including, but not limited to, trucks, front-end loaders, crawlers, drills, shovels, and draglines. Most fires occur on or near engine exhaust systems, high-speed drive lines, malfunctioning high-pressure–high-temperature hydraulic systems, or faulty electrical components.

Total elimination of fire hazards is impossible, because sources of ignition and fuel for fires are inherent in the basic equipment design. The problem is further complicated by the collection of environmental debris. Therefore, efforts to reduce fire losses must be aimed at fire prevention and fire suppression.

To improve fire protection and prevention on surface mining equipment, some manufacturers of mining equipment emphasize the reduction of the fire potential of specific items in the original design of their equipment. Such items include turbochargers, exhaust manifolds and exhaust pipe shielding and insulation, location of combustible and flammable liquid reservoirs, and hydraulic and fuel-line routing.

Most surface mining equipment is required to have at least one hand-portable extinguisher mounted in a readily accessible location. Extinguishers are most effective when used by trained operators. However, considering the size and configuration of machines found at a mine, fires can be difficult or impossible to fight with a hand-held extinguisher. For this reason, fire suppression systems have been developed to aid in suppressing those fires that are hard to access and thereby to reduce "off-road" equipment fire losses.

The key to operator protection is early detection of fires to provide a warning to the operator, fuel shutoff to minimize fuel for the fire, and fire suppression during its earliest stages. Specialized systems to perform these functions can be required to protect the operator and the machines. To be totally effective, however, system operation must be fully understood by owners and operators, and provisions must be made for periodic inspection and maintenance.

Fire suppression systems, including hand-portable extinguishers, offer the mining industry a cost-effective tool by which personnel and investments in mining equipment can be protected.

A.12.3.4.1 Depending on the size of the vehicle and size of the fire, a 9.1 kg (20 lb) fire extinguisher could be more effective.

A.12.3.4.9(8) The same record tag or label can also indicate if recharging was performed.

A.12.3.5.2.1 A dry-chemical system is the preferred system for these areas.

A.12.3.5.2.2 Smoke detectors are not recommended because of the harsh environment.

A.12.3.5.3.1 Automatic systems are not necessary if the area is easily accessible for manual fire fighting.

A.12.3.5.4.2 Carbon dioxide would not be the best choice for fighting this type of fire due to the potential for the gas to be dispersed before the oxygen concentration is reduced enough to affect the fire.

For transformers over 5000 kVA, a fixed fire suppression system is recommended.

A.12.3.6.1.1 Equipment in this category is generally a vehicle weight of 90,720 kg (200,000 lb) or more and the size of a Hitachi 1800, Caterpillar 5230, Komatsu PC1000-6, Liebherr R984, DeMag H95, and Hitachi 1100.

A.12.3.8.1.1 Depending on the size of the vehicle and size of the fire, a 9.1 kg (20 lb) fire extinguisher could be more effective.

A.12.3.8.2.5 NFPA and manufacturers require 6-month inspections.

A.12.3.8.3.2 The following are examples of large equipment:

(1) Track dozer of 300 horsepower or more or 31,750 kg (70,000 lb) weight or more (e.g., Caterpillar D8R)
(2) Front-end loader of 400 horsepower or more and vehicle weight of 45,400 kg (100,000 lb) (e.g., Caterpillar 988)
(3) Wheel bulldozer of 300 horsepower or more and vehicle weight of 27,200 kg (60,000 lb) or more (e.g., Caterpillar 824G)
(4) Grader of 275 horsepower or more and vehicle weight of 25,000 kg (55,000 lb) or more (e.g., Caterpillar 16H)
(5) Pull-type scraper of 450 horsepower or more and vehicle weight of 44,450 kg (98,000 lb) or more (Caterpillar 631E)
(6) Scraper with push/pull twin engine of 450 horsepower and 490 horsepower or more and vehicle weight of 51,260 kg (113,000 lb) or more (e.g., Caterpillar 637E)
(7) Blast hole drill of 360 horsepower or more and weight of 30,845 kg (68,000 lb) or more (e.g., Ingersol-Rand DM-30)

A.12.3.8.3.3(4) Depending on the size of the equipment, additional ground-level manual actuators could be needed to provide quick access for manual activation of the system.

A.12.3.8.3.7 Periodic maintenance is required by NFPA standards and by manufacturers. Although other training resources are available, the fire suppression system manufacturer is the best source for proper training regarding their equipment.

A.13.7 A readily available supply can include a dedicated fire protection water supply, a pond or other large body of water, an industrial process water system, or large water trucks (tankers). If water trucks (tankers) are used, they should be of a capacity and quantity to deliver a continuous source of water for the duration of the fire-fighting effort. Personnel should be trained in emergency vehicle operation and mobile water supply shuttle procedures. If an impounded body of water is provided, it should be close and accessible enough to the protected property to allow fire fighters a quick response.

A.13.7.3 Chapter 5 and Appendix G of NFPA 1142 outline suggested methods for determining the estimated water supply (fire flow) that can be necessary for fire-fighting purposes.

A.13.10.1 The following should be considered when conducting a fire risk assessment on rubber and plastic lined equipment:

(1) Many fires occur annually inside rubber lined equipment in concentrator plants.
(2) Many rubber lined equipment fires are quickly controlled and not reported, but some have spread throughout a circuit or several circuits and have caused significant property damage and business interruption. If located near a wall or ceiling, heat inside an internal rubber lined system might cause structural damage.
(3) Rubber lined equipment fires are usually caused by hot work. These fires can occur when heating the outside of a steel pipe lined with rubber or plastic, with heat passing into the interior lining and ignition inside. They could also occur due to hot work over open-topped tanks and vessels, which will normally occur when the plant is down for maintenance and the systems are dry.
(4) Once a fire enters the inside of a dry rubber lined system, it can spread unchecked.
(5) Where practical during new process installations or modifications, the use of rubber or plastic lining and plastic vessel and piping should be minimized or eliminated.
(6) Hot work on or over plastic or rubber lined vessels should be minimized, and alternate methods of repair exhausted prior to permitting hot work.
(7) When hot work is necessary, and where practical, vessels can be flooded with process or fire protection water to minimize internal ignition.
(8) When hot work is necessary, and where practical, vessels and piping should be isolated by closing process valves or breaking connection to minimize internal fire spread between processing circuits.
(9) Protection options might include smoke or heat detection, local fixed automatic sprinkler or water spray suppression, extinguishers, or hand hose lines. Flooding a circuit with process water is a good suppression technique as long as the responding emergency team knows which valves to open and has planned for this contingency.

A.13.11.1 The following should be considered when conducting a fire risk assessment on plastic constructed equipment:

(1) Similar to rubber or plastic lined equipment, there is increasingly new equipment constructed entirely of plastic, such as process vessels, pipes, and cooling towers.
(2) Hazards are similar to rubber lined equipment, and identification, labeling, hazard awareness, and fire planning are required.
(3) The use of fixed automatic sprinkler systems over large concentrations of plastic equipment has been effective.

A.13.12.4 The following should be considered when conducting a fire risk assessment on a conveyor system:

(1) Belt fire retardancy
(2) Size and speed
(3) Degree of confinement
(4) Accessibility for manual fire fighting

Automatic sprinklers have been effective in limiting damage in conveyor systems.

A.13.12.6 Conveyor belt ignition sources include friction points, hot bearings, tracking, frame damage, electrical, combustible storage, hot work, and spontaneous combustion of spilled fuels. Acceptable protection systems for conveyors shall include automatic sprinklers, water spray systems, foam water systems, smoke and heat detection systems, dry chemical systems, pre-engineered dry chemical or wet chemical systems, portable extinguishers, and hand hose lines.

A.13.13.1 The following should be considered when conducting a fire risk assessment on a hydraulic or lubricating oil system:

(1) Individual and aggregate quantity of fluid or oil
(2) System location
(3) System design
(4) Type and fire hazard of fluid or oil
(5) Pressures
(6) Temperatures
(7) Presence of ignition sources
(8) Importance
(9) Attended or not
(10) Presence of personnel in area

Hydraulic fluid and lubrication oil tanks and pumps should be located as to not expose grouped electrical cables, rubber or plastic equipment, or other critical equipment to fire damage.

Acceptable protection systems shall include automatic sprinklers, water spray systems, dry chemical systems, pre-engineered dry chemical or wet chemical systems, portable hand hose lines and extinguishers, and detection.

A.13.14 Thermal oil systems are used in some mineral processing plants, such as molybdenum concentrator mills, for drying ore.

Chapter 8 of NFPA 664 is the primary reference in NFPA standards for thermal oil systems used in industrial processes. Even though the woodworking industry has unique equipment, the hot oil heating and distribution systems are similar, and the concepts provided in this standard can be utilized for the mineral processing industry.

A.13.14.1 As determined by the fire risk assessment, additional fire protection might be needed to fully protect thermal oil systems.

The following should be considered when conducting a fire risk assessment on a thermal oil system:

(1) Additional or back-up fixed fire suppression
(2) Locating the heater and tanks outdoors or in detached buildings
(3) Proper location and confinement of expansion and storage tanks and heaters
(4) Proper piping arrangement
(5) Process interlocks and controls
(6) Explosion protection
(7) Damage limiting construction from an oil mist explosion

A.13.16 Positive pressure should be maintained in electrical equipment rooms such as switch gear, motor control centers, and cable-spreading rooms to prevent the entry of fugitive dust that can cause overheating or short circuits.

Thermographic scanning can be performed on transformers, switchgear, and motor starters on an annual basis.

A.13.18 See Table A.13.18 for fire experience data justifying the addition of the requirements in Section 13.18.

A.13.18.1 The design intent within this standard for protection of hydro-metallurgical solvent extraction (SX) facilities is to limit a fire to a single train rather than to a single cell. A typical SX facility will have multiple (three or more) mixer-settler cells comprising a single train. The distance between cells within a single train might be only a few meters (feet), usually the width of a walkway. Parallel trains of multiple cells might also be present and these are usually separated from adjacent trains by 7.6 m to 15.24 m (25 ft to 50 ft), usually the width of a roadway.

Should the design intent be to limit the fire to a single cell, then additional fire protection might be required. The risk assessment should define the level of tolerable risk. The actions taken might then focus more on spatial separation, barriers, construction, and so forth.

Mining companies use solvent extraction (SX) processes to separate valuable base metal minerals. This technology is common with copper, uranium, nickel, cobalt, and many specialty metals. A typical hydro-metallurgical SX facility features thousands if not hundreds of thousands of cubic meters (gallons) of flammable or combustible liquids and is commonly located at a remote mining site near the ore body being mined. Larger SX facilities — notably copper and uranium — are located outdoors but might be located indoors for nickel, cobalt, lithium, iodine, and other metals.

A hydro-metallurgical SX facility should not be confused with an agricultural SX facility that uses low flash point flammable solvents, like hexane, for recovering edible oils from soybeans, canola, and corn, and that has a higher hazard. NFPA 36 applies to protection of agricultural solvent extraction plants but does not apply to and should not be applied for protection of hydro-metallurgical SX facilities.

Severe fire hazards exist with mineral SX facilities due to large volumes of combustible or flammable liquids, often in large open pools. Because SX solvents are normally cold (that is, at ambient temperature well below their boiling points), severe explosion hazards generally do not exist. Most large copper-uranium–type SX facilities use a grade of high purity kerosene, but some more refined metals like lithium feature lower flash point alcohols. Fires are generally two-dimensional pool fires rather than three-dimensional fires. Rarely will a pressurized jet spray occur. SX operations at elevated temperatures also affect the flash point of the solvent (refer to A.13.18.5).

Historically, losses in hydro-metallurgical SX facilities have been infrequent but severe. Two significantly large SX fires occurred within 6 months at one Australian copper-uranium mine. The primary conclusions from the two Australian fires are the following:

(1) Thermoplastic high density polyethylene (HDPE) pipes fail prematurely under fire conditions and rapidly release solvents.
(2) Plastic pipes can allow fire spread internally within the pipes.
(3) Stainless steel piping is preferable to plastic but can be attacked by chlorides and might not be suitable for all SX facility services.
(4) While combustible, structural fiber reinforced plastic (FRP) piping is better than HDPE because it does not soften or fail as fast.
(5) Electrical static charge buildup can occur in both metal and plastic due to the movement of flammable or combustible solvents.
(6) Static charge can potentially ignite solvent mists inside pipes.
(7) Static charge can be minimized by:
    (a) Conductive lining inside pipes
    (b) Improved grounding and bonding
    (c) Control of free-falling liquids and mist generation by submerging pipes in the solution
(8) High speed fire detection systems are preferable.
(9) Fireproofing of control system cabling is needed.
(10) Larger capacity fire protection/suppression systems are needed as follows:
    (a) Foam-water suppression systems are preferable to water-based systems.
    (b) High capacity fire water pumping systems.
    (c) Foam-water systems on pipe racks.
    (d) Foam-water systems for all diked areas.
    (e) Deluge (open-head) protection on solvent feed pumps.
(11) High capacity drainage systems are needed.
(12) Diversion systems for spilled solvents might be needed.
(13) Improved dike design is needed to minimize solvent pooling.
(14) Separation of equipment and financial assets.

Table A.13.18 Example Global Fire Losses Involving Hydro-Metallurgical Solvent Extraction Plants[1]

Location	Date	Process	Protection	Incident	Cause	Results
Norway (Ref: 2)	1972	Cobalt-nickel SX using kerosene; glass piping; indoor process	Manual response with water hoses	Solvent spill into pit below M-S; glass piping failed under fire exposure	Hot work	Three fatalities; plant destroyed; $75 M damage; six months production outage
U.S. (Ref: Private files)	1975	Rhenium-tungsten SX using mineral spirits and perchloric acid; plastic piping (FRP); indoor process	Automatic sprinklers over process area; manual response with water hoses	Small solvent spill spread into M-S cells and through plant; additional solvent fed by failed plastic pipes	Perchloric acid reaction	Plant destroyed; >$10 M damage; six months production outage
Namibia (Ref: Private files)	1978	Uranium SX using kerosene; outdoor process; plastic piping	Manual response with water hoses	Solvent leaked from plastic pipe; additional solvent fed by failed plastic pipes	Electrical	Total plant damage; >$50 M damage; four months production outage
Australia (Ref: 3, 4)	1999	Uranium-copper SX using kerosene; outdoor process; plastic (HDPE) piping	Partial foam-water sprinklers; manual response with foam-monitor nozzles	Solvent release at plastic pipe; fire spread throughout local area; additional solvent fed by failed plastic pipes	Not reported	Partial plant damage; >$40 M damage; nine months production outage
Australia (Ref: 3, 4)	2001	Uranium-copper SX using kerosene; outdoor process; plastic (HDPE) piping	Partial foam-water sprinklers; manual response with foam-monitor nozzles	Solvent release at plastic pipe; fire spread throughout wide area; additional solvent fed by failed plastic pipes	Possible static ignition inside nonconductive plastic pipe	Widespread plant severe damage; >$100 M damage; two years production outage
U.S. (Ref: 4, 5)	2003	Copper SX using kerosene solvent; outdoor process	Unknown	Solvent fire involving M-S cells	Unknown	Four M-S cells partially damaged; $5–10 M damage reported by AP
Mexico (Ref: Internet news services)	2003	Copper SX using kerosene solvent; outdoor process	Unknown	Solvent fire involving M-S cells	Not reported	Not reported

Note: Financial loss estimates are indexed to 2005 U.S. currency.

References for Table A.13.18

1. Moore, L., "Using Principles of Inherent Safety for Design of Hydrometallurgical Solvent Extraction Plants," Society of Mining and Exploration (SME) 2006 Annual Meeting, St. Louis, MO, April 2006.

2. Hoy-Peterson, R., *Fire Prevention in Solvent Extraction Plants*, Proceedings of the 1st International Loss Prevention Symposium, The Hague/Delft, the Netherlands, May 1974.

3. Rizzuto, F., "Fire Protection for Solvent Extraction Plants, What We Can Learn from Olympic Dam," *Plumbing Engineer*, 2002, pp. 43–49.

4. *Mining Journal* (various 1999–2004), Albert House, 1 Slinger Street, London, UK, Published by Mining Communications Ltd.

5. Associated Press, *Fire deals big hit to Phelps Dodge*, Oct. 21, 2003.

The fires demonstrated that more rigorous and comprehensive fire protection standards are needed for SX facilities. They also demonstrated the need for process safety management (PSM) oversight and the need for better inherent safety practices in SX facility design.

The need for fixed automatic fire suppression systems actuated by high speed detection systems is readily apparent. A number of suppression systems such as closed head or deluge water-spray, foam-water delivered by nozzles or foam chambers, dry chemical, or high pressure water mist might be applicable and suitable, depending on local conditions. Drainage, isolation, and confinement are also important protection measures.

Some protection solutions and options are as follows:

(1) Where possible, avoid below-grade spaces for tank farms and process equipment. Where possible, site all facilities at the same grade.
(2) Where lower grade tank farms are present and where solvents can flow from upper level processes, provide a barrier to flow. Where plastic pipes penetrate a barrier, the use of steel spools on both sides of the barrier should be considered. The steel spool pieces can help prevent internal fire spread within the plastic pipes. A 3 m (10 ft) long steel spool has proven effective.
(3) Where pipes enter a lower grade tank farm, provide automatic shutoff valves to prevent continued flow of organic solvents or drainage into a fire area.
(4) Avoid use of sub-grade trenches for solvent piping systems. Where possible, locate pipes above grade. Where trenches are required, subdivide trenches with dikes or curbs and do not drain into lower grade areas such as tank farms.
(5) Provide dikes and curbs around tanks, pumps, and process vessels.
(6) Avoid or minimize the use of combustible (plastic) and frangible (glass) piping systems and vessels. Avoid the use of thermoplastics such as HDPE, medium density polyethylene (MDPE), and polypropylene (PP) for piping systems.
(7) Avoid the use of rubber couplings on solvent lines, especially on pump suction lines.
(8) Substitute steel or concrete for plastic where possible for vessels and piping.
(9) Where use of steel piping is not possible due to corrosive effects, substitute a structural (thermoset) plastic such as fiber reinforced plastic (FRP) or polyvinyl chloride (PVC).
(10) Consider drainage patterns during design. Where practical, provide emergency drainage to a remote catch basin or pond from all diked areas and pipe trenches.
(11) Provide emergency dump capability from all tanks and vessels that actuates either manually or upon fire detection with drainage to remote catch basin or pond.
(12) Space mixer-settler tanks and storage tanks as far apart as possible.
(13) Lower roofs and covers on tanks and process vessel to minimize vapor collection space above liquid surfaces.
(14) Consider ignition sources in design.
    (a) Where nonconductive* solvents are used with plastic piping systems, provide a conductive internal pipe liner (i.e., carbon) to dissipate static charges generated by liquid flow. Bond and ground the system, including at flanges. [*Note: A conductive fluid is one with a conductivity of 250 picosiemens per meter (pS/m) or greater.]
    (b) Submerge or lower solvent feed pipes where they enter solvent pools (i.e., inside mixer-settler and tank discharge) to minimize static discharge from free-falling flammable liquids and to minimize solvent mist development.
    (c) Inspect piping for jarosite or other nonconductive inorganic coating that might compromise conductive liners.
    (d) Provide electrically classified electrical equipment in solvent handling areas. Base the classification on types and hazards of solvents in process. In some cases, explosionproof equipment may be needed.
(15) Provide fixed water, foam-water, or dry chemical fire suppression as follows:
    (a) Interior of mixer-settler vessels
    (b) Over the surface of open mixer-settler tanks
    (c) Along launders and open solvent weirs outside of mixer-settler vessels
    (d) Inside sub-grade pipe trenches carrying solvents where drainage is missing or poor, and liquids can accumulate
    (e) Inside solvent storage tanks
    (f) Inside dikes enclosing solvent storage tanks
    (g) Over solvent pumps
    (h) Along the exterior sides of tanks and mixer-settlers if spaced closer than 15 m (50 ft) from each other
    (i) Over elevated pipe racks carrying flammable solvents in plastic pipes
    (j) Over other critical equipment (like transformers) or outside along important building walls (i.e., MCC rooms) that are within 15 m (50 ft) of a solvent fire area
(16) Conduct a process hazard analysis (such as a HAZOP) on all new and existing SX facilities. Conduct revalidation process hazard analysis (PHA) every 5 years and during major changes.
(17) Operate facility under a process safety management system with emphasis on management of change.

The use of inherent safety (IS) principles in design and operation of solvent extraction (SX) facilities is advised.

The mining industry has designed and constructed facilities with an emphasis on personnel safety, production efficiency, and cost effectiveness. The use of IS to eliminate or minimize property fire exposures in the mining industry has not seen widespread practice. Lessons learned from the mainstream chemical processing industries (CPI) appear not to have been well-communicated or applied.

As an example, most copper SX facilities in use today have been designed to use some form of a sub-grade processing area (tank farm) and one-way gravity flow as a cost- and production-effective solution for transferring liquids and minerals through the process. This has resulted in SX facilities constructed with process equipment at different grade levels so that solutions can flow “downhill” and accumulate. Because of the use of large quantities of combustible or flammable liquids and the potential for these liquids — if released — to flow unimpeded into other areas, gravity SX processes represent severe inherent fire consequences unless costly barriers, drainage, and channeling are also provided.

While this layout is used to ensure a cost-effective operation, it has resulted in significant exposures to high value production and equipment. The use of sub-grade production units is a generally inherent unsafe layout where flammable liquids are used.

Gravity-assist layout is only one example where copper SX facilities have been designed and constructed without IS consideration. The use of combustible and frangible corrosion-resistant materials — such as glass, wood, and plastic — for flammable/combustible liquid storage, processing, and piping systems has significantly increased the fire hazards of these facilities. These construction materials are not of sufficient strength and durability to prevent fire spread and can rapidly fail under fire conditions, releasing flammable contents.

Another example of inherently unsafe layout is the widespread use of sub-grade trenches to carry solvent pipe systems. Access to trenches for fire fighting is usually limited and the trenches often drain directly into the lower grade tank farm areas. Trenches usually encircle solvent-filled cells and have open grated coverings; therefore they represent severe fire risk to production equipment such as mixer-settlers (M-S). Trenches also offer low spots for vapors or liquids to accumulate and might require mechanical ventilation systems to prevent flammable vapor accumulation. The use of plastic piping in trenches further increases the hazard. The CPI long ago discontinued the use of sub-grade trenches for transporting combustible/flammable materials, replaced with elevated, easily accessible, and well-ventilated pipe racks.

The classical and common approach to loss prevention for industrial facilities has been to accept a hazard and to protect against it. This approach usually requires expensive and sophisticated retrofitted protection systems, which are subject to failure during the life of the plant. An inherently safer plant eliminates or reduces the hazard to where protection systems might not be needed or can be reduced, saving initial installation cost, lifetime maintenance and testing, and potential loss costs should systems fail.

The "hypothetical" ideal IS approach would be to completely change the technology or process chemistry of SX facilities. The extent to which this could be technically or economically achieved is not known, but some ideas are the following:

(1) Develop and use a nonflammable organic solvent.
(2) Develop and use a less flammable organic solvent.
(3) Find an additive that lowers the resistance coefficient of the solvent to eliminate the potential for static electricity generation.
(4) Develop a new process to extract minerals by significant reduction in quantities and flow of solvent and eliminate large open pools of flammable liquids.

Given that the basic science and technology of a well-established process cannot always be economically changed and that combustible solvents will likely continue to be used in large quantities, potential IS opportunities should focus on changes to design and layout concepts. Some ideas are the following:

(1) Stop or reduce the practice of gravity flow in the SX process.
(2) Install equipment and processes at the same grade level rather than using lower grade tank farms.
(3) Eliminate the use of sub-grade trenches for piping; place piping on elevated pipe racks located away from solvent storage or drainage discharge areas.
(4) Separate buildings, vessels, and process areas based on a risk assessment that includes the impact of radiant heat, wind effects, and drainage patterns.
(5) Lower mixer-settler roofs to rest on or near the top of the liquid layer to minimize or eliminate space for flammable vapor accumulation.
(6) Provide liquid barriers such as walls, curbs, and dikes between buildings, vessels, and process areas.
(7) Provide high-capacity drainage systems for spilled solvents, with discharge to a safe, remote area.
(8) Provide high-capacity emergency dump systems for mixer-settler cells and other vessels that contain large quantities of solvents, with discharge to a safe, remote area.
(9) Locate solvent pumps outside of dikes or sub-grade areas that enclose solvent tanks and other equipment.
(10) Separate process control and safety interlock instrumentation from power cables.
(11) Use robust, fire-resistant, conductive materials (like stainless steel) for piping and vessels rather than combustible, frangible, or nonconductive materials like thermoplastics or glass. When steel cannot be used, consider use of a more durable and fire-resistant structural thermoset plastic such as FRP/GRP with a conductive lining.
(12) Eliminate polymeric materials such as rubber for flexible connections on piping and pumps.
(13) Use seal-less or double sealed pumps for solvents.
(14) Use cooling water jackets around pump seals and bearings.
(15) Find methods to reduce static or mist/aerosol generation in solvent systems such as submerging in-feed nozzles, minimizing bends and restrictions in piping, reducing solvent flow velocities, and using low-turbulence pumps.
(16) Provide high capacity emergency dump systems for mixer-settler cells and other vessels containing large quantities of solvents, with discharge to a safe, remote area.

A.13.18.5 Because some SX facilities are located at high altitudes, flash point assignment can be critical to the risk assessment. Flash points, when tested, are calibrated and reported based on mean sea level in accordance with ASTM D56, *Standard Test Method for Flash Point by the Tag Closed Cup Tester.* Due to partial pressure effects, flash points decrease as altitude increases. For example, a combustible liquid with a flash point of 41°C (105°F) at sea level has a flash point of 33°C (91°F) at 3,048 m (10,000 ft) and 30°C (86°F) at 4,268 m (14,000 ft).

A.13.18.8 Because mineral solvents are usually organic, they are heavier than air, and suction for ventilation systems, when provided, should be near floor level.

A.13.18.9 Suppressing a fire in flammable solvents depends to a great extent on speed of detection. UV/IR detection systems have proven suitable for enclosed mixer-settler cells. Electrical resistance wires have proven effective in pipe trenches and along pipe racks. Other more conventional heat and flame detection systems are also suitable if properly located, spaced, and calibrated.

A.13.18.10 Pregnant liquor solution (PLS) feed is a noncombustible acidic feedstock solution feeding the facility. This is usually gravity-fed from a PLS holding pond above the SX facility. Should a fire occur and PLS solution be allowed to continue to flow into the SX facility, mixer-settler cells might overflow and spread burning and/or high-acid concentration solvents throughout the facility. It is necessary to have control over this feed system in an emergency from both a fire perspective and an environmental perspective. Either manual or automatic valves are suitable. When manual valves are used, the emergency response plan should include provisions to shut off the PLS valve.

A.13.19 See Table A.13.18 for fire experience data justifying the addition of the requirements in Section 13.19.

A.13.19.1.1 Although water-only deluge, foam-water, and dry chemical systems might be effective in controlling or suppressing SX facility fires, there might be use for more than one application in a given facility. Manual response has been ineffective in recent losses, and automatic suppression is advised for both existing and new facilities.

While water spray can be effective, due to potentially high flow requirements a mixer-settler cell might overflow during the suppression process. This might create additional concerns with drainage and fire spread.

Foam has been shown to be an effective suppressant medium for SX fires. However, environmental aspects, potential contamination of process liquids (particularly associated with accidental system initiation), and the difficulty or inability to conduct system flow tests on a periodic basis are negative points in the selection of foam.

High pressure water mist or fog might prove to be a potentially effective suppressant medium and might not create the contamination, environmental, and testing obstacles that accompany foam or the large volumes that accompany conventional high density water deluge systems. Currently, there are no public domain tests conducted on mist systems for pool fires of the size involved in a large SX settler; thus, actual suppressability under all fire conditions has not been demonstrated.

A.13.19.1.2 The following best practices design guidance for automatic fire suppression systems is advised:

For settler tanks or cells, use either Type 1 foam chambers or open head deluge sprinklers with foam discharge. When using foam chambers, provide a 3 percent aqueous film-forming foam (AFFF) foam discharge, in accordance with NFPA 11, with a density of 4.1 L/min/m^2 (0.10 gpm/ft^2) over the entire settler area. When using open head deluge sprinklers, provide a 3 percent AFFF foam discharge, in accordance with NFPA 16, with a density of 6.5 L/min/m^2 (0.16 gpm/ft^2). Design for a 20-minute discharge period.

For mixers, launders, drainage sumps, and piping trenches, use open head deluge sprinklers and provide a 3 percent AFFF foam discharge, in accordance with NFPA 16, with a density of 6.5 L/min/m^2 (0.16 gpm/ft^2) and a 20-minute foam discharge period.

For the interior of tank farm vessels containing combustible or flammable liquids such as loaded organic tanks, coalescers, crud treatment tanks, and diluent tanks use a Type 1 foam chamber and provide a 3 percent automatic AFFF foam discharge, in accordance with NFPA 11, into each of the tanks with a density of 4.1 L/min/m^2 (0.10 gpm/ft^2) and a 20- minute foam discharge period.

For the exterior surfaces of tank farm equipment containing combustible or flammable liquids such as loaded organic tanks, coalescers, crud treatment tanks, diluent tanks, crud treatment filters, centrifuges, pumps, and pipe racks, provide automatic open head (water only) deluge sprinklers based on a discharge density of 10.2 L/min/m^2 (0.25 gpm/ft^2).

A.13.19.1.3 Actuation of automatic fire suppression systems can be done using ultraviolet/infrared (UV/IR) dual spectrum detectors, heat detection cable, rate of rise heat detectors, or standard air pilot heads. High speed detection is considered advisable to suppress a solvent fire in its incipient stages.

Annex B Fire Risk Assessment

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Fire Risk Assessment. There are many techniques available to assess risk. The four general techniques are experience, augmented experience, creative, and analytical.

Experience (qualitative) techniques are as follows:

(1) Use of standard designs
(2) Use of recognized standards
(3) Use of experts
(4) Qualitative approach

Augmented experience (qualitative) techniques are as follows:

(1) Secondary safety checks outside of design process
(2) Safety review meetings
(3) Multidisciplinary teams
(4) Avoid blind spots
(5) "What-if" analysis
(6) Qualitative approach

Creative (qualitative) techniques are as follows:

(1) Seek improvements or innovations
(2) Brainstorming
(3) Hazard and operability studies

Analytical (quantitative) techniques are as follows:

(1) Logic trees
(2) Fault event trees
(3) Failure modes and analysis
(4) Quantitative risk assessment
(5) Detailed analytical checklists

In all cases, a fire risk assessment consists of the following four steps:

(1) Identify the potential for fire and explosion.
(2) Assess the consequences of fire and explosion.
(3) Determine the need for fire protection.
(4) Select appropriate option(s).

The following fire risk assessment outline is a suggested procedure to identify the elements in the items defined above. Figure B.1 provides a diagram of the process. Specific examples are given for risks associated with mobile and self-propelled equipment, but the process can be used for other hazards such as conveyor belts, rubber lined equipment, and building protection.

Additional guidance in performing fire risk assessments is provided in several of the reference publications listed in Annex C.

B.1.1 Identify the Potential for Fire and Explosion.

B.1.1.1 Ignition sources are as follows:

(1) High temperatures, which are usually found in the vicinity of a vehicle engine and exhaust system; pumps; batteries; wiring; switches; electrical motors; generators; and friction sources such as bearings, brakes, and gears
(2) Electrical, including switch gear; MCC; circuit breakers; motors and generators; transformers; battery boxes; substations; cable reels, trays, and splices; and collector rings
(3) Hot work such as cutting and welding
(4) Other, including smoking materials, chemical reactions, and spontaneous ignition sources

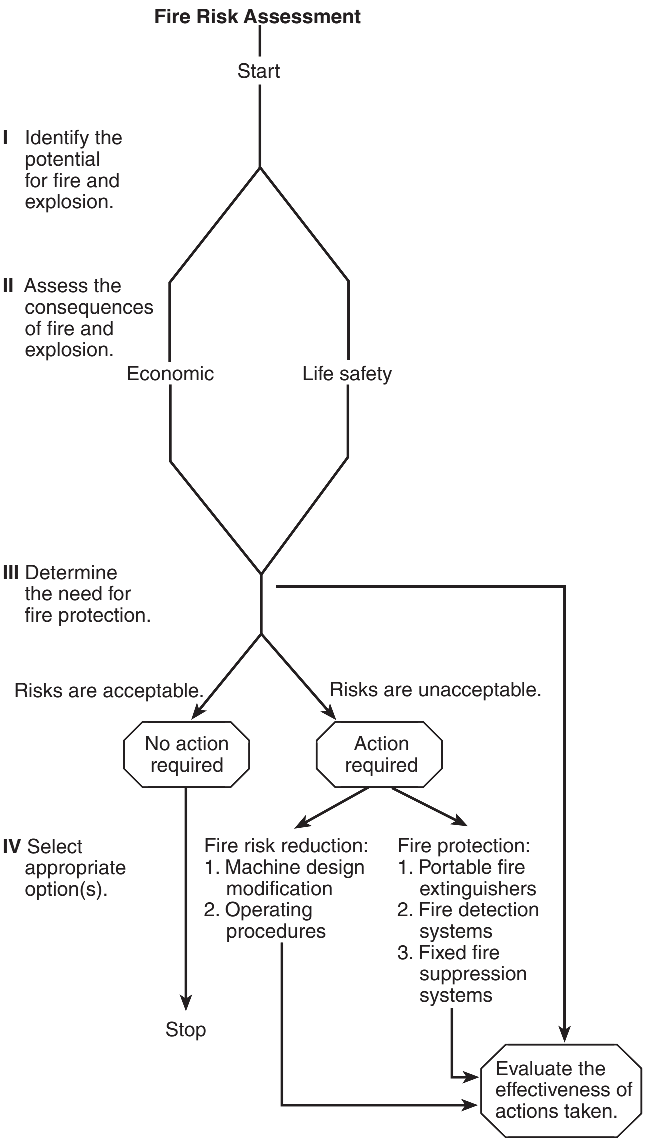

FIGURE B.1 Fire Risk Assessment Chart.

B.1.1.2 Fuel sources are as follows:

(1) Class A, including combustible debris, wood, rags, electrical insulation, coal dust, upholstery, hoses, tires, and seats
(2) Class B, including flammable and combustible liquid materials such as gasoline, diesel fuel, liquefied petroleum gas (propane), hydraulic fluids, some coolant combinations, grease, and oil
(3) Class D, which includes some new mobile equipment that have magnesium transmission components that cannot be extinguished with conventional fire suppression agents

B.1.1.3 Probability of the coexistence of fuel and ignition sources is as follows:

(1) Proximity of fuel to ignition sources should be assessed as follows:
    (a) An assessment should be made of existing areas where lubrication, hydraulic oil, fuel lines, rubber and plastic, and other combustibles are in proximity to an ignition source.
    (b) In identifying risk areas, note that a combustible liquid can spray or drip onto a hot surface remote from the rupture or leak point.
(2) Previous fire experience on mobile equipment and in industrial settings similar to mining should be considered in the fire risk assessment.
(3) Quality of maintenance should be assessed as follows:
    (a) Replacement parts should be at least equal in performance to original parts. Examples are hoses, bearings, fittings, and electrical equipment on mobile equipment or bearings on motors for conveyor systems.
    (b) Maintenance should be performed in accordance with recommendations and schedules supplied by the equipment manufacturer.
(4) The presence of accumulations of combustible materials such as oil-soaked waste and fuel spillage represent potential fire hazards.

B.1.2 Assess the Consequences of Fire and Explosion.

B.1.2.1 Personnel exposure should be assessed as follows:

(1) Determine the number of persons involved and their location during routine and maintenance operations.
(2) Determine the exposure to potential fire and explosion risks for each person and whether the fire and smoke could impair safe egress from his or her work location.

B.1.2.2 Economic risks should be assessed as follows:

(1) Consider the cost of repairs, replacement, cleanup, and damage to the work site.
(2) Items to consider are production loss, personnel overtime, interruption of customer deliveries, and replacement equipment rental.

B.1.3 Determine the Need for Fire Protection.

B.1.3.1 Mandatory Requirements. Certain fire prevention and fire suppression requirements are mandated by company policy, insurance companies, and government agencies.

B.1.3.2 Identified Needs. Additional fire precautions beyond those that are mandated might prove to be necessary, after the fire risk assessment.

B.1.3.3 Evaluation. If the fire risk assessment has disclosed unacceptable personnel risks, economic risks, or both, appropriate fire protection options should be determined. If the risks are found acceptable, no further action is required.

B.1.4 Select Appropriate Option(s).

B.1.4.1 Risk reduction should be considered as follows:

(1) Evaluate equipment to determine whether the risk from the start or the spread of a fire or the risk to personnel from a fire can be reduced. Examples concerning how to reduce the start or spread of a fire include physical barriers between fuel sources and ignition sources; thermal shields over hot surfaces; hose and wiring harness routing, support, and protection; and power shutoffs. Examples for reducing the threat of fire to personnel include emergency egress provisions and relocating or shielding potential fire hazards.
(2) Reduce the threat of fire and explosion through implementation of policies and procedures. Examples include

effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, and development of emergency plans and strategies that deal with fire and explosion hazards. Such emergency plans can include use of company fire brigades and other available equipment such as fire trucks and water wagons, and the response of local fire departments.

(3) Determine whether risk reduction reduces risks to acceptable levels. If risks are within acceptable levels, no further action is required. If unacceptable risks still exist, then action is required either to further reduce hazards or to install fire detection/suppression equipment or a combination of both.

B.1.4.2 Fire detection and suppression equipment should be considered as follows:

(1) Identify available alternatives as follows:
   (a) Portable protection options include hand-portable extinguishers, hose reels and lines, wheeled extinguishers, and skid-mounted extinguishers. To handle difficult fires, larger capacity extinguishers that provide more agent, greater range, and longer discharge time are recommended for agent selection *(see B.1.5.1)*.
   (b) Fire detection devices can be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other systems such as door closers and exhaust fans. *(For a discussion of detector and control options, selection, and placement, see B.1.5.3 and B.1.5.4.)*
   (c) Fixed system protection can be accomplished by local application, total flooding, or a combination of both, or automatic sprinklers. *(For agent selection, see B.1.5.1. For fixed fire suppression system options, see B.1.5.2.)*
(2) Compare capability with need. Mandatory requirements and identified needs should be matched with the most cost-effective approach to fire detection, fire suppression, or both.
(3) Select equipment. The selection of all equipment used for detection and suppression of fires in mining equipment should be based upon consideration of the environment where the equipment will function and should be tested. Testing should include provisions for determining the adequacy and durability of the equipment, and the manufacturer should demonstrate that such tests have been conducted.
(4) Evaluate. Determine whether risk reduction results in compliance with mandatory requirements or reduces risks to acceptable levels, or both. If risks are within acceptable levels, no further action is required. If unacceptable risks still exist, then action is required either to reduce hazards further or to install fire detection/suppression equipment or a combination of both.

NOTE: A more detailed discussion of fire suppression and detection equipment can be found in the references in Annex C and in NFPA 10.

B.1.5 Fire Protection Agents and Equipment.

B.1.5.1 The following extinguishants are commonly used in the mining industry for mobile equipment:

(1) Class A agents are as follows:
   (a) Dry chemicals (ABC) with ammonium phosphate as the basic ingredient
   (b) Foams such as protein, fluoroprotein, aqueous film forming, and medium and high expansion
   (c) Water
   (d) Clean agents (gaseous)
(2) Class B agents are dry chemicals (BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition, as follows:
   (a) Foams such as protein, fluoroprotein, aqueous film forming, and medium and high expansion
   (b) Carbon dioxide
   (c) Water
   (d) Clean agents
(3) Class C agents are dry chemicals (ABC or BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition, as follows:
   (a) Carbon dioxide
   (b) Water
   (c) Clean agents
(4) Class D agents are dry powder agents composed of sodium chloride or graphite with other particulate material added, as well as inert materials such as dry sand, foundry flux, and so on.

B.1.5.2 The design and layout of fixed fire suppression systems should be based upon the method of application of the fire suppressant to the area to be protected. Methods of delivery include the following:

(1) Local application consisting of a supply of suppressant permanently connected to a distribution system arranged to discharge onto a defined area or space
(2) Total flooding consisting of a supply of suppressant permanently connected to a distribution system arranged to discharge into an enclosed space
(3) A combination of B.1.5.2(1) and B.1.5.2(2) above
(4) Automatic sprinklers consisting of a supply of suppressant (normally water) permanently connected to a distribution system to discharge the suppressant

B.1.5.3 Detector options are as follows:

(1) Automatic fire detection devices are covered by *NFPA 72*. One fire detection device that is commonly used in self-propelled and mobile mining equipment but is not covered in *NFPA 72* is fusible plastic tube. It comprises a sensing element consisting of a plastic tube pressurized with inert gas. Heat from the fire causes the tube to burst, releasing the gas pressure and activating a mechanical pneumatic actuator.
(2) Consideration should be given to the physical configuration of the area to be protected when selecting and locating fire detectors. A detector's response time is dependent upon its type and proximity to a fire. For spacing, see *NFPA 72*. Other factors to be considered in fire detector placement are ambient temperature, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

B.1.5.4 Depending on mining equipment configuration, use, ground speed capability, degree of hazard enclosure, operating personnel locations, and other factors, consideration can be required of system control options such as the following:

(1) Discharge time delay
(2) Discharge abort switch

(3) Audible and visual alarms
(4) Pre-discharge alarm
(5) Detection circuit supervision

B.2 Electrical Ignition Hazards. Self-propelled and mobile surface mining equipment powered by electrical energy is normally supplied through portable electrical power cables carrying high-voltage, three-phase, ac power. Existing regulations require that the electrical system be designed to protect personnel by limiting the voltage rise of the machine frame, in the event of a ground fault, to a maximum of 100 volts. Protection on such electrical systems includes the following:

(1) Normal overcurrent protection
(2) Ground-fault current limitation (normally to about 15 amperes)
(3) Ground-fault overcurrent tripping (usually at about 7 amperes to 10 amperes)
(4) Monitoring of continuity of the ground conductor in the trailing cable and instantaneous tripping if continuity is lost
(5) Operational damage

Physical impact from external material at a chute or face, which can roll or slide onto equipment, can cause leaks in fuel or hydraulic lines as well as damage to electrical components and wiring.

Electrical systems having these protective features are singularly free of fires, as fault current is low and faults are cleared rapidly.

When equipment contains one or more transformers designed and installed to reduce the high voltage supplied through the portable cable to a lower utilization voltage, no requirements for ground-fault current limitation or tripping on ground-fault interruptors are necessary. All equipment on the machine is effectively frame grounded, and there is no risk to personnel due to frame voltage rise.

Alternatively, a ground detection system can be used on an ungrounded utilization voltage system, provided the first ground, which would cause an alarm, is found and repaired promptly. Use of a time delay to allow an orderly and safe shutdown of a machine followed by automatic removal of power from the grounded circuit is recommended.

B.2.1 Assess the consequences of fire, as follows:

(1) Determine whether personnel can be exposed to the effects of a fire. These effects could include the following:
    (a) Direct exposure of the operator or nearby personnel to heat, smoke, and toxic fire gases from the burning equipment.
    (b) Exposure of personnel located away from the equipment fire site to products of combustion by the mine ventilation.
    (c) Equipment fire spread to other combustibles such as timber supports, combustible minerals, explosives, and lubricants. Such fires can grow in intensity, producing increased quantities of toxic combustion products, complicating fire-fighting efforts, and interfering with evacuation and rescue operations.
    (d) The possibility of the equipment fire or secondary fires causing ventilation disturbances such as throttling or reversals, contaminating escapeways in an unpredictable manner.
(2) Determine the economic loss resulting from a fire on a piece of equipment, including both property damage and business interruption costs, and consider the following factors:
    (a) Fire involving a single piece of equipment could cause property damage and loss of production until the fire is extinguished and the equipment is repaired or replaced.
    (b) Fire spread to nearby combustible material, including combustible mineral seams, can have greater economic effects than the initial fire.

B.2.2 Determine the need for fire protection. If the risk analysis discloses unacceptable personnel risks, economic risks, or both, appropriate fire protection options should be determined.

B.2.3 Select appropriate fire protection option(s), as follows:

(1) Hazard reduction should be considered as follows:
    (a) Evaluate equipment to determine if the risk from the start or the spread of a fire can be reduced.
    (b) Reduce the threat of fire through implementation of company policies and procedures. Examples include effective equipment maintenance programs, adequate housekeeping procedures, proper employee training, development of emergency plans, and strategies that deal directly with fire.
    (c) Determine whether fire risk reduction practices reduce risks to acceptable levels. If risks are acceptable, no further action is necessary. If unacceptable risks still exist, action is needed either to reduce risks further or to install fire detection/suppression equipment, or a combination of both.
(2) Identify available fire detection and suppression equipment alternatives as follows:
    (a) Portable protection options include portable hand extinguishers, hose reels and lines, wheeled extinguishers, and skid-mounted extinguishers. For difficult fires, larger capacity extinguishers that provide more agent, greater range, and longer discharge time are recommended. *(See B.1.5.1 for agent selection.)*
    (b) Fire detection devices can be used to provide early warning of fires, actuate a fire suppression system, shut down equipment, and operate other fire control systems such as ventilation devices and fire doors. *(For a discussion of detector and control options, selection, and placement, see B.1.5.3 and B.1.5.4.)*
    (c) Fixed fire suppression systems should be considered as follows:
        i. Accomplish fixed system protection by local application, total flooding, a combination of both, or automatic sprinklers. *[See B.2.3(3) for agent selection. See B.2.3(3)(b)ii for fixed fire suppression options.]*
        ii. Compare capability with need. Identified needs should be matched with the most cost-effective approach to fire detection, fire suppression, or both.
        iii. Select equipment. The selection of all equipment used for all detection and suppression of fires in mining equipment should be based on consideration of the environment in which the equipment functions.
        iv. Evaluate fixed fire suppression systems. Determine whether fire risk reduction complies with mandatory requirements and reduces risks to acceptable levels. If risks are within acceptable levels, no further action is necessary. If not, additional action is needed either to reduce fire risks or to install fire detection/suppression equipment, or a combination of both.

(3) Fire protection agents and equipment should be considered as follows:

 (a) The following extinguishing agents commonly are used in the mining industry:

  i. Class A, including dry chemicals (ABC) with ammonium phosphate as the basic ingredient; foams such as protein, fluoroprotein, aqueous film-forming, and medium- and high-expansion; water; and water-based antifreeze solution

  ii. Class B, including dry chemicals (BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition; foams such as protein, fluoroprotein, aqueous film-forming, and medium- and high-expansion; carbon dioxide; water spray or fog; and water-based antifreeze solution

  iii. Class C, including dry chemicals (ABC or BC) with sodium bicarbonate, ammonium phosphate, potassium bicarbonate, urea-based potassium bicarbonate, or potassium chloride as the basic composition; carbon dioxide; fixed water spray; and water fog

  iv. Class D, including dry powder agents composed of sodium chloride or graphite with other particulate material added and inert materials such as dry sand and foundry flux

 (b) Method of application should be as follows:

  i. Portable extinguisher of the hand-held or wheeled type or transportable systems consisting of a hose reel or rack, hose, and discharge nozzle connected to an extinguishing agent supply

  ii. Fixed systems, including local application consisting of a supply of extinguishing agent permanently connected to a distribution system, arranged to discharge onto a defined area or space; total flooding consisting of a supply of extinguishing agent permanently connected to a distribution system, arranged to discharge into an enclosed space; combination of B.2.3(3)(a)i and B.2.3(3)(a)ii; automatic sprinklers consisting of a supply of extinguishing agent (normally water) permanently connected to a distribution system to discharge the suppressant; water spray; and water fog

 (c) For guidance in the selection and placement of fire detectors, see *NFPA 72*. Some fire detectors used in conjunction with mining equipment, but not covered in *NFPA 72*, include the following:

  i. Fusible plastic tube: A sensing element consisting of a plastic tube pressurized with inert gas. Heat from the fire causes the tube to burst, releasing the gas pressure and activating a mechanical pneumatic actuator.

  ii. Thermistor strip: A line-type device with a sensing element consisting of a thin metal tube containing two electrical conductors. The conductors are separated by a thermistor material whose resistance (or capacitance) varies with temperature. By monitoring resistance (or capacitance) changes, corresponding temperature changes can be detected.

  iii. Metal hydride: A line-type device with a sensing element consisting of a thin metal tube containing a hydrogen-charged metal hydride wire. The tube is sealed at one end and is connected to a sensitive pressure switch at the other end. When exposed to the heat from a fire, copious amounts of hydrogen gas are released from the metal hydride wire, actuating the pressure switch.

  Consideration should be given to the physical configuration of the area or equipment to be protected when selecting and installing detectors. For spacing information, see *NFPA 72*. Among the factors affecting detector performance are its proximity to a fire, ambient temperatures, climatic conditions, shock and vibration, air contamination, ventilation flows, and maintenance requirements.

(4) Depending on mining equipment configuration, use, ground speed capability, enclosures, location of operating personnel, and other factors, the following special control options should be considered:

 (a) Mechanical or electrical equipment engine shutdown
 (b) Discharge time delay
 (c) Discharge abort switch
 (d) Audible and visual alarms
 (e) Pre-discharge alarm
 (f) Detection circuit supervision

Consideration should be given to the advisability of providing automatic engine shutdown on mobile equipment. Factors such as ground speed, slope braking capability, and availability of secondary steering as described in SAE J1511, *Steering for Off-Road, Rubber-Tired Machines*, should be included in this analysis.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

Fire Protection Handbook, 20th edition, 2008.

NFPA 10, *Standard for Portable Fire Extinguishers*, 2013 edition.

NFPA 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2010 edition.

NFPA 16, *Standard for the Installation of Foam-Water Sprinkler and Foam-Water Spray Systems*, 2015 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2013 edition.

NFPA 72®, *National Fire Alarm and Signaling Code*, 2013 edition.

NFPA 77, *Recommended Practice on Static Electricity*, 2014 edition.

NFPA *101®*, *Life Safety Code®*, 2015 edition.

NFPA 326, *Standard for the Safeguarding of Tanks and Containers for Entry, Cleaning, or Repair*, 2015 edition.

NFPA 664, *Standard for the Prevention of Fires and Explosions in Wood Processing and Woodworking Facilities*, 2012 edition.

NFPA 1142, *Standard on Water Supplies for Suburban and Rural Fire Fighting*, 2012 edition.

C.1.2 Other Publications.

C.1.2.1 API Publications. American Petroleum Institute, 1220 L. Street, N.W., Washington, DC 20005-4070.

API 620, *Recommended Rules for the Design and Construction of Large, Welded, Low-Pressure Storage Tanks,* 2008.

API 650, *Standard for Welded Steel Tanks for Oil Storage,* 2012.

API 2000, *Standard for Venting Atmospheric and Low-Pressure Storage Tanks,* 2009.

C.1.2.2 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

ASME *Boiler and Pressure Vessel Code,* 2013.

C.1.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 56, *Standard Test Method for Flash Point by the Tag Closed Cup Tester*, 2010.

ASTM D 93, *Standard Test Methods for Flash Point by the Pensky-Martens Closed-Cup Tester*, 2013.

ASTM D 3278, *Standard Method of Tests for Flash Point of Liquids by Small-Scale Closed-Cup Apparatus*, 2011.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

C.1.2.4 AWS Publications. American Welding Society, 550 N.W. Le Jeune Road, Miami, FL 33126.

AWS F4.1, *Safe Practices for the Preparation of Containers and Piping for Welding and Cutting*, 2007.

C.1.2.5 SAE Publications. Society of Automotive Engineers, 400 Commonwealth Drive, Warrendale, PA 15096.

SAE J1511, *Steering for Off-Road, Rubber-Tired Machines*, 1994.

C.1.2.6 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 80, *Standard for Steel Tanks for Oil Burner Fuels or Other Combustible Liquids*, 2007, revised 2009.

UL 142, *Standard for Steel Aboveground Tanks for Flammable and Combustible Liquids*, 2006, revised 2010.

C.1.2.7 U.S. Government Publications. U.S. Government Printing Office, Washington, DC, 20402.

Title 18, Code of Federal Regulations, Chapter 1, Federal Energy Regulatory Commission.

"The Health and Safety Implications of the Use of Diesel-Powered Equipment in Underground Mines," Mine Safety and Health Administration, Arlington, VA, 1987.

C.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

C.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30A, *Code for Motor Fuel Dispensing Facilities and Repair Garages*, 2015 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*, 2015 edition.

C.2.2 U.S. Department of Interior Bureau of Mines Publications. National Technical Information Service (NTIS), 5285 Port Royal Road, Springfield, VA 22161.

The following former Bureau of Mines reports and articles are available for purchase from the NTIS and for Open File (OFR) inspection at the following locations: National Institute for Occupational Safety & Health (NIOSH) Facilities: Pittsburgh, PA and Spokane, WA; U.S. Geological Survey, Reston, VA; and the National MSHA Technical Information Center and Library, Beaver, WV (e-mail: Library@MSHA.gov).

Baker, R. M.,"An Annotated Bibliography of Metal and Nonmetal Mine Fire Reports," 1980. U.S. BuMines OFR 68 (1)-(3)-81. NTIS PB 81-223711.

Kasten, A. E., "Develop and Test an Automatic Fire Control System for Surface Mining Machinery, Volume I, Systems Development," 1977. U.S. BuMines OFR 119-78. NTIS PB 293 983.

Lease, W., "Development, Installation, and Testing Services for an Automatic, Point-Type Thermal Sensor Fire Protection System on a Mining Dozer," 1976. U.S. BuMines OFR 71-77. NTIS PB 266075/AS.

Lease, W. D., "Development of an Automatic Fire Protection System for Surface Vehicles," 1981. U.S. BuMines OFR 73-82. NTIS PB 82-215765.

McDonald, L.A., "Development and Test of an Automatic Fire Control System for Surface Mining Machinery, Volume II, Reliability Testing," 1981.

McDonald, L.A., "Improved Fire Protection System for AN-FO Haulers and Loaders," 1982. U.S. BuMines OFR 46-83.

Rizzuto, F., "Fire Protection for Solvent Extraction Plants — What We Can Learn from Olympic Dam," *Plumbing Engineer*, November 2002, pp. 43–50.

Stevens, R. B., "Improved Sensors and Fire Control System for Mining Equipment," 1972. U.S. BuMines OFR 25 (1)-(2)-74. NTIS PB 232405 and NTIS PB 232406.

Stevens, R. B., "Automatic Fire Sensing and Suppression System for Mobile Mining Equipment," 1978. U.S. BuMines OFR 34-79. NTIS PB 294 731.

Walker, B., "Investigation into a Fire Which Occurred at a Copper and Uranium Plant SX 21st October 2001, Olympic Dam Copper/Uranium Mine, Roxby Downs, South Australia," Fire Cause Investigation Section, South Australian Metropolitan Fire Service, South Australia, 2002.

The following Bureau of Mines reports are available from the U.S. Government Printing Office, Washington, DC 20402.

Johnson, G. A., "Automatic Fire Protection Systems for Large Haulage Vehicles; Prototype Development and In-Mine Testing," 1978. U.S. BuMines IC 8683.

Pomroy, W. H., "Automatic Fire Protection Systems for Surface Mining Equipment," 1980. U.S. BuMines IC 8832.

Pomroy, W. H., "Economic Analysis of Surface Mining Mobile Equipment Fire Protection Systems," 1982. U.S. BuMines RI 8698.

U.S. BuMines Mining Research Staff, "Metal Mine Fire Protection Research," 1977, BuMines IC 8752.

U.S. BuMines Technology News No. 50, 1978, "Bulldozer Fire Protection."

U.S. BuMines Technology News No. 70, 1979, "Fire Protection for Blasthole Drill."

U.S. BuMines Technology News No. 74, 1979, "Fire Protection for Front-End Loaders."

U.S. BuMines Technology News No. 77, 1980, "Loading Shovel Fire Protection."

U.S. BuMines Technology News No. 78, 1980, “Fire Protection for Hydraulic Excavators.”

U.S. BuMines Technology News No. 79, 1980, “Automatic Fire Protection for Mining Trucks.”

U.S. BuMines Technology News No. 106, 1981, “Dragline Fire Protection.”

U.S. BuMines Technology News No. 107, 1981, “An-Fo Hauler Fire Protection.”

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Christensen, B. C. and Reid, G. R. “Improved Fire Protection System for Underground Fueling Areas, Volume I.” U.S. Bureau of Mines/Ansul Co. Final Report for Contract H0262023. U.S. BuMines OFR-120-78. NTIS No. PB-288-298-AS.

McDonald, L., Kennedy, D., and Reid, G. “Improved Fire Protection System for Underground Fueling Areas, Volume II.” U.S. Bureau of Mines/Ansul Co. Final Report for Contract H0262023. U.S. BuMines OFR-160-82. NTIS No. PB-83-113-744.

C.2.3 Other Publications. Jenson, R., ed., *Fire Protection for the Design Professional*, Cahners Books, Boston, MA, 1975.

C.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 130

Standard for

Fixed Guideway Transit and Passenger Rail Systems

2014 Edition

This edition of NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems,* was prepared by the Technical Committee on Fixed Guideway Transit and Passenger Rail Systems and acted on by NFPA at its June Association Technical Meeting held June 10–13, 2013, in Chicago, IL. It was issued by the Standards Council on August 1, 2013, with an effective date of August 21, 2013, and supersedes all previous editions.

This edition of NFPA 130 was approved as an American National Standard on August 21, 2013.

Origin and Development of NFPA 130

The Fixed Guideway Transit Systems Technical Committee was formed in 1975 and immediately began work on the development of NFPA 130. One of the primary concerns of the committee in the preparation of this document centered on the potential for entrapment and injury of large numbers of people who routinely use these types of mass transportation facilities.

During the preparation of the first edition of this document, several significant fires occurred in fixed guideway systems, but fortunately the loss of life was limited. The committee noted that the minimal loss of life was due primarily to chance events more than any preconceived plan or the operation of protective systems.

The committee developed material on fire protection requirements to be included in NFPA 130, *Standard for Fixed Guideway Transit Systems*. This material was adopted by NFPA in 1983. The 1983 edition was partially revised in 1986 to conform with the NFPA *Manual of Style*. Incorporated revisions included a new Chapter 8; a new Appendix F, "Creepage Distance"; minor revisions to the first four chapters and to Appendices A, B, C, and E; and a complete revision of Appendix D.

The scope of the 1988 edition was expanded to include automated guideway transit (AGT) systems. The sample calculations in Appendix C were revised, and Appendix D was completely revised.

The 1990 edition included minor changes to integrate provisions and special requirements for AGT systems into the standard. Table 1 from Appendix D was moved into Chapter 4, "Vehicles," and new vehicle risk assessment material was added to Appendix D.

Definitions for *enclosed station* and *open station* were added in the 1993 edition, along with minor changes to Chapters 2 and 3; the 1995 edition made minor changes to Chapters 1, 2, and 3.

The 1997 edition included a new chapter on emergency ventilation systems for transit stations and trainways. A new Appendix B addressing ventilation replaced the previous Appendix B, "Air Quality Criteria in Emergencies." Also, the first three sections of Chapter 6 (renumbered as Chapter 7 in the 1997 edition), "Emergency Procedures," were revised, and several new definitions were added.

The 2000 edition of NFPA 130 addressed passenger rail systems in addition to fixed guideway transit systems. The document was retitled to reflect that addition, and changes were made throughout the document to incorporate passenger rail requirements. Additionally, much of Chapter 2 was rewritten to incorporate changes that were made to the egress calculations in NFPA *101*®, *Life Safety Code*®. The examples in Appendix C were modified using the new calculation methods. The protection requirements for Chapter 3 were modified, addressing emergency lighting and standpipes. Chapter 4 also was modified to clarify and expand the emergency ventilation requirements.

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The 2003 edition was reformatted in accordance with the 2003 *Manual of Style for NFPA Technical Committee Documents*. Beyond those editorial changes, there were technical revisions to the egress requirements and calculations for stations. The chapter on vehicles was extensively rewritten to include a performance-based design approach to vehicle design as well as changes to the traditional prescriptive-based requirements.

The 2007 edition included revisions affecting station egress calculations, the use of escalators in the means of egress, vehicle interior fire resistance, and power supply to tunnel ventilation systems. The chapter on vehicle maintenance facilities was removed because requirements for that occupancy are addressed in other codes; the performance-based vehicle design requirements were substantially revised to more accurately address the unique qualities of rail vehicles.

The 2010 edition of NFPA 130 included provisions that allowed elevators to be counted as contributing to the means of egress in stations. The 2010 edition also contained revisions relating to escalators, doors, gates, and turnstile-type fare equipment. The units in the standard were updated in accordance with the 2004 *Manual of Style for NFPA Technical Committee Documents*. Several fire scenarios were added to Annex A to provide guidance on the types of fires that can occur in vehicles, stations, and the operating environment as well.

The 2014 edition of NFPA 130 includes substantial re-organization of Chapters 5 and 6 for consistency and consolidation of wire and cable requirements into a new Chapter 12. Other changes include reconciliation of terminology related to enclosed trainways and engineering versus fire hazard analysis; revisions to interior finish requirements; revisions to requirements for prevention of flammable and combustible liquids intrusion in Chapters 5 and 6; and improvements to Annex C.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents pertaining to fire safety requirements for underground, surface, and elevated fixed guideway transit and passenger rail systems including stations, trainways, emergency ventilation systems, vehicles, emergency procedures, communications and control systems and for life safety from fire and fire protection in stations, trainways, and vehicles. Stations shall pertain to stations accommodating occupants of the fixed guideway transit and passenger rail systems and incidental occupancies in the stations.

NFPA 130

Standard for

Fixed Guideway Transit and Passenger Rail Systems

2014 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex H. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex H.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall cover life safety from fire and fire protection requirements for fixed guideway transit and passenger rail systems, including, but not limited to, stations, trainways, emergency ventilation systems, vehicles, emergency procedures, communications, and control systems.

1.1.2 Fixed guideway transit and passenger rail stations shall pertain to stations accommodating only passengers and employees of the fixed guideway transit and passenger rail systems and incidental occupancies in the stations. This standard establishes minimum requirements for each of the identified subsystems.

1.1.3 This standard shall not cover requirements for the following:

(1) Conventional freight systems
(2) Buses and trolley coaches
(3) Circus trains
(4) Tourist, scenic, historic, or excursion operations
(5) Any other system of transportation not included in the definition of *fixed guideway transit system (see 3.3.52.1)* or *passenger rail system (see 3.3.52.2)*
(6)*Shelter stops

1.1.4 To the extent that a system, including those listed in 1.1.3(1) through 1.1.3(6), introduces hazards of a nature similar to those addressed herein, this standard shall be permitted to be used as a guide.

1.2 Purpose. The purpose of this standard shall be to establish minimum requirements that will provide a reasonable degree of safety from fire and its related hazards in fixed guideway transit and passenger rail system environments.

1.3 Application.

1.3.1 This standard shall apply to new fixed guideway transit and passenger rail systems and to extensions of existing systems.

1.3.2 The portion of the standard dealing with emergency procedures shall apply to new and existing systems.

1.3.3* The standard also shall be used for purchases of new rolling stock and retrofitting of existing equipment or facilities except in those instances where compliance with the standard will make the improvement or expansion incompatible with the existing system.

1.3.4 This standard shall also apply as a basis for fixed guideway transit and passenger rail systems where nonelectric and combination electric-other (such as diesel) vehicles are used. Where such vehicles are not passenger-carrying vehicles or are buses or trolley coaches, the standard shall not apply to those vehicles but shall apply to the fixed guideway transit and passenger rail systems in which such vehicles are used.

1.4* Equivalency. Nothing in this standard is intended to prevent or discourage the use of new methods, materials, or devices, provided that sufficient technical data are submitted to the authority having jurisdiction to demonstrate that the new method, material, or device is equivalent to or superior to the requirements of this standard with respect to fire performance and life safety.

1.4.1 Technical Documentation. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 Approval. The new methods, materials, or devices shall be approved for the intended purpose.

1.4.3* Equivalent Compliance. Alternative systems, methods, materials, or devices approved as equivalent shall be recognized as being in compliance with this standard.

1.5 Units and Formulas.

1.5.1 SI Units. The metric units of measurement in this standard are in accordance with the International System of Units (SI).

1.5.2 Primary and Equivalent Values. If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value might be approximated.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2013 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection,* 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.

NFPA 70®, National Electrical Code®, 2014 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Noncombustible Particulate Solids,* 2010 edition.

NFPA *101®, Life Safety Code®,* 2012 edition.

NFPA 110, *Standard for Emergency and Standby Power Systems,* 2013 edition.

NFPA 220, *Standard on Types of Building Construction,* 2012 edition.

NFPA 241, *Standard for Safeguarding Construction, Alteration, and Demolition Operations,* 2013 edition.

• NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source,* 2011 edition.

NFPA 262, *Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces,* 2011 edition.

• NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2011 edition.

NFPA 703, *Standard for Fire Retardant–Treated Wood and Fire-Retardant Coatings for Building Materials,* 2012 edition.

2.3 Other Publications.

2.3.1 AMCA Publications. Air Movement and Control Association International, Inc., 30 West University Drive, Arlington Heights, IL, 60004-1893.

ANSI/AMCA 210, *Laboratory Methods of Testing Fans for Aerodynamic Performance Rating*, 2007.

AMCA 250, *Laboratory Methods of Testing Jet Tunnel Fans for Performance*, 2005.

AMCA 300, *Reverberant Room Method for Sound Testing of Fans*, 2008.

2.3.2 APTA Publications. American Public Transportation Association, 1666 K Street NW, Washington, DC 20006.

APTA SS-PS-002, Rev 3, *Standard for Emergency Signage for Egress/Access of Passenger Rail Equipment*, 1998, revised 2007.

2.3.3 ASHRAE Publications. ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.

ASHRAE *Handbook — Fundamentals*, 2009.

ASHRAE 149, *Standard of Laboratory Methods of Testing Fans Used to Exhaust Smoke in Smoke Management Systems*, 2009.

2.3.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM C 1166, *Standard Test Method for Flame Propagation of Dense and Cellular Elastometric Gaskets and Accessories,* 2006 (2011).

ASTM D 2724, *Standard Test Methods for Bonded, Fused, and Laminated Apparel Fabrics*, 2006 (2011)e1.

ASTM D 3574, *Standard Test Methods for Flexible Cellular Materials — Slab, Bonded, and Molded Urethane Foams*, 2011.

ASTM D 3675, *Standard Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source*, 2011.

ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2012b.

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

ASTM E 162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*, 2012a.

ASTM E 648, *Standard Test Method for Critical Radiant Flux of Floor-Covering Systems Using a Radiant Heat Energy Source*, 2010e1.

ASTM E 662, *Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials*, 2012.

ASTM E 814, *Standard Test Method for Fire Tests of Through-Penetration Fire Stops*, 2011a.

ASTM E 1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2011b.

ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, 2012.

ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses*, 2012.

ASTM E 2061, *Standard Guide for Fire Hazard Assessment of Rail Transportation Vehicles*, 2012.

ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-Shaped Airflow Stabilizer, at 750°C*, 2012.

2.3.5 California Technical Bulletins. State of California, Department of Consumer Affairs, Bureau of Home Furnishings and Thermal Insulation, 3485 Orange Grove Avenue, North Highlands, CA 95660-5595.

Technical Bulletin 129, *Flammability Test Procedure for Mattresses for Use in Public Buildings*, October 1992.

Technical Bulletin 133, *Flammability Test Procedure for Seating Furniture for Use in Public Occupancies*, January 1991.

2.3.6 ICEA Publications. Insulated Cable Engineers Association, P.O. Box 1568, Carrollton, GA 30112.

ICEA S-73-532/NEMA WC-57, *Standard for Control, Thermocouple Extension, and Instrumentation Cables*, 2004.

ICEA S-95-658/NEMA WC-70, *Nonshielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy*, 1999.

2.3.7 IEC Publications. International Electrotechnical Commission, 3, rue de Varembé, P.O. Box 131, CH-1211 Geneva 20, Switzerland.

IEC 60331-11, *Tests for electric cables under fire conditions — Circuit integrity — Part 11: Apparatus — Fire alone at a flame temperature of at least 750°C*, 2009.

IEC 62520, *Railway applications electric traction, short primary type linear induction motors (LIM) fed by power converters*, 2011.

2.3.8 IEEE Publications. Institute of Electrical and Electronics Engineers, Three Park Avenue, 17th Floor, New York, NY 10016-5997.

IEEE 11, *Standard for Rotating Electric Machinery for Rail and Road Vehicles*, 2000.

IEEE 16, *American Standard for Electric Control Apparatus for Land Transportation Vehicles*, 2004.

IEEE 1202, *Standard for Flame-Propagation Testing of Wire and Cable*, 2006.

2.3.9 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 44, *Standard for Safety Thermoset-Insulated Wires and Cables*, 2010.

ANSI/UL 83, *Standard for Safety Thermoplastic-Insulated Wires and Cables*, 2008.

ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials,* 2011.

ANSI/UL 1685, *Standard for Vertical-Tray Fire-Propagation and Smoke-Release Test for Electrical and Optical-Fiber Cables*, 2007, revised 2010.

UL 1724, *Outline of Investigation for Fire Tests for Electrical Circuit Protective Systems,* 2006.

ANSI/UL 2196, *Standard for Safety for Tests for Fire Resistive Cables*, 2001, revised 2012.

2.3.10 U.S. Government Publications. U.S. Government Printing Office, Washington, DC 20402.

Title 14, Code of Federal Regulations, Part 25, Appendix F, Part I, "Vertical Test."

2.3.11 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 72®, *National Fire Alarm and Signaling Code,* 2013 edition.
NFPA *101*®, *Life Safety Code*®, 2012 edition.
NFPA 253, *Standard Method of Test for Critical Radiant Flux of Floor Covering Systems Using a Radiant Heat Energy Source,* 2011 edition.
NFPA 270, *Standard Test Method for Measurement of Smoke Obscuration Using a Conical Radiant Source in a Single Closed Chamber,* 2013 edition.
NFPA 402, *Guide for Aircraft Rescue and Fire-Fighting Operations,* 2013 edition.
NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents,* 2013 edition.
NFPA 502, *Standard for Road Tunnels, Bridges, and Other Limited Access Highways,* 2014 edition.
NFPA 921, *Guide for Fire and Explosion Investigations,* 2011 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1* Airflow Control Devices. Nontraditional equipment used to minimize tunnel airflow, including air curtains, barriers, brattices, tunnel doors, downstands, enclosures, tunnel gates, and so forth.

3.3.2 Ancillary Area/Ancillary Space. The nonpublic areas or spaces of the stations usually used to house or contain operating, maintenance, or support equipment and functions.

3.3.3 Authority. The agency legally established and authorized to operate a fixed guideway transit and/or passenger rail system.

3.3.4 Backlayering. The reversal of movement of smoke and hot gases counter to the direction of the ventilation airflow.

3.3.5* Blue Light Station. A location along the trainway, indicated by a blue light, where a person can communicate with the operations control center and disconnect traction power.

3.3.6 Building. Any structure or group of structures in which fixed guideway transit and/or passenger rail vehicles are stored or maintained, including those in which inspection and service functions are performed, and other ancillary structures, such as substations and air-conditioning or ventilation facilities.

3.3.7 Combustible Load of a Vehicle. The total value of heat energy that can be released through complete combustion of the components of a vehicle or fuel, expressed in joules [British thermal units (Btu)].

3.3.8 Command Post (CP). The location at the scene of an emergency where the incident commander is located and where command, coordination, control, and communications are centralized. [**402,** 2013]

3.3.9 Communications. Radio, telephone, and messenger services throughout the system and particularly at the operations control center and command post.

3.3.10 Computational Fluid Dynamics. A solution of fundamental equations of fluid flow using computer techniques allowing the engineer to identify velocities, pressures, temperatures, and so forth.

3.3.11* Concourse. Intermediate level(s) or area(s) connecting a station platform(s) to a public way via stairs, escalators, or corridors.

3.3.12 Critical Radiant Flux. The level of incident radiant heat energy in units of W/cm^2 on a floor covering system at the most distant flameout point. [**253,** 2011]

3.3.13 Critical Velocity. The minimum steady-state velocity of the ventilation airflow moving toward the fire within a tunnel or passageway that is required to prevent backlayering at the fire site.

3.3.14 Emergency Procedures Plan. A plan that is developed by the authority with the cooperation of all participating agencies and that details specific actions required by all those who will respond during an emergency.

3.3.15* Engineering Analysis. A system analysis that evaluates all the various factors of relative to specific objectives for system performance.

3.3.15.1* ***Fire Hazard Analysis.*** A specific type of engineering analysis relative to the contribution of a material, component, or assembly to the overall fire hazard and the estimation of the potential severity of fires that can develop under defined fire scenarios.

3.3.16 Equivalency. An alternative means of providing an equal or greater degree of safety than that afforded by strict conformance to prescribed codes and standards.

3.3.17 Fire Command Center. The principal attended or unattended room or area where the status of the detection, alarm communications, control systems, and other emergency systems is displayed and from which the system(s) can be manually controlled. [**72**, 2013]

3.3.18 Fire Emergency. The existence of, or threat of, fire or the development of smoke or fumes, or any combination thereof, that demands immediate action to correct or alleviate the condition or situation. [**502,** 2014]

3.3.19 Fire Growth Rate. Rate of change of the heat release rate. Some factors that affect the fire growth rate are exposure, geometry, flame spread, and fire barriers.

3.3.20 Fire Load.

3.3.20.1* ***Effective Fire Load.*** The portion of the total fire load (in joules or Btu) under a given, specific fire scenario of a certain fuel package that would be expected to be released in a design fire incident.

3.3.20.2* ***Total Fire Load.*** The total heat energy (in joules or Btu) of all combustibles available from the constituent materials of a certain fuel package.

3.3.21 Fire Smoke Release Rate. Rate of smoke release for a given fire scenario expressed as a function of time [in m^2/sec (ft^2/sec)].

3.3.22 Flaming Dripping. Periodic dripping of flaming material from the site of material burning or material installation.

3.3.23 Flaming Running. Continuous flaming material leaving the site of material burning or material installation.

3.3.24 Guideway. That portion of the fixed guideway transit or passenger rail system included within right-of-way fences, outside lines of curbs or shoulders, underground tunnels and stations, cut or fill slopes, ditches, channels, and waterways and including all appertaining structures.

3.3.25 Hazard. Real or potential condition that can cause injury.

3.3.26 Headway. The interval of time between the arrivals of consecutive trains at a platform in a station.

3.3.27* Heat Release Rate (HRR). The rate at which heat energy is generated by burning. [**921,** 2011]

3.3.27.1 ***Average Heat Release Rate (HRR_{180}).*** The average heat release rate per unit area, over the time period starting at time to ignition and ending 180 seconds later, as measured in ASTM E 1354 (kW/m^2).

3.3.27.2 ***Fire Heat Release Rate for Ventilation Calculations.*** Rate of energy release for a given fire scenario expressed as a function of time [W (Btu/s)].

3.3.28 Incident Commander (IC). The individual responsible for all incident activities, including the development of strategies and tactics and the ordering and the release of resources. [**472,** 2013]

• **3.3.29 Noncombustible (Material).** See Section 4.7.

3.3.30 Nonmechanical Emergency Ventilation System. A system of smoke reservoirs, smoke vents, and/or dampers that are designed to support the tenability criteria without the use of fans.

3.3.31 Occupancy.

3.3.31.1 ***Incidental Occupancies Within Stations.*** The use of a portion of the station by others who are neither transit system employees nor passengers and where such space remains under the control of the system-operating authority.

3.3.31.2 ***Nonsystem Occupancy.*** An occupancy not under the control of the system-operating authority.

3.3.32 Operations Control Center. The operations center where the authority controls and coordinates the systemwide movement of passengers and trains from which communication is maintained with supervisory and operating personnel of the authority and with participating agencies when required.

3.3.33 Participating Agency. A public, quasipublic, or private agency that has agreed to cooperate with and assist the authority during an emergency.

3.3.34 Passenger Load.

3.3.34.1 ***Detraining Load.*** The number of passengers alighting from a train at a platform.

3.3.34.2 ***Entraining Load.*** The number of passengers boarding a train at a platform.

3.3.34.3 ***Link Load.*** The number of passengers traveling between two stations on board a train or trains.

3.3.35 Point of Safety. A point of safety is one of the following: (1) an enclosed exit that leads to a public way or safe location outside the station, trainway, or vehicle; (2) an at-grade point beyond the vehicle, enclosing station, or trainway; (3) any other approved location.

3.3.36 Power Station. An electric-generating plant for supplying electrical energy to the system.

3.3.37 Power Substation. Location of electric equipment that does not generate electricity but receives and converts or transforms generated energy to usable electric energy.

3.3.38 Radiant Panel Index (I_s). The product of the flame spread factor (F_s) and the heat evolution factor (Q_s), as determined in ASTM E 162.

3.3.39 Replace in Kind. As applied to vehicles and facilities, to furnish with new parts or equipment of the same type but not necessarily of identical design.

3.3.40 Retrofit. As applied to vehicles and facilities, to furnish with new parts or equipment to constitute a deliberate modification of the original design (as opposed to an overhaul or a replacement in kind).

3.3.41 Smoke Obscuration. The reduction of light transmission by smoke, as measured by light attenuation. [**270,** 2013]

3.3.42 Specific Extinction Area. A measure of smoke obscuration potential per unit mass burnt, determined as the product of the specific extinction coefficient and the volumetric mass flow rate, divided by the mass loss rate [m/kg (ft/lb)].

3.3.43 Specific Optical Density (D_s). The optical density, as measured in ASTM E 662, over unit path length within a chamber of unit volume, produced from a specimen of unit surface area, that is irradiated by a heat flux of 2.5 W/cm^2 for a specified period of time.

3.3.44 Station. A place designated for the purpose of loading and unloading passengers, including patron service areas and ancillary spaces associated with the same structure.

3.3.44.1 ***Enclosed Station.*** A station or portion thereof that does not meet the definition of an open station.

3.3.44.2* ***Open Station.*** A station that is constructed such that it is directly open to the atmosphere and smoke and heat are allowed to disperse directly into the atmosphere.

3.3.45 Station Platform. The area of a station immediately adjacent to a guideway, used primarily for loading and unloading passengers.

3.3.46 Structure.

3.3.46.1 ***Elevated Structure.*** Any structure not otherwise defined as a surface or underground structure.

3.3.46.2 ***Surface Structure.*** Any at-grade or unroofed structure other than an elevated or underground structure.

3.3.47 System. See 3.3.52.1, Fixed Guideway Transit System, or 3.3.52.2, Passenger Rail System.

3.3.48 Tenable Environment. An environment that permits the self-rescue or survival of occupants.

3.3.49 Tourist, Scenic, Historic, or Excursion Operations. Railroad operations, often using antiquated equipment, that are principally intended to carry passengers traveling for pleasure purposes.

3.3.50 Track.

3.3.50.1 ***Storage Track.*** A portion of the trainway used for temporary storage or light cleaning of trains and not intended to be used for trains occupied by passengers.

3.3.50.2 ***Tail Track.*** A portion of dead-end trainway used for temporary storage, turn-around, or light cleaning of trains and not intended to be used for trains occupied by passengers.

3.3.51 Trainway. That portion of the system in which the vehicles operate.

3.3.52 Transportation Systems.

3.3.52.1 ***Fixed Guideway Transit System.*** An electrified transportation system, utilizing a fixed guideway, operating on right-of-way for the mass movement of passengers within a metropolitan area, and consisting of its fixed guideways, transit vehicles, and other rolling stock; power systems; buildings; stations; and other stationary and movable apparatus, equipment, appurtenances, and structures.

3.3.52.1.1 ***Automated Fixed Guideway Transit System.*** A fixed guideway transit system that operates fully automated, driverless vehicles along an exclusive right-of-way.

3.3.52.2 ***Passenger Rail System.*** A transportation system, utilizing a rail guideway, operating on right-of-way for the movement of passengers within and between metropolitan areas, and consisting of its rail guideways, passenger rail vehicles, and other rolling stock; power systems; buildings; stations; and other stationary and movable apparatus, equipment, appurtenances, and structures.

3.3.53 Vehicle.

3.3.53.1 ***Fixed Guideway Transit Vehicle.*** An electrically propelled passenger-carrying vehicle characterized by high acceleration and braking rates for frequent starts and stops and fast passenger loading and unloading.

3.3.53.2 ***Passenger Rail Vehicle.*** A vehicle and/or power unit running on rails used to carry passengers and crew.

Chapter 4 General

4.1 Fire Safety of Systems.

4.1.1 Fire safety of systems shall be achieved through a composite of facility design, operating equipment, hardware, procedures, and software subsystems that are integrated to protect life and property from the effects of fire.

4.1.2 The level of fire safety desired for the whole system shall be achieved by integrating the required levels for each subsystem.

4.2 Goals.

4.2.1* The goals of this standard shall be to provide an environment for occupants of fixed guideway and passenger rail system elements that is safe from fire and similar emergencies to a practical extent based on the following measures:

(1) Protection of occupants not intimate with the initial fire development
(2) Maximizing the survivability of occupants intimate with the initial fire development

4.2.2 This standard is prepared with the intent of providing minimum requirements for those instances where noncombustible materials (as defined in Section 4.7) are not used due to other consideration in the design and construction of the system elements.

4.3 Objectives.

4.3.1 Occupant Protection. Systems shall be designed, constructed, and maintained to protect occupants who are not intimate with the initial fire development for the time needed to evacuate or relocate them or to defend such occupants in place during a fire or fire-related emergency.

4.3.2 Structural Integrity. Structural integrity of stations, trainways, and vehicles shall be maintained for the time needed to evacuate, relocate, or defend in place occupants who are not intimate with the initial fire development.

4.3.3 Systems Effectiveness. Systems utilized to achieve the goals stated in Section 4.2 shall be effective in mitigating the hazard or condition for which they are being used, shall be reliable, shall be maintained to the level at which they were designed to operate, and shall remain operational.

4.4* Assumption of a Single Fire Event. The protection methods described in this standard shall assume a single fire event from a single fire source.

4.5* Shared Use by Freight Systems. Where passenger and freight systems are operated concurrently through or adjacent to stations and trainways, the design of the station and trainway fire-life safety and fire protection systems shall consider the hazards associated with both uses, as approved.

4.6* Fire Scenarios. Design scenarios shall consider the location and size of a fire or a fire-related emergency.

4.7* Noncombustible Material.

4.7.1* A material that complies with any of the following shall be considered a noncombustible material: [**101:**4.6.13.1]

(1) A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat. [**101:**4.6.13.1(1)]
(2) A material that is reported as passing ASTM E 136. [**101:** 4.6.13.1(2)]
(3) A material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652. [**101:**4.6.13.1(3)]

4.8* Fire-Life Safety System Integrity. No part of the fire-life safety system critical to the intended system function that addresses an emergency shall be vulnerable to the emergency that it is supposed to address.

Chapter 5 Stations

5.1 General.

5.1.1 Applicability.

5.1.1.1 This chapter shall apply to all portions of stations.

5.1.2* Relationship to Local Codes.

5.1.2.1 The requirements in this chapter shall supplement the requirements of the locally applicable codes for the design and construction of stations.

5.1.2.2 Where the requirements in this chapter do not address a specific feature of fire protection or life safety, the requirements of the local codes shall be considered applicable.

5.1.3 Use and Occupancy.

5.1.3.1 The primary purpose of a station shall be for the use of the passengers who normally stay in a station structure for a period of time no longer than that necessary to wait for and enter a departing passenger-carrying vehicle or to exit the station after arriving on an incoming passenger-carrying vehicle.

5.1.3.2 Where contiguous nonsystem occupancies share common space with the station, where incidental occupancies are within the station, or where the station is integrated into a building used for nonsystem occupancy of which is for neither fixed guideway transit nor passenger rail, special considerations beyond this standard shall be necessary.

5.1.3.3 A station shall also be for the use of employees whose work assignments require their presence in the station structures.

5.2 Construction.

5.2.1 Safeguards During Construction.

5.2.1.1 During the course of construction, provisions of NFPA 241 shall apply except as modified herein.

5.2.1.2 Where access for fire fighting is restricted, standpipes sized for water flow and pressure for the maximum predicted construction fire load shall be installed to within 61 m (200 ft) of the most remote portion of the station.

5.2.1.3 The flow and pressure required at the outlet shall be approved.

5.2.1.4* Illumination levels within construction areas of enclosed stations shall not be less than 2.7 lx (0.25 ft-candles) at the walking surface.

5.2.2 Construction Type.

5.2.2.1 Building construction for all new enclosed stations shall be not less than Type I or Type II or combinations of Type I and Type II noncombustible construction as defined in NFPA 220, in accordance with the requirements of NFPA *101*, Chapter 12, for the station configuration or as determined by fire hazard analysis of potential fire exposure hazards to the structure.

5.2.2.2 Other types of construction as defined in NFPA 220 shall be permitted for open stations in accordance with the provisions of NFPA *101*, Chapter 12, for corresponding station configurations.

5.2.3 Flammable and Combustible Liquids Intrusion.

5.2.3.1 General. Protection of underground system structures against the accidental intrusion of flammable and combustible liquids shall be provided in accordance with this section.

5.2.3.2 Vehicle Roadway Terminations. Vent or fan shafts utilized for ventilation of underground system structures shall not terminate at grade on any vehicle roadway.

5.2.3.3 Median and Sidewalk Terminations. Vent and fan shafts shall be permitted to terminate in the median strips of divided highways, on sidewalks designed to accept such shafts, or in open space areas, provided that the grade level of the median strips, sidewalk, or open-space meets the following conditions:

(1) It is at a higher elevation than the surrounding grade level.
(2) It is separated from the roadway by a concrete curb at least 150 mm (6 in.) in height.

5.2.4 Compartmentation.

5.2.4.1 Interconnected Floor Levels. Interconnection between floor levels in stations shall be permitted as follows:

(1)*Stairs and escalators used by passengers shall not be required to be fire-separated.
(2) Public areas on different levels in open stations are permitted to be interconnected.
(3) Public areas on different levels in enclosed stations shall be permitted to be interconnected, provided fire separation is not required for smoke control or other fire protection purposes.

5.2.4.2* Separation Between Public and Nonpublic Floor Areas. All public areas shall be fire-separated from adjacent nonpublic areas.

5.2.4.3 Ancillary Spaces. Fire resistance ratings of separations between ancillary occupancies shall be established as required by NFPA *101* and in accordance with ASTM E 119 and ANSI/UL 263.

5.2.4.4* Agents' and Information Booths. Agents' or information booths shall comply with the following:

(1) Agents' or information booths shall be constructed of noncombustible materials.
(2) Booths used only as agents' and information booths shall not be required to be fire-separated from public station areas.

5.2.4.5* Separation Between System and Nonsystem Occupancies. All station public areas shall be fire separated from adjacent non-system occupancies.

5.2.5 Interior Finish.

5.2.5.1 Materials used as interior wall and ceiling finish in enclosed stations shall be noncombustible except as permitted in the following:

(1) Except as required for materials listed in (2), materials exhibiting a flame spread index not exceeding 25 and a smoke developed index not exceeding 450 when tested in accordance with ASTM E 84 shall be permitted as interior wall and ceiling finish in enclosed stations.
(2) The following materials shall not be used as interior wall or ceiling finish, whether exposed or covered by a textile or vinyl facing, unless they are tested in accordance with NFPA 286 and meet the requirements of (3):
    (a) Foam plastic insulation
    (b) Textile wall or ceiling coverings
    (c) Polypropylene
    (d) High-density polyethylene
(3) Materials in accordance with NFPA 286, and meeting the following requirements shall be permitted as interior wall and ceiling finish in enclosed stations.
    (a) Flames shall not spread to the ceiling during the 40 kW (135 kBtu/hr) exposure.
    (b) Flames shall not spread to the outer extremities of the sample on any wall or ceiling.
    (c) Flashover, as described in NFPA 286, shall not occur.
    (d) The peak heat release rate shall not exceed 800 kW (2730 kBtu/hr).
    (e) The total smoke released throughout the test shall not exceed 1000 m^2 (10,764 ft^2).

5.2.5.2 Materials used as interior floor finish materials in enclosed stations shall be noncombustible or shall exhibit a critical radiant flux not less than 0.8 W/cm^2 (0.7 $Btu/ft^2 \cdot sec$) when tested in accordance with ASTM E 648.

5.2.5.3 Materials used as interior finish in open stations shall comply with the requirements of NFPA *101*, Chapter 12.

5.2.6 Combustible Furnishings and Contents.

5.2.6.1* Where combustible furnishings or contents not specifically addressed in this standard are installed in a station, a fire hazard analysis shall be conducted to determine that the level of occupant fire safety is not adversely affected by the furnishings and contents.

5.2.6.2* Permanent rubbish containers in the station shall be manufactured of noncombustible materials.

5.2.6.3 Seating furniture in stations shall be noncombustible, or it shall have limited rates of heat release when tested in accordance with ASTM E 1537, as follows:

(1) The peak rate of heat release for a single seating furniture item shall not exceed 80 kW (270 kBtu/hr).
(2) The total energy released by a single seating furniture item during the first 10 minutes of the test shall not exceed 25 MJ (23,700 Btu).

5.2.6.4 Lockers shall be constructed of noncombustible materials.

5.3* Means of Egress.

5.3.1* General.

5.3.1.1 The provisions for means of egress for a station shall comply with Chapters 7 and 12 of NFPA *101*, except as herein modified.

5.3.1.2 For a station, the design of the means of egress shall be based on an emergency condition requiring evacuation of the train(s) and station occupants to a point of safety.

5.3.2 Occupant Load.

5.3.2.1* The occupant load for a station shall be based on the train load of trains simultaneously entering the station on all tracks in normal traffic direction plus the simultaneous entraining load awaiting trains.

(1) The train load shall consider only one train at any one track.
(2) The basis for calculating train and entraining loads shall be the peak period ridership figures as projected for design of a new system or as updated for an operating system.

5.3.2.2* For station(s) servicing areas such as civic centers, sports complexes, and convention centers, the peak ridership figures shall consider events that establish occupant loads not included in normal passenger loads.

5.3.2.3 At multilevel, multiline, or multiplatform stations, occupant loads shall be determined as follows:

(1) The maximum occupant load for each platform shall be considered separately for the purpose of sizing the means of egress from that platform.
(2)*Simultaneous loads shall be considered for all egress routes passing through each level of that station.

5.3.2.4 Where an area within a station is intended for use by other than passengers or employees, the following parameters shall apply:

(1) The occupant load for that area shall be determined in accordance with the provisions of NFPA *101* as appropriate for the use.
(2) The additional occupant load shall be included in determining the required egress from that area.
(3) The additional occupant load shall be permitted to be omitted from the station occupant load where the area has independent means of egress of sufficient number and capacity.

5.3.2.5* Calculation of Platform Occupant Load. The platform occupant load for each platform in a station shall be the maximum peak period occupant load calculated according to the following:

(1) The peak period occupant load for each platform shall be based on the simultaneous evacuation of the entraining load and the train load for that platform in the peak period.
(2) The entraining load for each platform shall be the sum of the entraining loads for each track serving that platform.
(3)*The entraining load for each track shall be based on the entraining load per train headway factored to account for service disruptions and system reaction time.
(4)*Where a platform serves more than one line on one track, the calculation of entraining load shall consider the combined effect of accumulation for each of the lines served.
(5) The train load for each platform shall be the sum of the train loads for each track serving that platform.
(6) The train load for each track shall be based on the train load per train headway factored to account for service disruptions and system reaction time.
(7) The maximum train load at each track shall be the maximum passenger capacity for the largest capacity train operating on that track during the peak period.

5.3.3* Capacity and Location of Means of Egress.

5.3.3.1* Platform Evacuation Time. There shall be sufficient egress capacity to evacuate the platform occupant load as defined in 5.3.2.5 from the station platform in 4 minutes or less.

5.3.3.2* Evacuation Time to a Point of Safety. The station shall be designed to permit evacuation from the most remote point on the platform to a point of safety in 6 minutes or less.

5.3.3.3 For open stations where the concourse is below or protected from the platform by distance or materials as determined by an appropriate engineering analysis, that concourse shall be permitted to be defined as a point of safety.

5.3.3.4 For enclosed stations equipped with an emergency ventilation system designed in accordance with Chapter 7 and where the emergency ventilation system provides protection for the concourse from exposure to the effects of a train fire at the platform as confirmed by engineering analysis, that concourse is permitted to be defined as a point of safety.

5.3.3.5 Travel Distance. The maximum travel distance on the platform to a point at which a means of egress route leaves the platform shall not exceed 100 m (325 ft).

5.3.3.6* Common Path of Travel. A common path of travel from the ends of the platform shall not exceed 25 m (82 ft) or one car length, whichever is greater.

5.3.3.7 Alternate Egress. At least two means of egress remote from each other shall be provided from each station platform as follows:

(1)*A means of egress used as a public circulation route shall be permitted to provide more than 50 percent of the required egress capacity from a station platform or other location.
(2) Means of egress from separate platforms shall be permitted to converge.
(3) Where means of egress routes from separate platforms converge, the subsequent capacity of the egress route shall be sufficient to maintain the required evacuation time from the incident platform.

5.3.3.8* Engineering Analysis. Modification of the evacuation times and travel distances shall be permitted based on an engineering analysis by evaluating material heat release rates, station geometry, and emergency ventilation systems.

5.3.4* Platforms, Corridors, and Ramps.

5.3.4.1* A minimum clear width of 1120 mm (44 in.) shall be provided along all platforms, corridors, and ramps serving as means of egress.

5.3.4.2 In computing the means of egress capacity available on platforms, corridors, and ramps, 300 mm (12 in.) shall be deducted at each sidewall, and 450 mm (18 in.) shall be deducted at platform edges that are open to the trainway.

5.3.4.3 The maximum means of egress capacity of platforms, corridors, and ramps shall be computed at 0.0819 p/mm-min (2.08 p/in.-min).

5.3.4.4* The maximum means of egress travel speed along platforms, corridors, and ramps shall be computed at 37.7 m/min (124 ft/min).

5.3.4.5* The means of egress travel speed for concourses and other areas where a lesser pedestrian density is anticipated shall be computed at 61.0 m/min (200 ft/min).

5.3.5 Stairs and Escalators.

5.3.5.1 Stairs and escalators permitted by 5.2.4.1 to be unenclosed shall be permitted to be counted as contributing to the means of egress capacity in stations as detailed in 5.2.2 and 5.3.3.

5.3.5.2 Stairs in the means of egress shall be a minimum of 1120 mm (44 in.) wide.

5.3.5.3* Capacity and travel speed for stairs and escalators shall be computed as follows:

(1) Capacity — 0.0555 p/mm-min (1.41 p/in.-min)
(2)*Travel speed — 14.6 m/min (48 ft/min) (indicates vertical component of travel speed)

5.3.5.4* Escalators shall not account for more than one-half of the means of egress capacity at any one level except as permitted by 5.3.5.5.

5.3.5.5 Escalators shall be permitted to account for more than one-half of the required means of egress capacity at any one level where the following criteria are met:

(1) The escalators are capable of being remotely brought to a stop in accordance with the requirements of 5.3.5.7(3)(b), 5.3.5.7(4), and 5.3.5.7(5).

(2) A portion of the means of egress capacity from each station level is stairs.
(3) For enclosed stations, at least one enclosed exit stair or exit passageway provides continuous access from the platforms to the public way.

5.3.5.6* In calculating the egress capacity of escalators, the following criteria shall be met:

(1) One escalator at each level shall be considered as being out of service.
(2) The escalator chosen shall be the one having the most adverse effect upon egress capacity.

5.3.5.7 Where escalators are permitted as a means of egress in stations, the following criteria shall be met:

(1)*The escalators shall be constructed of noncombustible materials.
(2)*Escalators running in the direction of egress shall be permitted to remain operating.
(3) Escalators running reverse to the direction of egress shall be capable of being stopped locally and remotely as follows:
   (a) Locally by a manual stopping device at the escalator
   (b) Remotely by one of the following:
      i. A manual stopping device at a remote location
      ii. As part of a pre-planned evacuation response
(4)*Where provision is made for remote stopping of escalators counted as means of egress, one of the following shall apply:
   (a) The stop shall be delayed until it is preceded by a minimum 15-second audible signal or warning message sounded at the escalator
   (b) Where escalators are equipped with the necessary controls to decelerate in a controlled manner under the full rated load, the stop shall be delayed for at least 5 seconds before beginning deceleration, and the deceleration, rate shall be no greater than 0.052 m/sec^2 (0.17 ft/sec^2).
(5) Where an audible signal or warning message is used, the following shall apply:
   (a) The signal or message shall have a sound intensity that is at least 15 dBA above the average ambient sound level for the entire length of the escalator.
   (b) The signal shall be distinct from the fire alarm signal.
   (c) The warning message shall meet audibility and intelligibility requirements.

5.3.5.8 Escalators with or without intermediate landings shall be acceptable as a means of egress, regardless of vertical rise.

5.3.5.9 Escalators exposed to the outdoor environment shall be provided with slip-resistant landing and floor plates, and if they are exposed to freezing temperatures, the landing and floor plates and the steps shall be heated to prevent the accumulation of ice and snow.

5.3.5.10 Stopped escalators shall be permitted to be started in the direction of egress in accordance with the requirements for stopping of escalators described in 5.3.5.7(3), 5.3.5.7(4), and 5.3.5.7(5), provided that the escalators can be restarted in a fully loaded condition and that passengers are given warning.

5.3.6 Elevators.

5.3.6.1 Elevators meeting the requirements of 5.3.6.2 through 5.3.6.4 shall be permitted to account for part of the means of egress capacity in stations.

5.3.6.2 Capacity. Where elevators are counted as contributing to the means of egress capacity, the following shall apply:

(1) They shall account for no more than 50 percent of the required egress capacity.
(2)*At least one elevator shall be considered out of service, and one elevator shall be reserved for fire service.
(3)*The capacity of each elevator shall be the carrying capacity of the elevator within 30 minutes.

5.3.6.3 Holding Area. Elevators counted as contributing to the means of egress capacity from any level of a station shall be accessed via holding areas or lobbies at that level, which shall be designed as follows:

(1) The holding areas or lobbies shall be separated from the platform by a smoketight fire separation having a fire resistance rating of at least 1 hour but not less than the time required to evacuate the holding area occupant load.
(2) At least one stair shall be accessible from the holding area.
(3) The holding area shall be sized to accommodate one person per 0.46 m^2 (5 ft^2).
(4) If the holding area includes portions of the platform, the area within 460 mm (18 in.) of the trainway shall not be considered in the calculation.
(5) Upon activation of smoke control in the platform or adjacent trainway areas, the holding area shall be pressurized to a minimum of 25 Pa (0.1003 in. of water gauge).
(6) The holding area shall be provided with emergency voice alarm devices with two-way communication to the system operations control center.

5.3.6.4 Design Features. Elevators counted as contributing to the means of egress capacity shall be designed as follows:

(1) Shaft enclosures shall be constructed as fire separations having a 2-hour fire resistance rating.
(2)*The design shall limit water flow into the shaft.
(3) No more than two elevators used for means of egress or fire department access shall share the same machine room.
(4) Machine rooms shall be separated from each other by fire separations having a minimum fire resistance rating of 2 hours.
(5) The elevators shall be connected to emergency power.
(6)*During emergency evacuation, the elevators shall travel only between the incident level and a point of safety.
(7)*Provisions for Phase I emergency recall operation shall be based on analysis of fire scenarios on each level served and demonstrate safe egress for those scenarios.

5.3.7* Doors, Gates, and Exit Hatches.

5.3.7.1 The egress capacity for doors and gates in a means of egress serving public areas shall be computed as follows:

(1) 60 people per minute (p/min) for single leaf doors and gates
(2)*0.0819 p/mm-min (2.08 p/in.-min) for bi-parting multileaf doors and gates measured for the clear width dimension.

5.3.7.2 Gates in a means of egress shall be designed in accordance with the requirements for doors serving as a means of egress.

5.3.7.3 Where used, exit hatches shall comply with the requirements of 6.3.3.15 through 6.3.3.17.

5.3.8 Fare Barriers.

5.3.8.1 Fare barriers complying with 5.3.8.2 through 5.3.8.5 shall be permitted in the means of egress serving stations.

5.3.8.2* Except as permitted in 5.3.8.3, fare barriers in the required means of egress shall be designed to release, permitting unimpeded travel in the direction of egress under all the following conditions:

(1) Power failure or ground fault condition
(2) Activation of the station fire alarm signal
(3) Manual activation from a switch in a constantly attended location in the station or operations control center

5.3.8.3 Fare barriers that do not comply with the requirements of 5.3.8.2 shall be permitted in the means of egress where barriers in the equipment are designed to provide egress when a horizontal force not exceeding 66N (15lbf) is applied in the egress direction.

5.3.8.4 Gate-type fare barriers in the means of egress shall meet the following criteria:

(1)*Each unit shall provide a minimum of 455 mm (18 in.) clear width at and below a height of 1000 mm (39.5 in.) and 530 mm (21 in.) clear width above that height.
(2) Each unit shall be credited with a capacity of 50 p/min for egress calculations.

5.3.8.5 Turnstile-type fare barriers shall be permitted in accordance with NFPA *101* and shall in the means of egress shall meet the following criteria:

(1) Dimensions shall be in accordance with the requirements of NFPA *101.*
(2) Turnstiles that drop away from the egress opening under the conditions listed in 5.3.8.2 or 5.3.8.3 shall be credited with a capacity of 50 p/min for egress calculations.
(3) Turnstiles that revolve freely in the direction of egress under the conditions listed in 5.3.8.2 shall meet the following criteria:
    (a) Each unit shall be credited with a capacity of 25 p/min for egress calculations.
    (b) The turnstiles shall not account for more than 50 percent of the required egress capacity for each egress route.

5.3.8.6* Fare barriers shall be designed so that their failure to operate properly will not prohibit movement of passengers in the direction of emergency egress.

5.3.9 Horizontal Exits.

5.3.9.1* Horizontal exits compliant with NFPA *101* shall be permitted for up to 100 percent of the number of horizontal exits and required egress capacity provided that not more than 50 percent of the number and required capacity is into a single building.

5.3.10 Platform Screen and Edge Doors.

5.3.10.1 Horizontal sliding platform screen or platform edge doors shall be permitted to separate the platform from the trainway in stations, provided that the following criteria are met:

(1) The doors permit emergency egress from the train to the platform regardless of the stopping position of the train.
(2) The doors provide egress when a force not exceeding 220 N (50 lb) is applied from the train side of the doors.
(3) The doors are designed to withstand positive and negative pressures caused by passing trains.

5.3.11 Means of Egress Lighting.

5.3.11.1 Illumination of the means of egress in stations, including escalators that are considered a means of egress, shall be in accordance with Section 7.8 of NFPA *101.*

5.3.11.2 Means of egress, including escalators considered as means of egress, shall be provided with a system of emergency lighting in accordance with Section 7.9 of NFPA *101.*

5.3.11.3 In addition to the requirements of 5.3.11.1 and 5.3.11.2:

(1) Lighting for stairs and escalators shall be designed to emphasize illumination on the top and bottom steps and landings.
(2) Where newel- and comb-lighting is provided for escalator steps, such lighting shall be on emergency power circuits.

5.4 Fire Protection.

5.4.1* Fire Command Center.

5.4.1.1 Enclosed stations shall be provided with a fire command center in accordance with *NFPA 72.*

5.4.1.2 The ventilation systems at adjacent trainways and stations shall be permitted to be omitted from the controls of the fire command center.

5.4.2 Protective Signaling Systems.

5.4.2.1 Stations equipped with fire alarm devices shall be protected by a proprietary supervising station alarm system as defined in *NFPA 72.*

5.4.2.2* Each station having fire alarm initiating devices shall be provided with a fire alarm annunciator panel at a location that is accessible to emergency response personnel in accordance with *NFPA 72.*

5.4.2.3 The location of the fire alarm annunciator panel shall be approved.

5.4.2.4 Annunciator panels shall announce by audible alarm the activation of any fire alarm initiating device in the station and visually display the location of the actuated device.

5.4.2.5 When activated, all indicator signals for fire alarms, smoke detection, valve switches, and waterflow shall be transmitted simultaneously to the local station and to the operations control center.

5.4.2.6* Separate zones shall be established on local station annunciator panels to monitor waterflow on sprinkler systems and supervise main control valves.

5.4.2.7 Automatic fire detection shall be provided in all ancillary spaces by the installation of listed combination fixed-temperature and rate-of-rise heat detectors or listed smoke detectors except where protected by automatic sprinklers.

5.4.2.8 Fire alarm systems shall be inspected, tested, and maintained in accordance with *NFPA 72.*

5.4.3 Emergency Communication.

5.4.3.1 A public address (PA) system and emergency voice alarm reporting devices, such as emergency telephone boxes or manual fire alarm boxes conforming to *NFPA 72*, shall be required in stations.

5.4.3.2 The operations control center and each system station shall be equipped with an approved emergency voice/alarm communication system so that appropriate announcements can be made regarding fire alarms, including provisions for giving necessary information and directions to the public upon receipt of any manual or automatic fire alarm signal.

5.4.3.3 The notification devices shall be placed in approved locations at each facility.

5.4.3.4 Emergency alarm reporting devices shall be located on passenger platforms and throughout the stations such that the travel distance from any point in the public area shall not exceed 100 m (325 ft) unless otherwise approved.

5.4.3.5 Such emergency devices shall be distinctive in color, and their locations shall be plainly indicated by appropriate signs.

5.4.4 Automatic Fire Suppression Systems.

5.4.4.1* An automatic sprinkler protection system shall be provided in areas of stations used for concessions, in storage areas, in trash rooms, and other similar areas with combustible loadings, except trainways.

5.4.4.2 Sprinkler protection shall be permitted to be omitted in areas of open stations remotely located from public spaces.

5.4.4.3 Installation of sprinkler systems shall comply with NFPA 13 or applicable local codes as required.

5.4.4.4 A sprinkler system waterflow alarm and supervisory signal service shall be installed.

5.4.4.5 Other fire suppression systems, if approved, shall be permitted to be substituted for automatic sprinkler systems in the areas listed in 5.4.4.1.

5.4.4.6 Automatic fire sprinkler systems shall be tested and maintained in accordance with NFPA 25.

5.4.5 Standpipe and Hose Systems.

5.4.5.1* Class I standpipes shall be installed in enclosed stations in accordance with NFPA 14 except as modified herein.

5.4.5.2 Standpipe systems shall not be required to be enclosed in fire-rated construction provided the following conditions are met:

(1) The system is cross-connected or fed from two locations.
(2) Isolation valves are installed not more than 245 m (800 ft) apart.

5.4.5.3 In addition to the usual identification required on fire department connections for standpipes, there shall also be wording to identify the fire department connection as part of the station system.

5.4.5.4* Standpipes shall be permitted to be of the dry type with the approval of the authority having jurisdiction provided the following requirements are met:

(1)*Systems shall be installed in a manner so that the water is delivered to all hose connections on the system in 10 minutes or less.
(2) Combination air relief–vacuum valves shall be installed at each high point on the system.

5.4.5.5 Dry standpipes shall be permitted to be concealed without the piping integrity being monitored with a supervisory air pressure provided they are pressure tested annually.

5.4.5.6 Where enclosed stations include more than one platform level (such as crossover subway lines), there shall be a cross-connection pipe of a minimum size of 100 mm (4 in.) in diameter between each standpipe system, so that supplying water through any fire department connection will furnish water throughout the entire system.

5.4.5.7 Standpipe and hose systems shall be tested and maintained in accordance with NFPA 25.

5.4.6 Portable Fire Extinguishers. Portable fire extinguishers in such number, size, type, and location as determined by the authority having jurisdiction shall be provided.

5.4.6.1 Portable fire extinguishers shall be maintained in accordance with NFPA 10.

5.4.7 Ventilation.

5.4.7.1 Emergency ventilation shall be provided in enclosed stations in accordance with Chapter 7.

5.4.8 Emergency Power.

5.4.8.1 Emergency power in accordance with Article 700 of *NFPA 70,* and Chapter 4 of NFPA 110 shall be provided for enclosed stations.

5.4.8.2 The supply system for emergency purposes, in addition to the normal services to the station building, shall be one or more of the types of systems described in 700.12(A) through 700.12(E) of *NFPA 70*.

5.4.8.3 The emergency power system shall have a capacity and rating sufficient to supply all equipment required to be connected by 5.4.8.5.

5.4.8.4 Selective load pickup and load shedding shall be permitted in accordance with *NFPA 70*.

5.4.8.5 Systems connected to the emergency power system shall include the following:

(1) Emergency lighting
(2) Protective signaling systems
(3) Emergency communication system
(4) Fire command center
(5) Elevators providing required egress capacity [see 5.3.6.4(5)]

5.4.8.6 The emergency lighting and communications circuits shall be protected from physical damage by system vehicles or other normal system operations and from fire as described in 12.4.4.

Chapter 6 Trainways

6.1 General.

6.1.1* Applicability. This chapter applies to all portions of the trainway, including pocket storage and tail tracks not intended for occupancy by passengers.

6.1.2 Use and Occupancy.

6.1.2.1 Passengers shall enter the trainways only in the event that it becomes necessary to evacuate a train.

6.1.2.2 Evacuation shall take place only under the guidance and control of authorized, trained system employees or other authorized personnel as warranted under an emergency situation.

6.1.2.3* Warning signs in accordance with 6.3.5.1 shall be posted at locations where unauthorized personnel might trespass.

6.2 Construction.

6.2.1 Safeguards During Construction.

6.2.1.1 A standpipe system shall be installed in enclosed trainways under construction in accordance with NFPA 241.

6.2.1.2 The standpipe system shall be installed before the enclosed trainway has exceeded a length of 61 m (200 ft) beyond any access shaft or portal and shall be extended as work progresses to within 61 m (200 ft) of the most remote portion of the enclosed trainway.

6.2.1.3 Standpipes shall be sized for approved water flow and pressure at the outlet, based upon the maximum predicted fire load.

6.2.1.4 Reducers or adapters shall meet the following criteria:

(1) Be provided and attached for connection to the contractor's hose
(2) Be readily removable through the use of a fire fighter's hose spanner wrench

6.2.1.5 Risers shall meet the following criteria:

(1) Be identified with signs as outlined in 6.4.4.7
(2) Be readily accessible for fire department use
(3) Be protected from accidental damage

6.2.1.6* Illumination levels in enclosed trainways under construction shall not be less than 2.7 lx (0.25 ft-candles) at the walking surface.

6.2.2 Construction Type.

6.2.2.1* Cut and Cover. Where trainway sections are to be constructed by the cut-and-cover method, perimeter walls and related construction shall be not less than Type I or Type II or combinations of Type I or Type II noncombustible construction as defined in NFPA 220, as determined by an engineering analysis of potential fire exposure hazards to the structure.

6.2.2.2 Bored Tunnels. Where trainway sections are to be constructed by a tunneling method through earth, unprotected steel liners, reinforced concrete, shotcrete, or equivalent shall be used.

6.2.2.3 Rock Tunnels. Rock tunnels shall be permitted to utilize steel bents with concrete liner if lining is required.

6.2.2.4 Underwater Tubes. Underwater tubes shall be not less than Type II (000) noncombustible construction as defined in NFPA 220, as applicable.

6.2.2.5 Exit and Ventilation Structures. Remote vertical exit shafts and ventilation structures shall be not less than Type I (332) noncombustible construction as defined in NFPA 220.

6.2.2.6 Surface. Construction materials shall be not less than Type II (000) noncombustible material as defined in NFPA 220, as determined by a fire hazard analysis of potential fire exposure hazards to the structure.

6.2.2.7 Elevated. All structures necessary for trainway support and all structures and enclosures on or under trainways shall be of not less than Type I or Type II (000) or combinations of Type I or Type II noncombustible construction as defined in NFPA 220, as determined by a fire hazard analysis of potential fire exposure hazards to the structure.

6.2.3 Flammable and Combustible Liquids Intrusion.

6.2.3.1 General. Protection of underground system structures against the accidental intrusion of flammable and combustible liquids shall meet the requirements of 5.2.3.

6.2.4* Compartmentation.

6.2.4.1 Ancillary areas shall be separated from trainway areas within underwater trainway sections by construction having a minimum 3-hour fire-resistance rating.

6.2.4.2 Ancillary areas shall be separated from trainway areas within enclosed trainway sections by construction having a minimum 2-hour fire-resistance rating.

6.2.5 Combustible Components.

6.2.5.1 Where combustible components not specifically addressed in this standard are installed in a trainway, a fire hazard analysis shall be conducted to determine that the level of occupant fire safety is not adversely affected by the contents.

6.2.5.2 The fire hazard analysis required by 6.2.5.1 shall meet the following criteria:

(1) It shall include, as a minimum, an examination of peak heat release rate for combustible elements, total heat released, ignition temperatures, radiant heating view factors, and behavior of the component during internal or external fire scenarios.
(2) It shall determine that, if a fire propagates beyond involving the component of fire origin, a level of fire safety is provided within an enclosed trainway commensurate with this standard.

6.2.5.3 Computer modeling, material fire testing, or full-scale fire testing shall be conducted to assess performance in potential fire scenarios.

6.2.6 Walking Surfaces.

6.2.6.1 Walking surfaces designated for evacuation of passengers shall be constructed of noncombustible materials.

6.2.7 Coverboard or Protective Material.

6.2.7.1 Coverboard or protective material shall have a flame spread index of not more than 25 and a smoke developed index not exceeding 450 when tested in accordance with ASTM E 84.

6.2.7.2 Coverboard protective material tested in accordance with NFPA 286 shall comply with the following:

(1) Flames shall not spread to the ceiling during the 40 kW (135 kBtu/hr) exposure.
(2) Flames shall not spread to the outer extremities of the sample on any test room wall or ceiling.
(3) Flashover as described in NFPA 286 shall not occur.
(4) The peak heat release rate throughout the test shall not exceed 800 kW (2730 kBtu/hr).
(5) The total smoke released throughout the test shall not exceed 1000 m^2 (10,764 ft^2).

6.2.8 Rail Ties.

6.2.8.1 Rail ties used in enclosed locations shall be noncombustible materials.

6.2.8.2 Rail ties used at switch or crossover locations shall comply with 6.2.8.1 or shall be fire–retardant treated wood in accordance with NFPA 703.

6.2.8.3 Rail ties and tie blocks in enclosed track sections shall be permitted to be of wood encased in concrete such that only the top surface is exposed.

6.3 Emergency Egress.

6.3.1 Location of Egress Routes.

6.3.1.1* The system shall incorporate a walk surface or other approved means for passengers to evacuate a train at any point along the trainway so that they can proceed to the nearest station or other point of safety.

6.3.1.2 Walkway continuity shall be maintained at special track sections (e.g., crossovers, pocket tracks).

6.3.1.3 Walkway continuity shall be provided by crosswalks at track level.

6.3.1.4* Within enclosed trainways, the maximum distance between exits shall not exceed 762 m (2500 ft).

6.3.1.5 Cross-passageways shall be permitted to be used in lieu of emergency exit stairways to the surface where trainways in tunnels are divided by a minimum of 2 hour–rated fire separations or where trainways are in twin bores.

6.3.1.6 Where cross-passageways are utilized in lieu of emergency exit stairways, the following requirements shall apply:

(1) Cross-passageways shall not be farther than 244 m (800 ft) apart.
(2)*Cross-passageways shall not be farther than 244 m (800 ft) from the station or portal of the enclosed trainway.
(3) Cross-passageways shall be separated from the trainway with self-closing fire door assemblies having a fire protection rating of 1½ hours.
(4) A tenable environment shall be maintained in the portion of the trainway that is not involved in an emergency and that is being used for evacuation.
(5) A ventilation system for the incident trainway shall be designed to control smoke in the vicinity of the passengers.
(6) Provisions shall be made for evacuating passengers via the non-incident trainway to a nearby station or other emergency exit.
(7)*The provisions shall include measures to protect passengers from oncoming traffic and from other hazards.

6.3.1.7 Where cross-passageways are used in lieu of emergency exit stairways, the interior of the cross-passage shall not be used for any purpose other than as an area of refuge or for access/egress to the opposite tunnel except under the following conditions:

(1) The use of cross-passages for the installation of noncombustible equipment is permitted.
(2) Installed equipment does not intrude into the required clear width of the cross-passage.

6.3.1.8 In areas where cross-passageways are provided, walkways shall be provided on the cross-passageway side of the trainway for unobstructed access to the cross-passageway.

6.3.1.9 For open-cut trainways, an engineering analysis shall be conducted to evaluate the impact of the trainway configuration on safe egress from a train fire to a point of safety.

6.3.1.10 Where the engineering analysis indicates that the configuration will impact tenability beyond the immediate vicinity of the fire, egress routes shall be provided such that the maximum distance from any point within the open-cut section to a point of egress from the trainway shall not be more than 381 m (1250 ft).

6.3.2 Size of Egress Routes

6.3.2.1* The means of egress within the trainway shall be provided with an unobstructed clear width graduating from 610 mm (24 in.) at the walking surface to 760 mm (30 in.) at 1575 mm (62 in.) above the walking surface to 430 mm (17 in.) at 2025 mm (80 in.) above the walking surface.

6.3.2.2 Cross-passageways shall be a minimum of 1120 mm (44 in.) in clear width and 2100 mm (7 ft) in height.

6.3.2.3* The width of exit stairs shall not be required to exceed 1120 mm (44 in.) for enclosed trainways.

6.3.2.4* Doors in egress routes serving trainways shall have a minimum clear width of 810 mm (32 in.).

6.3.3* Egress Components.

6.3.3.1 Walking surfaces serving as egress routes within guideways shall have a uniform, slip-resistant design.

6.3.3.2 Guideway crosswalks shall have a uniform walking surface at the top of the rail.

6.3.3.3 Where the trainway track bed serves as the emergency egress pathway, it shall be nominally level and free of obstructions.

6.3.3.4 Except as permitted in 6.3.3.3, walking surfaces shall have a uniform, slip-resistant design.

6.3.3.5* Walkways that are more than 760 mm (30 in.) above the floor or grade below shall be provided with a continuous guard to prevent falls over the open side.

6.3.3.6 Guards shall not be required along the trainway side of raised walkways where the bottom of the trainway is closed by a deck or grating.

6.3.3.7 Guards shall not be required on raised walkways that are located between two trainways.

6.3.3.8* Walkways that are more than 760 mm (30 in.) above the floor or grade below shall be provided with a continuous handrail along the side opposite the trainway.

6.3.3.9 Raised walkways that are greater than 1120 mm (44 in.) wide and located between two trainways shall not be required to have a handrail.

6.3.3.10 Exit stairs and doors shall comply with Chapter 7 of NFPA *101*, except as herein modified.

6.3.3.11 Doors in the means of egress, except cross-passageway doors, shall open in the direction of exit travel.

6.3.3.12 Doors in the means of egress shall comply with the following:

(1) Open fully when a force not exceeding 220 N (50 lb) is applied to the latch side of the door
(2) Be adequate to withstand positive and negative pressures caused by passing trains and the emergency ventilation system

6.3.3.13 Horizontal sliding doors shall be permitted in cross-passageways.

6.3.3.14 Platform end gates shall meet the clear width requirements for gate-type fare barriers. *(See Chapter 5.)*

6.3.3.15 Exit hatches shall be permitted in the means of egress, provided the following conditions are met:

(1) Hatches shall be equipped with a manual opening device that can be readily opened from the egress side.
(2) Hatches shall be operable with not more than one releasing operation.
(3) The force required to open the hatch when applied at the opening device shall not exceed 130 N (30 lb).
(4) The hatch shall be equipped with a hold-open device that automatically latches the door in the open position to prevent accidental closure.

6.3.3.16 Exit hatches shall be capable of being opened from the discharge side to permit access by authorized personnel.

6.3.3.17* Exit hatches shall be conspicuously marked on the discharge side to prevent possible blockage.

6.3.4 Traction Power Protection.

6.3.4.1* This subsection shall apply to the traction power subsystem installed in all trainways, which shall include the wayside pothead, the cable between the pothead and the contact (third) rail or overhead contact system (OCS), the contact rail or OCS supports, and special warning and identification devices, as well as electrical appurtenances associated with overhead contact systems.

6.3.4.2 To provide safety isolation from the contact rail, the following requirements shall apply:

(1) Power rail conductor(s) (dc or ac, which supply power to the vehicle for propulsion and other loads) shall be secured to insulating supports, bonded at joints, and protected to prevent contact with personnel.
(2) The design shall include measures to prevent inadvertent contact with the live power rails where such power rails are adjacent to emergency or service walkways and where walkways cross over trainways.
(3) Coverboards, where used, shall be capable of supporting a vertical load of 1125 N (250 lb) at any point with no visible permanent deflection.

6.3.4.3 To provide isolation from the overhead contact system, the following requirements shall apply:

(1) Power conductor(s) (dc or ac, which supply power to the vehicle for propulsion and other loads) shall be secured to insulating supports, bonded at joints, and protected to prevent contact with personnel.
(2) Insulating material for the cable connecting power to the power rail or OCS shall meet the FT4/IEEE 1202 exposure requirements for cable char height, total smoke released, and peak smoke release rate of ANSI/UL 1685.

6.3.5 Signage, Illumination, and Emergency Lighting.

6.3.5.1 Warning signs posted on entrances to the trainway and on fences or barriers adjacent to the trainway shall clearly state the hazard (e.g., DANGER HIGH VOLTAGE — 750 VOLTS) with letter sizes and colors in conformance with *NFPA 70* and Occupational Safety and Health Administration (OSHA) requirements.

6.3.5.2 System egress points shall be illuminated.

6.3.5.3 Points of exit from elevated and enclosed trainways shall be marked with internally or externally illuminated signs.

6.3.5.4 Identification. Emergency exit facilities shall be identified and maintained to allow for their intended use.

6.3.5.5 Enclosed trainways greater in length than the minimum length of one train shall be provided with directional signs as appropriate for the emergency procedures developed for the fixed guideway transit or passenger rail system in accordance with Chapter 9.

6.3.5.6 Directional signs indicating station or portal directions shall be installed at maximum 25 m (82 ft) intervals on either side of the enclosed trainways.

6.3.5.7 Directional signs shall be readily visible by passengers for emergency evacuation.

6.3.5.8 The requirements of 6.3.5.9 through 6.3.5.14 shall apply to all enclosed trainways that are greater than 30.5 m (100 ft) in length or two car lengths, whichever is greater.

6.3.5.9* Lighting systems shall be designed so that, during a period of evacuation, illumination levels of trainway walkways and walking surfaces shall not be less than 2.7 lx (0.25 ft-candles), measured along the path of egress at the walking surface.

6.3.5.10 The emergency lighting system in the trainway shall produce illumination on the walkway that does not exceed a uniformity ratio of 10:1 for the maximum maintained horizontal illuminance to the minimum maintained horizontal illuminance.

6.3.5.11* Point illumination of means of egress elements shall be permitted to exceed the 10:1 uniformity ratio.

6.3.5.12 Lighting systems for enclosed trainways shall be installed in accordance with Sections 7.8 and 7.9 of NFPA *101*, except as otherwise noted in 6.3.5.

6.3.5.13 Exit lights, essential signs, and emergency lights shall be included in the emergency lighting system in accordance with *NFPA 70*.

6.3.5.14 Emergency fixtures, exit lights, and signs shall be wired separately from emergency distribution panels.

6.4 Fire Protection and Life Safety Systems.

6.4.1 Emergency Access.

6.4.1.1 Except as described herein, points of egress and exits from the guideway shall serve as emergency access routes.

6.4.1.2 If security fences are used along the trainway, access gates shall be provided in security fences, as deemed necessary by the authority having jurisdiction.

6.4.1.3 Access gates shall be a minimum 1120 mm (44 in.) wide and shall be of the hinged or sliding type.

6.4.1.4 Access gates shall be placed as close as practicable to the portals to permit easy access to tunnels.

6.4.1.5 Information that clearly identifies the route and location of each gate shall be provided on the gates or adjacent thereto.

6.4.1.6 Access to the elevated trainway shall be from stations or by mobile ladder equipment from roadways adjacent to the trackway.

6.4.1.7 If no adjacent or crossing roadways exist for the elevated trainway, access roads at a maximum of 762 m (2500 ft) intervals shall be required.

6.4.1.8 Where the configuration of an open-cut trainway prevents or impedes access for firefighting, provisions shall be made to permit fire fighter access to that section of trainway at intervals not exceeding 762 m (2500 ft).

6.4.2 Blue Light Stations.

6.4.2.1* Blue light stations shall be provided at the following locations:

(1) At the ends of station platforms
(2) At cross-passageways
(3) At emergency access points
(4) At traction power substations
(5) In enclosed trainways as approved

6.4.2.2 Adjacent to each blue light station, information shall be provided that identifies the location of that station and the distance to an exit in each direction.

6.4.2.3 For blue light stations at elevated guideways, the graphics shall be legible from the ground level outside the trackway.

6.4.2.4 In systems with overhead traction power, the requirement to disconnect traction power shall be permitted by an approved alternative means.

6.4.3 Automatic Fire Detection.

6.4.3.1 Heat and smoke detectors shall be installed at traction power substations and signal bungalows and shall be connected to the operations control center.

6.4.3.2 Signals received from such devices shall be identifiable as to the origin of the signals.

6.4.4 Standpipe and Hose Systems.

6.4.4.1 An approved fire standpipe system shall be provided in enclosed trainways where physical factors prevent or impede access to the water supply or fire apparatus, where required by the authority having jurisdiction.

6.4.4.2* Class I standpipe systems shall be installed in trainways in accordance with NFPA 14 except as modified herein.

6.4.4.3 Standpipe systems shall not be required to be enclosed in fire-rated construction, provided the following conditions are met:

(1) The system is cross-connected or fed from two locations.
(2) Isolation valves are installed not more than 244 m (800 ft) apart.

6.4.4.4 Standpipes shall be permitted to be of the dry type with the approval of the authority having jurisdiction provided the following conditions are met:

(1)*Standpipes shall be installed so that the water is delivered to all hose connections on that standpipe in 10 minutes or less.
(2) Combination air relief–vacuum valves shall be installed at each high point on the standpipe.

6.4.4.5 Standpipe systems shall be provided with an approved water supply capable of supplying the system demand for a minimum of 1 hour.

6.4.4.6 Acceptable water supplies shall include the following:

(1) Municipal or privately owned waterworks systems that have adequate pressure, flow rate, and level of integrity
(2) Automatic or manually controlled fire pumps that are connected to water source
(3) Pressure-type or gravity-type storage tanks that are installed in accordance with NFPA 22

6.4.4.7 Identification numbers and letters conforming to the system sectional identification numbers and letters shall be provided at each surface fire department connection and at each hose valve on the standpipe lines.

6.4.4.8 Identifying signs shall be affixed to enclosed trainway walls at each hose outlet valve or shall be painted directly on the standpipe in white letters next to each hose outlet valve.

6.4.4.9 Exposed standpipe lines and identification signs shall be painted as required by the authority having jurisdiction.

6.4.4.10 A fire department access road shall extend to within 30.5 m (100 ft) of the fire department connection.

6.4.5 Portable Fire Extinguishers.

6.4.5.1 Portable fire extinguishers shall be provided in such numbers, sizes, and types and at such locations in enclosed trainways as determined by the authority having jurisdiction.

6.4.6 Ventilation.

6.4.6.1 Except as described in 6.4.6.2 and 6.4.6.3, emergency ventilation shall be provided in enclosed trainways in accordance with Chapter 7.

6.4.6.2* Emergency ventilation meeting the tenability criteria for occupied spaces shall not be required in tail track areas where engineering analysis indicates that a fire on a train in the tail track area will not impact passengers or passenger areas.

6.4.6.3* Emergency ventilation meeting the tenability criteria for occupied areas shall not be required in storage track areas where the storage track has no openings along its length to passenger trainway areas and where an engineering analysis indicates that a fire on a train in the storage track area will not impact passengers or passenger areas.

6.4.7 Emergency Power.

6.4.7.1 Enclosed trainways shall be such that, in the event of failure of the normal supply to or within the system, emergency power shall be provided in accordance with Article 700 of *NFPA 70* and Chapter 4 of NFPA 110. The supply system for emergency purposes, in addition to the normal services to the trainway, shall be one or more of the types of systems described in 700.12(A) through 700.12(E) of *NFPA 70*.

6.4.7.2 The following systems shall be connected to the emergency power system:

(1) Emergency lighting
(2) Protective signaling systems
(3) Emergency communication system
(4) Fire command center

6.4.7.3 The emergency lighting and communications circuits shall be protected from physical damage by system vehicles or other normal system operations and from fire as described in 12.4.4.

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Chapter 7 Emergency Ventilation System

7.1 General.

7.1.1* This chapter defines the requirements for the environmental conditions and the mechanical and nonmechanical ventilation systems used to meet those requirements for a fire emergency in a system station, trainway, or both as required by 5.3.3 and 6.3.2.

7.1.2 The requirement for a mechanical or nonmechanical system intended for the purpose of emergency ventilation shall be determined in accordance with 7.1.2.1 through 7.1.2.4.

7.1.2.1 For length determination, all contiguous enclosed trainway and underground system station segments between portals shall be included.

7.1.2.2* A mechanical emergency ventilation system shall be provided in the following locations:

(1) In an enclosed system station
(2) In a system underground or enclosed trainway that is greater in length than 1000 ft (305 m)

7.1.2.3 A mechanical emergency ventilation system shall not be required in the following locations:

(1) In an open system station
(2) Where the length of an underground trainway is less than or equal to 200 ft (61 m)

7.1.2.4 Where supported by engineering analysis, a nonmechanical emergency ventilation system shall be permitted to be provided in lieu of a mechanical emergency ventilation system in the following locations:

(1) Where the length of the underground or enclosed trainway is less than or equal to 1000 ft (305 m) and greater than 200 ft (61 m)
(2) In an enclosed station where engineering analysis indicates that a nonmechanical emergency ventilation system supports the tenability criteria of the project

7.1.2.5 In the event that an engineering analysis is not conducted or does not support the use of a nonmechanical emergency ventilation system for the configurations described in 7.1.2.4, a mechanical emergency ventilation system shall be provided.

7.1.3 The engineering analysis of the ventilation system shall include a validated subway analytical simulation program augmented as appropriate by a quantitative analysis of airflow dynamics produced in the fire scenario, such as would result from the application of validated computational fluid dynamics (CFD) techniques. The results of the analysis shall include the no-fire (or cold) air velocities that can be measured during commissioning to confirm that a mechanical ventilation system as built meets the requirements determined by the analysis.

7.1.4 Where required by 7.1.2, the mechanical emergency ventilation system shall make provisions for the protection of passengers, employees, and emergency personnel from fire and smoke during a fire emergency.

7.2 Design.

7.2.1 The emergency ventilation system shall be designed to do the following:

(1) Provide a tenable environment along the path of egress from a fire incident in enclosed stations and enclosed trainways
(2) Produce sufficient airflow rates within enclosed trainways to meet critical velocity
(3)*Be capable of reaching full operational mode within 180 seconds
(4) Accommodate the maximum number of trains that could be between ventilation shafts during an emergency
(5) Maintain the required airflow rates for a minimum of 1 hour but not less than the required time of tenability

7.2.1.1 Where the airflow rates required to accomplish 7.2.1(1), 7.2.1(2), or approved alternative performance criteria are dependent upon the unimpaired function of the air distribution system, that system shall be designed to continue operation when exposed to the conditions generated during the design incident for the duration determined as per 7.2.1(5). Although rating is not required, materials or systems that are fire rated for the required duration shall be permitted to be used.

7.2.2 Point-extract ventilation systems shall be permitted subject to an engineering analysis that demonstrates the system will confine the spread of smoke in the tunnel to a length of 150 m (500 ft) or less.

7.2.3 The design shall encompass the following:

(1) The fire heat release rate and fire smoke release rate produced by the combustible load of a vehicle and any combustible materials that could contribute to the fire load at the incident site
(2) The fire growth rate
(3) Station and trainway geometries
(4) The effects of elevation, elevation differences, ambient temperature differences, and ambient wind
(5) A system of fans, shafts, and devices for directing airflow in stations and trainways
(6) A program of predetermined emergency response procedures capable of initiating prompt response from the operations control center in the event of a fire emergency
(7) A ventilation system reliability analysis that, as a minimum, considers the following subsystems:
    (a) Electrical
    (b) Mechanical
    (c) Supervisory control

7.2.4 Criteria for the system reliability analysis in 7.2.3(7) shall be established and approved.

7.2.4.1 The analysis shall consider as a minimum the following events:

(1) Fire in trainway or station
(2) Local incident within the electrical utility that interrupts power to the emergency ventilation system
(3) Derailment

7.2.5* The design and operation of the signaling system, traction power blocks, and ventilation system shall be coordinated to match the total number of trains that could be between ventilation shafts during an emergency.

7.2.6* The time-of-tenability criteria for stations and trainways shall be established and approved. For stations, the time shall be greater than the calculated egress time used to establish egress capacity in 5.3.2.1.

7.2.7 Ventilation air distribution systems shall be permitted to serve more than one trainway.

7.3 Emergency Ventilation Fans.

7.3.1 The ventilation system fans that are designated for use in fire and similar emergencies shall be capable of satisfying the emergency ventilation requirements to move trainway air in either direction as required to provide the needed ventilation response.

7.3.1.1 Individual emergency ventilation fan motors shall be designed to achieve their full operating speed in no more than

30 seconds from a stopped position when started across the line and in no more than 60 seconds for variable-speed motors.

7.3.1.2 The ventilation system designated for use in emergencies shall be capable of operating at full capacity in either the supply mode or exhaust mode to provide the needed ventilation response where dilution of noxious products is to be maximized.

7.3.1.3 The ventilation system designated for use in emergencies shall be capable of being turned off and dampers closed to provide the needed ventilation response where dispersion of noxious products is to be minimized.

7.3.2 Emergency ventilation fans, their motors, and all related components exposed to the exhaust airflow shall be designed to operate at the fan inlet airflow hot temperature condition from the design fan for a minimum of 1 hour.

7.3.2.1 The fan inlet airflow hot temperature shall be determined by an engineering analysis, however, this temperature shall not be less than 150°C (302°F).

7.3.2.2 The fan inlet airflow hot temperature shall be determined using the design fire at a location in the immediate vicinity of the emergency ventilation system track/station inlet(s), as applicable. Airflow rates shall be based upon the tunnel ventilation critical velocity or station tenability requirements, as applicable. These airflow rates will most likely be from location(s) that are different then the location for this hot temperature analysis.

7.3.2.3 Dampers that serve more than one trainway from a common duct system shall not be required to have a fire rating.

7.3.3 Fans shall be rated in accordance with the ANSI/AMCA 210, AMCA 300, AMCA 250, ASHRAE *Handbook — Fundamentals*, and ASHRAE 149.

7.3.4 Local fan motor starters and related operating control devices shall be located away from the direct airstream of the fans to the greatest extent practical.

7.3.4.1 Thermal overload protective devices in motors or on motor controls of fans used for emergency ventilation shall not be permitted.

7.3.5 Fans that are associated only with passenger or employee comfort and that are not designed to function as a part of the emergency ventilation system shall shut down automatically on identification and initiation of a fire emergency ventilation program so as not to jeopardize or conflict with emergency airflows.

7.3.5.1 Nonemergency ventilation airflows that do not impact the emergency ventilation airflows shall be permitted to be left operational where identified in the engineering analysis.

7.3.6 Critical fans required in battery rooms or similar spaces where hydrogen gases or other hazardous gases might be released shall be designed to meet the ventilation requirements of NFPA 91.

7.3.6.1 These fans and other critical fans in automatic train control rooms, communications rooms, and so forth, shall be identified in the engineering analysis and shall remain operational as required during the fire emergency.

7.4 Airflow Control Devices.

7.4.1 Devices that are interrelated with the emergency ventilation system and that are required to meet the emergency ventilation system airflows shall be structurally capable of withstanding both maximum repetitive and additive piston pressures of moving trains and emergency airflow velocities.

7.4.2 Devices in the emergency ventilation system that are exposed to the exhaust airflow and are critical to the system's effective functioning in the event of an emergency shall be constructed of materials suitable for operation in an ambient atmosphere at the design condition determined in 7.3.2.

7.4.2.1 Finishes applied to noncombustible devices shall not be required to meet the provisions of 7.4.2.

7.4.3 Other devices shall be designed to operate throughout the anticipated temperature range. Overcurrent elements in devices or on device controls required to support the emergency ventilation shall not be permitted where such overcurrent elements are subject to false operation due to exposure to elevated temperatures during a fire emergency.

7.5 Testing.

7.5.1* Equipment used for emergency ventilation (including fans, dampers, and airflow control devices) shall be listed for the application or shall be approved by the AHJ in accordance with the requirements of a recognized standard for the type of equipment to be installed.

7.5.2* The no-fire (or cold) airflows provided by the installed mechanical ventilation system shall be measured during commissioning to confirm that the airflows meet the requirements determined by the analysis.

7.6 Shafts.

7.6.1 Shafts that penetrate the surface and that are used for intake and discharge in fire or smoke emergencies shall be positioned or protected to prevent recirculation of smoke into the system through surface openings.

7.6.2 If the configuration required by 7.5.1 is not possible, surface openings shall be protected by other means to prevent smoke from re-entering the system.

7.6.3 Adjacent structures and property uses also shall be considered.

7.7 Emergency Ventilation System.

7.7.1 Operation of the emergency ventilation system components shall be initiated from the operations control center.

7.7.1.1 The operations control center shall receive verification of proper response by emergency ventilation fan(s) and an interrelated device(s).

7.7.1.2 Local controls shall be permitted to override the operations control center in all modes in the event the operations control center becomes inoperative or where the operation of the emergency ventilation system components is specifically redirected to another site.

7.7.2 For electrical substations and distribution rooms serving emergency ventilation systems where the local environmental conditions require the use of mechanical ventilation or cooling to maintain the space temperature below the electrical equipment operating limits, such mechanical ventilation or cooling systems shall be designed so that failure of any single air moving or cooling unit does not result in the loss of the electrical supply to the emergency ventilation fans during the specified period of operation.

7.8 Power Supply for Emergency Ventilation Systems.

7.8.1 The design of the power for the emergency ventilation system shall comply with the requirements of Article 700 of *NFPA 70*.

7.8.1.1 Alternatively, the design of the power for the emergency ventilation system shall be permitted to be based upon the results of the electrical reliability analysis according to 7.2.3(7), as approved.

7.8.1.2 The emergency ventilation circuits routed through the station public areas and trainway shall be protected from physical damage by fixed guideway transit or passenger rail vehicles or other normal operations and from fire as described in 12.4.4.

7.8.2 Overcurrent elements that are designed to protect conductors serving motors for both emergency fans and related emergency devices shall not be permitted where such overcurrent elements are subject to false operation due to exposure to elevated temperatures during a fire emergency. All other motor and fan protection devices shall be bypassed during a fire emergency, except for motor overcurrent and excessive vibration.

7.8.3 For electrical substations and distribution rooms serving emergency ventilation systems where the local environmental conditions require the use of mechanical ventilation or cooling to maintain the space temperature below the electrical equipment operating limits, such mechanical ventilation or cooling systems shall be designed so that failure of any single air-moving or air-cooling unit does not result in the loss of the electrical supply to the tunnel ventilation fans during the specified period of operation.

Chapter 8 Vehicles

8.1 Applicability.

8.1.1 New Vehicles. All new passenger-carrying vehicles shall be, at a minimum, designed and constructed to conform to the requirements set forth in this chapter.

8.1.2 Retrofit. Where existing passenger-carrying vehicles are to be retrofitted, the appropriate sections of this standard shall apply only to the extent of such retrofit.

8.2* Compliance Options. Passenger-carrying vehicles shall be designed to meet the prescriptive requirements of Section 8.3 through Section 8.10 or the engineering analysis requirements of Section 8.11.

8.3 Equipment Arrangement.

8.3.1 Equipment posing an ignition threat in vehicles, including associated electrical services, shall be isolated from the combustible materials in the passenger and crew compartments.

8.3.2* Equipment other than comfort heating equipment operating on voltage of greater than 300 V shall be located external to or isolated from passenger and crew compartments to prevent electrical failures from extending into those areas.

8.3.2.1 Vehicles powered by overhead contact shall be designed to prevent arc penetration, ignition, and fire spread growth of the roof assembly.

8.3.3 Methods used to isolate ignition sources from combustible materials shall be demonstrated to the AHJ to be suitable through testing and/or analysis.

8.3.4 Fuel tanks shall be designed to minimize passenger and crew exposure to fuel hazards.

8.4 Flammability and Smoke Emission.

8.4.1* The test procedures and minimum performance for materials and assemblies shall be as detailed in Table 8.4.1.

8.4.1.1* Materials tested for surface flammability shall not exhibit any flaming running or flaming dripping.

8.4.1.2 The ASTM E 662 maximum test limits for smoke emission (specific optical density) shall be based on both the flaming and the nonflaming modes.

8.4.1.3* Testing of a complete seat assembly (including cushions, fabric layers, and upholstery) according to ASTM E 1537 using the pass/fail criteria of California Technical Bulletin 133 and testing of a complete mattress assembly (including foam and ticking) according to ASTM E 1590 using the pass/fail criteria of California Technical Bulletin 129 shall be permitted in lieu of the test methods prescribed herein, provided the assembly component units remain unchanged or new (replacement) assembly components possess fire performance properties equivalent to those of the original components tested.

8.4.1.3.1 A fire hazard analysis shall also be conducted that considers the operating environment within which the seat or mattress assembly will be used in relation to the risk of vandalism, puncture, cutting, introduction of additional combustibles, or other acts that potentially expose the individual components of the assemblies to an ignition source.

8.4.1.3.2 The requirements of 8.4.1.5 through 8.4.1.8 shall be met.

8.4.1.4 Testing shall be performed without upholstery.

8.4.1.5 The surface flammability and smoke emission characteristics shall be demonstrated to be permanent after dynamic testing according to ASTM D 3574, Test I_2 or Test I_3, both using Procedure B, except that the test samples shall be a minimum of 150 mm (6 in.) × 450 mm (18 in.) × the thickness used in end-use configuration, or multiples thereof. If Test I_3 is used, the size of the indentor described in Section 96.2 of ASTM D 3574 shall be modified to accommodate the specified test specimen.

8.4.1.6 The surface flammability and smoke emission characteristics shall be demonstrated to be permanent by washing, if appropriate, in accordance with the manufacturer's recommended procedure. If a washing procedure is not provided by the manufacturer, the fabric shall be washed in accordance with ASTM E 2061, Annex A1.

8.4.1.7 The surface flammability and smoke emission characteristics shall be demonstrated to be permanent by dry cleaning, if appropriate, according to ASTM D 2724.

8.4.1.8 Materials that cannot be washed or dry-cleaned shall be so labeled and shall meet the applicable performance criteria after being cleaned as recommended by the manufacturer.

8.4.1.9 Combustible operational and safety signage shall not be required to meet flame spread or smoke emission requirements if the combustible mass of a single sign does not exceed 500 g (1.1 lb) and the aggregate area of combustible signage does not exceed 1 ft^2 per foot of car length.

Table 8.4.1 Fire Test Procedures and Performance Criteria for Materials and Assemblies

Category	Function of Material	Test Method	Performance Criteria
Cushioning	All individual flexible cushioning materials used in seat cushions, mattresses, mattress pads, armrests, crash pads, and grab rail padding [a–e]	ASTM D 3675	$I_s \leq 25$
		ASTM E 662	D_s (1.5) ≤ 100 D_s (4.0) ≤ 175
Fabrics	Seat upholstery, mattress ticking and covers, curtains, draperies, window shades, and woven seat cushion suspensions[a–c, f–h]	14 CFR 25, Appendix F, Part I (vertical test)	Flame time ≤ 10 sec Burn length ≤ 6 in.
		ASTM E 662	D_s (4.0) ≤ 200
Other vehicle components	Seat and mattress frames, wall and ceiling lining and panels, seat and toilet shrouds, toilet seats, trays and other tables, partitions, shelves, opaque windscreens, combustible signage, end caps, roof housings, articulation bellows, exterior shells, nonmetallic skirts, and component boxes and covers[a,b,i–k]	ASTM E 162	$I_s \leq 35$
		ASTM E 662	D_s (1.5) ≤ 100 D_s (4.0) ≤ 200
	Thermal and acoustical insulation[a,b]	ASTM E 162	$I_s \leq 25$
		ASTM E 662	D_s (4.0) ≤ 100
	HVAC ducting[a,b]	ASTM E 162	$I_s \leq 25$
		ASTM E 662	D_s (4.0) ≤ 100
	Floor covering[b,k,l]	ASTM E 648	CRF ≥ 5 kW/m^2
		ASTM E 662	D_s (1.5) ≤ 100 D_s (4.0) ≤ 200
	Light diffusers, windows, and transparent plastic windscreens[b,i]	ASTM E 162	$I_s \leq 100$
		ASTM E 662	D_s (1.5) ≤ 100 D_s (4.0) ≤ 200
	Adhesives and sealants	ASTM E 162	$I_s \leq 35$
		ASTM E 662	D_s (1.5) ≤ and D_s (4.0) ≤ 200
Elastomers[a,b,i,j]	Window gaskets, door nosings, intercar diaphragms, seat cushion suspension diaphragms, and roof mats	ASTM C 1166	Flame propagation ≤ 100 mm (4 in.)
		ASTM E 662	D_s (1.5) ≤ 100 D_s (4.0) ≤ 200
Wire and cable	All	See 8.6.7.1.1.1 through 8.6.7.1.3.	See 8.6.7.1.1.1 through 8.6.7.1.3.
Structural components[m]	Flooring,[n] other[o]	ASTM E 119	Pass

[a]See 8.4.1.1.
[b]See 8.4.1.2.
[c]See 8.4.1.3.
[d]See 8.4.1.4.
[e]See 8.4.1.5.
[f]See 8.4.1.6.
[g]See 8.4.1.7.
[h]See 8.4.1.8.
[i]See 8.4.1.9.
[j]See 8.4.1.10.
[k]See 8.4.1.11.
[l]See 8.4.1.12.
[m]See 8.4.1.13.
[n]See 8.4.1.14.
[o]See 8.4.1.15.

8.4.1.10* Materials used to fabricate miscellaneous, discontinuous small parts (such as knobs, rollers, fasteners, clips, grommets, and small electrical parts) that will not contribute materially to fire growth in end use configuration shall be exempt from flammability and smoke emission performance requirements, provided that the surface area of any individual small part is less than 100 cm^2 (16 $in.^2$) in end use configuration and an appropriate fire hazard analysis is conducted that addresses the location and quantity of the materials used and the vulnerability of the materials to ignition and contribution to flame spread.

8.4.1.11 Carpeting used as a wall or ceiling covering shall be tested according to ASTM E 162 and ASTM E 662 and shall meet the respective criteria of $I_s \leq 35$, D_s (1.5) ≤ 100, and D_s (4.0) ≤ 200. *(See 8.4.1.1 and 8.4.1.2.)*

8.4.1.12 If padding is used in the actual installation, floor covering shall be tested with padding in accordance with NFPA 253 or ASTM E 648.

8.4.1.13 Penetrations (ducts, etc.) shall be designed against acting as passageways for fire and smoke, and representative penetrations of each type shall be included as part of test assemblies.

8.4.1.14* See Section 8.5.

8.4.1.15* Portions of the vehicle body that separate the major ignition source, energy sources, or sources of fuel load from vehicle interiors shall have fire resistance as determined by a fire hazard analysis acceptable to the authority having jurisdiction that addresses the location and quantity of the materials used, as well as vulnerability of the materials to ignition, flame spread, and smoke generation. These portions shall include equipment-carrying portions of a vehicle's roof and the interior structure separating the levels of a bi-level car but do not include a flooring assembly subject to Section 8.5. In those cases, the use of the NFPA 251 (ASTM E 119) test procedure shall not be required.

8.4.2* Materials intended for use in a limited area of the vehicle and not meeting the requirements of Table 8.4.1 shall be permitted only after an appropriate fire hazard analysis establishes, within the limits of precision, that the material produces a contribution to fire hazard equal to or less than a material meeting the appropriate criteria of Table 8.4.1, where the alternative material is used in the same location to fulfill a function similar to the candidate material.

8.5 Fire Performance.

8.5.1 Assembly Testing.

8.5.1.1 Floor Assembly. All vehicle floor assemblies shall be tested as specified in 8.5.1.3.

8.5.1.1.1 Test Sample Size and Loading.

8.5.1.1.1.1 The size of the exposed portion of the floor assembly shall be at least 3.7 m (12 ft) long by the normal width of the vehicle floor.

8.5.1.1.1.2 The floor assembly shall be tested with a representative loading consistent with the vehicle design.

8.5.1.1.1.3 The loading shall take into consideration the dead weight of items on the floor, dead loads due to equipment above and below the floor, the weight of a crush load of passengers, and other relevant design loads.

8.5.1.2 Roof Assembly.

8.5.1.2.1 Vehicles that contain propulsion equipment or equipment that operates at voltages higher than 600 V on the roof shall demonstrate roof assembly fire resistance testing as specified in 8.5.1.3.

8.5.1.2.2 Vehicles that travel through tunnels and have a roof that is constructed of a combustible material shall require a fire hazard analysis to demonstrate that rapid fire spread to passenger and crew compartments or local roof collapse is not possible during the exposure period.

8.5.1.3 Test Details. Fire resistance testing on assemblies shall be conducted in accordance with NFPA 251 or ASTM E 119.

8.5.1.3.1 Test assemblies shall be representative of the vehicle construction and shall be tested in a configuration to demonstrate that a fire will not extend into the passenger and crew areas during the fire exposure duration.

8.5.1.3.1.1 Unexposed side thermocouples shall be installed in accordance with NFPA 251 or ASTM E 119.

8.5.1.3.1.2 The support of the test sample shall be limited to the transverse ends of the test sample only.

8.5.1.3.1.3 The test assembly shall contain one of each type of penetration included in the assembly construction.

(A) Penetrations shall be installed in the test assembly in accordance with Section 7 of ASTM E 814.

(B) In cases in which there are multiple sizes of the same type of penetration, the penetration determined to be the most likely to allow hot gas or flame passage shall be included in the assembly.

(C) No temperatures shall be required to be measured at the penetrations.

8.5.1.3.2 The minimum fire exposure duration shall be the greater of the following:

(1)*Twice the maximum expected time period under normal circumstances for a vehicle to stop completely and safely from its maximum operating speed, plus the time necessary to evacuate a full load of passengers from the vehicle under approved conditions
(2)*15 minutes for automated guideway transit (AGT) vehicles, 30 minutes for all other passenger-carrying vehicles

8.5.1.3.3 During the entire fire exposure, the following parameters shall apply:

(1) Transmission of heat through the assembly shall not be sufficient to raise the temperature on its unexposed surface more than 139°C (250°F) average and 181°C (325°F) single point.
(2)*The assembly shall not permit the passage of flame or gases hot enough to ignite cotton waste on the unexposed surface of the assembly.
(3) The assembly shall support the representative loading.

8.5.2 Vehicle Sides and Ends. A fire hazard analysis shall be conducted to demonstrate that fires originating outside the vehicle shall not extend into the passenger and crew areas before the vehicle is evacuated.

8.5.3 Equipment Lockers.

8.5.3.1 Portions of the vehicle that separate isolating electric equipment greater than 300 V and related wiring from the passenger and crew areas shall be lined with an arc-resistant lining.

8.5.3.2 Penetrations and access panels located between the locker and the passenger and crew areas shall be tested in accordance with ASTM E 814 and shall have an F rating of 15 minutes.

8.5.3.2.1 The separation assembly shall not allow the passage of flame for the entire exposure duration.

8.6 Electrical Fire Safety.

8.6.1 General Construction. All motors, motor control, current collectors, and auxiliaries shall be of a type and construction suitable for use on fixed guideway transit and passenger rail vehicles.

8.6.2 Clearance and Creepage.

8.6.2.1 Electrical Circuit. Electrical circuits and associated cabling shall be designed with clearance and creepage distance between voltage potentials and car body ground considering the environmental conditions to which the circuits and cabling will be subjected.

8.6.2.2* Air Clearance. The air clearance distances between voltage potentials (up to 2000 V) and ground shall comply with the following formula:

$$\text{Clearance (mm)} = 3.175 + (0.0127 \times \text{nominal voltage})$$
$$[\text{Clearance (in.)} = 0.125 + (0.0005 \times \text{nominal voltage})]$$

8.6.2.3 Creepage Distance.

8.6.2.3.1 Creepage distance for voltage potentials (up to 2000 V) to ground in ordinary enclosed environments shall comply with the following formula:

$$\text{Creepage (mm)} = 3.175 + (0.047625 \times \text{nominal voltage})$$
$$[\text{Creepage (in.)} = 0.125 + (0.001875 \times \text{nominal voltage})]$$

8.6.2.3.2* In other than ordinary enclosed environments, creepage distances shall be modified according to the anticipated severity of the environment.

8.6.3 Propulsion Motors.

8.6.3.1 Rotary motors shall be rated and tested in accordance with IEEE 11. Linear induction motors shall be rated and tested in accordance with IEC 62520.

8.6.3.2 Motor leads shall have insulation suitable for the operating environment.

8.6.3.3 Motor leads shall be supported and protected against mechanical damage.

8.6.3.4 Motor leads, where entering the frame, shall be securely clamped and shall fit snugly to prevent moisture from entering the motor case.

8.6.3.5 Drip loops shall be formed in motor leads to minimize water running along the lead onto the motor case.

8.6.3.6 The current value used in determining the minimum size of motor leads shall be no less than 50 percent of the maximum load current seen under the most severe normal duty or as determined by root-mean-square (rms) calculation, whichever is greater.

8.6.3.7 Car-borne propulsion configurations other than those for rotary motors shall be designed and constructed to provide a similar level of rating and testing as that for rotary motors.

8.6.4 Motor Control.

8.6.4.1 Motor control shall be rated and tested in accordance with IEEE 16.

8.6.4.2 Control equipment enclosures shall be arranged and installed to provide protection against moisture and mechanical damage.

8.6.4.3 Metal enclosures that surround arcing devices shall be lined with insulating material unless otherwise permitted in 8.6.4.5.

8.6.4.4 Shields or separations shall be provided to prevent arcing to adjacent equipment and wiring.

8.6.4.5 Metal enclosures shall not be required to be lined where the arc chutes extend through the enclosure and vent the arc to the outside air.

8.6.5 Propulsion and Braking System Resistors.

8.6.5.1* Self-ventilated propulsion and braking resistors shall be mounted to prevent ignition and dissipate heat away from combustible train materials.

8.6.5.2 Heat-resisting barriers of at least 6 mm (¼ in.) noncombustible insulating material or of sheet metal not less than 1 mm (0.04 in.) thick shall be installed extending horizontally beyond resistor supports to ensure protection from overheated resistors.

8.6.5.3 Forced ventilated resistors shall be mounted as follows:

(1) In ducts, enclosures, or compartments of noncombustible material
(2) With air space between the resistor enclosure and combustible materials

8.6.5.4 Provisions shall be made to filter the air where the operating environment is severe.

8.6.5.5 Power resistor circuits shall incorporate protective devices for the following failures:

(1) Ventilation airflow, if appropriate
(2) Temperature controls, if appropriate
(3) Short circuit in supply wiring, if appropriate

8.6.5.6 Resistor elements, resistor frames, and support shall be electrically insulated from each other.

8.6.5.7 The insulation shall be removed from resistor leads a minimum of 75 mm (3 in.) back from their terminals except where such removal introduces potential grounding conditions.

8.6.5.8 Where forced ventilation is provided, the resistor leads shall be separated, secured, and cleated for protection in the event of loss of air circulation of the ventilating system.

8.6.5.9 Leads shall be routed or otherwise protected from resistor heat.

8.6.5.10 The current value used in determining the minimum size of resistor leads shall be no less than 110 percent of the load current seen by the lead under the most severe duty cycle or as determined by rms calculation.

8.6.6 Current Collectors.

8.6.6.1 The minimum size of current collector leads shall be determined by adding the maximum auxiliary loads to the propulsion motor loads.

8.6.6.2 The equivalent regenerative load shall be included in the propulsion system equipped with regenerative capability.

8.6.6.3 For vehicles that have more than one current collector, all current-carrying components shall be sized for continuous operation in the event power collection to the vehicle is restricted to a single collector.

8.6.7 Wiring.

8.6.7.1 Electrical Insulation.

8.6.7.1.1 All wires and cables shall be resistant to the spread of fire and shall have reduced smoke emissions by complying with 8.6.7.1.1.1 or 8.6.7.1.1.2.

8.6.7.1.1.1 All wires and cables shall comply with the FT4/IEEE 1202 exposure requirements for cable char height and with ANSI/UL 1685 for total smoke released and peak smoke release rate.

8.6.7.1.1.2 Wires and cables listed as having adequate fire-resistant and low-smoke-producing characteristics, by having a flame travel distance that does not exceed 1.5 m (5 ft) and generating a maximum peak optical density of smoke of 0.50 and a maximum average optical density of smoke of 0.15 when tested in accordance with NFPA 262, shall be permitted for use instead of the wires and cables specified in 8.6.7.1.1.1.

8.6.7.1.2 Low voltage power and control wires and cables (i.e., less than 100 V ac and 150 V dc) shall comply with 8.6.7.1.1 and either of the following:

(1) The physical, mechanical, and electrical performance requirements of ICEA S-95-658/NEMA WC-70 or ICEA S-73-532/NEMA WC-57, as applicable
(2) The physical, mechanical, and electrical performance requirements of ANSI/UL 44 for thermosetting insulation and ANSI/UL 83 for thermoplastic insulation as applicable.

8.6.7.1.3* Communication and data cables shall comply with 8.6.7.1.1 and the corresponding specifications.

8.6.7.1.4 Wires and cables used for heat, smoke, or other detection system shall comply with 8.6.7.1.1 and one of the following:

(1) Be capable of having 15-minute circuit integrity when tested in accordance with IEC 60331-11
(2) Demonstrate that, if circuit integrity is tested during the vertical flame test, a current continues operating for at least 5 minutes during the test
(3) Have circuit integrity cable in accordance with *NFPA 70*

8.6.7.2 Minimum Wire Size. In no case shall single conductor wire (not part of multi-conductor cable) smaller than the following sizes be used:

(1) 14 AWG (cross-section 2.1 mm^2) for wire pulled through conduits or wireways or installed exposed between enclosures
(2) 22 AWG (cross-section 0.33 mm^2) for all wires, including those used on electronic units, equipment within a rack, cards, card racks, and wire laid in wireways

8.6.7.3 Cable and Wire Sizes.

8.6.7.3.1 Conductor sizes shall be selected on the basis of current-carrying capacity, mechanical strength, temperature and flexibility requirements, and maximum allowable voltage drops.

8.6.7.3.2 Conductors shall be no smaller than the minimum sizes specified in 8.6.7.2.

8.6.7.3.3 Conductors shall be derated for grouping and shall be derated for ambient temperature greater than the manufacturer's design value in accordance with criteria specified by the authority having jurisdiction.

8.6.7.4 Wiring Methods.

8.6.7.4.1 Conductors of all sizes shall be provided with mechanical and environmental protection and shall be installed, with the exception of low-voltage dc circuits, in any one of, or combination of, the following ways:

(1) In raceways: metallic and nonmetallic, rigid or flexible
(2) In enclosures, boxes, or cabinets for apparatus housing
(3) Exposed: cleated, tied, or secured by other means

8.6.7.4.2 Firestops shall be provided in raceways.

8.6.7.4.3 Wires connected to different sources of energy shall not be cabled together or be run in the same conduit, raceway, tubing, junction box, or cable unless all such wires are insulated for the highest rated voltage in such locations or unless physical separation is provided.

8.6.7.4.4 Wires connected to electronic control apparatus shall not touch wires connected to a higher voltage source of energy than control voltage.

8.6.7.4.5 Conduits, electrical metallic tubing, nonmetallic ducts or tubing, and all wires with their outer casings shall be installed as follows:

(1) Extended into devices and cases where practicable
(2) Rigidly secured in place by means of cleats, straps, or bushings to prevent vibration or movement and to give environmental protection
(3) Run continuously into junction boxes or enclosing cases and be securely fastened to those devices

8.6.7.4.6 Splices outside of junction boxes shall be approved.

8.6.7.4.7 Connections and terminations shall be made in a manner to ensure their tightness and integrity.

8.6.7.4.8 Conductors and enclosures of any kind shall be protected from the environment and from mechanical damage, including damage from other larger conductors.

8.6.8 Overload Protection.

8.6.8.1 Propulsion Line Breaker.

8.6.8.1.1 A main, automatic circuit line breaker or line switch and overload relay for the protection of the power circuits shall be provided.

8.6.8.1.2 The circuit breaker arc chute shall be vented directly to the outside air.

8.6.8.2 Main Fuse Protection.

8.6.8.2.1 Cartridge-type fuses, if used in addition to the automatic circuit breaker, shall be installed in approved boxes or cabinets.

8.6.8.2.2 Railway-type ribbon fuses, if used, shall be in boxes designed specifically for this purpose and shall be equipped with arc blowout aids.

8.6.8.2.3 Third-rail shoe fuses mounted on the shoe beams shall be mounted to direct the arc away from grounded parts.

8.6.8.3 Auxiliary Circuits.

8.6.8.3.1 Circuits used for purposes other than propelling the vehicle shall be connected to the main cable at a point between the current collector and the protective device for the traction motors.

8.6.8.3.2 Each circuit or group of circuits shall be provided with at least one circuit breaker, fused switch, or fuse located as near as practicable to the point of connection of the auxiliary circuit.

8.6.8.3.2.1 Protection shall be permitted to be omitted in circuits controlling safety devices.

8.6.9 Battery Installation. Batteries and their associated circuitry shall be installed with the following requirements:

(1) Battery charging systems shall be designed to prevent overcharging of the battery.
(2) The battery shall be designed with an emergency cutoff system.
(3) The battery installation area shall be provided with a heat, smoke, or other fire detection system as appropriate for the environment in which it will operate.
(4) The battery installation area shall be separated from the car interior by the use of materials that are noncombustible, in accordance with the requirements of ASTM E 136.
(5) The battery installation area shall not use materials with hygroscopic properties.
(6) The battery installation area shall be provided with sufficient diffusion and ventilation of the gases from the battery to prevent the accumulation of an explosive mixture.
(7) Battery casing material shall comply with a radiant panel index that does not exceed 35 when tested in accordance with ASTM E 162, with specific optical density of smoke at 4 minutes into the test that does not exceed 200, and with specific optical density at 1.5 minutes that does not exceed 100 when tested in accordance with ASTM E 662 at the thickness of the casing material used in the battery.

8.7 Ventilation. Vehicles shall have provisions to deactivate all ventilation systems manually or automatically.

8.8 Emergency Egress Facilities.

8.8.1* Each vehicle shall be provided with a minimum of two means of emergency egress located on the sides or at the end(s), installed as remotely from each other as practicable.

8.8.1.1* Alternative means of emergency egress, including roof hatches as necessary for the type of vehicle, shall be approved.

8.8.2 A means to allow passengers to evacuate the vehicle safely to a walk surface or other suitable area under the supervision of authorized employees in case of an emergency shall be provided.

8.8.3 Emergency Lighting.

8.8.3.1* Emergency lighting facilities shall be provided such that the level of illumination of the means of egress conforms to the following:

(1) A minimum average illumination level of 10 lx (0.93 ft-candle), measured at the floor level adjacent to each interior door, with each interior door providing access to an exterior door (such as a door opening into a vestibule) or other emergency egress facility
(2) A minimum average illumination level of 10 lx (0.93 ft-candle), measured 610 mm (24 in.) above floor level along the center of each aisle and passageway
(3) A minimum illumination level of 1 lx (0.093 ft-candle), measured 610 mm (24 in.) above floor level at any point along the center of each aisle and passageway

8.8.3.2 The emergency lighting system power shall be automatically obtained from storage batteries.

8.8.3.3* The emergency lighting system storage batteries shall have a capacity capable of maintaining the lighting illumination level at not less than 60 percent of the minimum light levels specified in 8.8.3.1 for a period of time to permit evacuation but in no case less than the following periods:

(1) 60 minutes for a fixed guideway transit vehicle
(2) 90 minutes for a passenger rail vehicle

8.8.4* Operation of Means of Emergency Egress. Means of emergency egress using doors, windows, or roof hatches shall be capable of being operated manually from the interior and exterior of the vehicle without special tools.

8.8.5* Marking and Instructions for Operation of Means of Emergency Egress.

8.8.5.1 Interior.

8.8.5.1.1 A sign visible at all lighting levels that clearly and conspicuously identifies the means of emergency egress shall be provided adjacent to the means of emergency egress.

8.8.5.1.2 Instructions for the operation of the vehicle means of emergency egress shall be at or near the means of emergency egress.

8.8.5.1.3 Signs and instructions required by 8.8.5.1.1 and 8.8.5.1.2 shall meet the requirements of APTA SS-PS-002.

8.8.5.2 Exterior. The location and instructions for the operation of vehicle means of emergency access shall be legibly marked on or near the means of egress on the outside of the vehicle with retroreflective material in accordance with APTA SS-PS-002.

8.9 Protective Devices.

8.9.1 General. During normal vehicle operation, protective devices shall not introduce new hazards.

8.9.2 Communications.

8.9.2.1 Each vehicle, except as required in 8.9.2.2, shall be equipped with a communication system consisting of the following:

(1) A public address (PA) system whereby the train crew personnel, and, at the option of the authority, the operations control center can make announcements to the passengers
(2) A radio system whereby the train operator can communicate with the operations control center
(3) An intercommunication system whereby the train crew can communicate with one another
(4) At the option of the authority, a device that can be used by passengers to alert the operator of an emergency

8.9.2.2 Each AGT system vehicle shall be equipped with a communication system consisting of the following:

(1) A PA system whereby the operations control center can make announcements to the passengers
(2) A system whereby the passengers can communicate with the operations control center

8.9.2.3 Unauthorized opening of doors or emergency exit facilities on vehicles shall be automatically communicated to the operations control center or train operator.

8.9.3 Portable Fire Extinguishers.

8.9.3.1 Each vehicle or operator's cab shall be equipped with an approved portable fire extinguisher, unless otherwise permitted in 8.9.3.3.

8.9.3.2 Portable fire extinguishers shall be selected, inspected, and maintained in accordance with NFPA 10.

8.9.3.3 Portable fire extinguishers shall not be required in the vehicle or cab where sufficient wayside extinguishers, standpipe systems, or other fire-fighting equipment is available.

8.9.4 Lightning Protection.

8.9.4.1 Each vehicle that is supplied power from the overhead electrical contact wire shall be provided with a suitable and effective lightning arrester for the protection of all electrical circuits.

8.9.4.2 Lightning arresters on vehicles shall have a grounding connection of not less than 6 AWG or cross-section of 13.3 mm^2 and be run in as straight a line as possible to the ground.

8.9.4.2.1 Lightning arresters shall be properly protected against mechanical injury.

8.9.4.2.2 The grounding conductor shall not be run in metal conduit unless such conduit is bonded to the grounding conductor at both ends.

8.9.5 Heater Protection.

8.9.5.1 All heater elements shall incorporate protective devices for the following failures:

(1) Ventilation airflow, if appropriate
(2) Failure of temperature controls or occurrence of overtemperature conditions, as appropriate
(3) Short circuits and overloads in supply wiring

8.9.5.2 Heater-forced air distribution ducts shall incorporate overtemperature sensors, fusible links, airflow devices, or other means to detect overtemperature or lack of airflow.

8.9.6 Testing and Maintenance.

8.9.6.1 Qualification testing shall be performed by the equipment manufacturer in accordance with the following:

(1) IEEE 16
(2) IEEE 11
(3) Any additional tests specified by the AHJ

8.9.6.2 Periodic maintenance shall be performed in accordance with maintenance manuals furnished by the equipment manufacturer.

8.9.6.2.1 The degree and the frequency of maintenance shall be based on operating experience as determined by the authority.

8.10 Vehicle Support and Guidance System.

8.10.1 The vehicle support and guidance system (i.e., wheels, tires, magnetic or pneumatic levitation) shall be capable of safely supporting and guiding the vehicle in normal service.

8.10.2 Failure of the support, guidance, or levitation system shall not result in a condition that is unsafe to passengers.

8.10.3 Under loss of guideway clearance, the system shall be capable of safe operation until such time that the failure is detected by operation or maintenance personnel and the vehicle is taken out of service.

8.11 Engineering Analysis Option.

8.11.1* General. The requirements of this section shall apply to fixed guideway and passenger rail vehicles designed to meet the engineering analysis option permitted by Section 8.2 and to meet the goals and objectives stated in Sections 4.2 and 4.3.

8.11.1.1 In the application of Section 8.11, engineering analysis design activities shall be carried out by an individual or entity having qualifications acceptable to the authority having jurisdiction.

8.11.1.2 In the application of Section 8.11, the design, engineering analysis, and documentation shall be approved.

8.11.2* Basis for Engineering Analysis.

8.11.2.1 For this engineering analysis option, the broad goals and objectives specified in Sections 4.2 and 4.3 shall be converted into specific performance criteria based on the unique features and operating environment of the vehicle.

8.11.2.2 These specific criteria shall be used as the basis of the engineering analysis.

8.11.3 Retained Prescriptive Requirements. Retained prescriptive requirements shall be those specified in Sections 8.7 through 8.10.

8.11.4 Independent Review. The authority having jurisdiction shall, at its discretion, require an approved, independent third party to review the proposed design to provide an evaluation of the design.

8.11.5 Sources of Data.

8.11.5.1 Data sources used in performance-based design activities shall be identified and documented for each input data requirement that must be met, using a source other than a design fire scenario, an assumption, or a vehicle design specification.

8.11.5.2 The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

8.11.6 Maintenance of Design Features.

8.11.6.1 Design features required to meet performance goals and objectives of this standard shall be intrinsic to the vehicle design or capable of being maintained throughout the life of the vehicle.

8.11.6.2 All documented assumptions, design specifications, and operating environment criteria shall be complied with throughout the life of the vehicles, such that vehicles continue to satisfy the goals and objectives specified in Sections 4.2 and 4.3.

8.11.6.3 Any variations made to vehicle original design features that affect life safety and fire protection shall be approved prior to the actual change being made.

Chapter 9 Emergency Procedures

9.1 General.

9.1.1 The authority responsible for the safe and efficient operation of a fixed guideway transit or passenger rail system shall anticipate and plan for emergencies that could involve the system.

9.1.2 Participating agencies shall be invited to assist with the preparations of the emergency procedure plan.

9.1.3 The emergency response agencies shall review and approve the emergency procedures plan prior to its implementation.

9.2 Emergency Management.

9.2.1 Operational procedures for the management of emergency situations shall be predefined for situations within the fixed guideway transit or passenger rail system.

9.2.2 Operational procedures shall be recorded, accessible, and managed from a dedicated source at the operations control center.

9.2.3 Passengers shall be advised and informed during an emergency, to discourage panic or stress during adverse circumstances.

9.2.4* Personnel whose duties take them onto the operational system shall be trained for emergency response pending the arrival of jurisdictional personnel.

9.2.5 Emergency personnel training shall be kept current through periodic drills and review courses.

9.3 Emergencies. The emergency management plan shall address the following types of emergencies:

(1) Fire or smoke conditions within the system structures, including stations, guideways (revenue or nonrevenue), and support facilities
(2) Collision or derailment involving the following:
  (a) Rail vehicles on the guideway
  (b) Rail vehicles with privately owned vehicles
  (c) Intrusion into the right-of-way from adjacent roads or properties
(3) Loss of primary power source resulting in stalled trains, loss of illumination, and availability of emergency power
(4) Evacuation of passengers from a train to all right-of-way configurations under circumstances where assistance is required
(5) Passenger panic
(6) Disabled, stalled, or stopped trains due to adverse personnel/passenger emergency conditions
(7) Tunnel flooding from internal or external sources
(8) Disruption of service due to disasters or dangerous conditions adjacent to the system, such as hazardous spills on adjacent roads or police activities or pursuits dangerously close to the operational system
(9) Structural collapse or imminent collapse of the authority property or adjacent property that threatens safe operations of the system
(10) Hazardous materials accidentally or intentionally released into the system
(11) Serious vandalism or criminal acts, including terrorism
(12) First aid or medical care for passengers on trains and in stations
(13) Extreme weather conditions, such as heavy snows, high or low temperatures, sleet, or ice
(14) Earthquake
(15) Any other emergency as determined by the authority having jurisdiction

9.4* Emergency Procedures. Emergency procedures shall be developed to specifically address the various types of emergencies that might be experienced on the system and shall include, but not be limited to, the following:

(1) Identification of the type of emergency, name of authority, and the date the plan was adopted, reviewed, or revised, as applicable
(2) Policy, purpose, scope, and definitions
(3) Participating agencies and areas of responsibility, including governing officials and signatures of executives from each agency
(4) Safety procedures to be implemented specific to each type of emergency operation
(5) Purpose and operations of the operations control center and alternative location(s), as applicable
(6) Command post and auxiliary command post purposes, and operational procedures, as applicable
(7) Communications, types of communications available, procedures to maintain safe operation, and equipment to interface with responding agencies
(8) Fire and smoke emergency information and procedures, including the following:
  (a) Location of fire in station or support facility
  (b) Location of train in enclosed trainway and fire location on train
  (c) Fire detection systems/zones in stations
  (d) Fire protection systems and devices and their locations/points of initiating operation
  (e) Locations of exits from and entrances to the incident site, including vehicular routes
  (f) Emergency ventilation system components and locations of equipment and local controls
  (g) Special equipment locations/cabinets
  (h) Agency(ies) to be notified and their phone numbers
  (i) Agency in command prior to and after the arrival of the local jurisdiction emergency response personnel
  (j) The preplanned mode of ventilation system operation (exhaust or supply)
  (k) Preplanned passenger evacuation direction as coordinated with fan mode operation
  (l) Fire and emergency incidents on adjoining properties
(9) Procedures typically implemented by responding jurisdictions for various types of emergencies as appropriate to site configuration
(10) Maps or plans of complex areas of the system at a minimum, such as underwater tubes, multilevel stations, adjacencies to places of large public assembly, or other unique areas
(11) Any other information or data that participating agencies determine to be necessary to provide effective response

9.5* Participating Agencies. Participating agencies to be summoned by operators of a fixed guideway transit or passenger rail system to cooperate and assist, depending on the nature of the emergency, shall include the following:

(1) Ambulance service
(2) Building department
(3) Fire department
(4) Medical service
(5) Police department
(6) Public works (e.g., bridges, streets, sewers)
(7) Sanitation department
(8) Utility companies (e.g., gas, electricity, telephone, steam)
(9) Water department (i.e., water supply)
(10) Local transportation companies
(11) Red Cross, Salvation Army, and similar agencies

9.6 Operations Control Center (OCC).

9.6.1 The authority shall operate an OCC for the operation and supervision of the system.

9.6.2 The OCC shall be staffed by trained and qualified personnel.

9.6.3 The OCC shall have the essential apparatus and equipment to communicate with, supervise, and coordinate all personnel and trains operating in the system.

9.6.4 The OCC shall provide the capability to communicate with participating agencies.

9.6.4.1 Agencies such as fire, police, ambulance, and medical service shall have direct telephone lines or designated telephone numbers used for emergencies involving the system.

9.6.5 Equipment shall be available and used for recording radio and telephone communications during an emergency.

9.6.6 OCC personnel shall be thoroughly conversant with the emergency procedure plan and shall be trained to employ it effectively whenever required.

9.6.7 The OCC shall be located in an area separated from other occupancies by 2-hour fire resistance construction.

9.6.8 The area shall be used for the OCC and similar activities and shall not be jeopardized by adjoining or adjacent occupancies.

9.6.9* The OCC shall be protected by fire detection, protection, and extinguishing equipment so that there will be early detection and extinguishment of any fire in the OCC.

9.6.10 Alternative location(s) shall be provided in the event the OCC is out of service for any reason and shall be equipped or have equipment readily available to function as required by the authority.

9.7 Liaison.

9.7.1 An up-to-date listing of all liaison personnel from participating agencies shall be maintained by the authority and shall be part of the emergency procedure plan.

9.7.2 The listing shall include the full name, title, agency, business telephone number(s), and home telephone number of the liaison and of an alternative liaison.

9.7.3 At least once every 3 months, the list shall be reviewed and tested to determine the ability to contact the liaison without delay.

9.8 Command Post.

9.8.1* During an emergency on the system that requires invoking the emergency procedure plan, a command post shall be established by the incident commander for the supervision and coordination of all personnel, equipment, and resources at the scene of the emergency.

9.8.2 The emergency procedure plan shall clearly delineate the authority or participating agency that is in command and that is responsible for supervision, correction, or alleviation of the emergency.

9.8.3 Participating agencies shall each assign a liaison to the command post.

9.8.4 Radio, telephone, and messenger service shall be used to communicate with participating agencies operating at an emergency.

9.8.5* Approved markers shall be used to identify the command post.

9.8.6 The emergency procedure plan shall prescribe the specific identification markers to be used for the command post and for personnel assigned thereto.

9.9* Auxiliary Command Post. When an emergency operation requires an auxiliary command post because of the extent of the operation, the person in command shall establish an auxiliary command post(s) that will function as a subordinate control.

9.10 Training, Exercises, Drills, and Critiques.

9.10.1 The authority and participating agency personnel shall be trained to function during an emergency.

9.10.1.1 The training shall cover all aspects of the emergency procedure plan.

9.10.2 Exercises and drills shall be conducted at least twice per year to prepare the authority and participating agency personnel for emergencies.

9.10.3 Critiques shall be held after the exercises, drills, and actual emergencies.

9.10.4 Drills shall be conducted at various locations on the system as well as at various times of the day so as to prepare as many emergency response personnel as possible.

9.11 Records. Written records and telephone and radio recordings shall be kept at the OCC, and written records shall be kept at the command post and auxiliary command post(s) during fire emergencies, exercises, and drills.

9.12 Removing and Restoring Traction Power.

9.12.1 During an emergency, the authority and participating agency personnel shall be supervised so that only the minimum number of essential persons operate on the trainway.

9.12.2 The emergency procedure plan shall have a defined procedure for removing and restoring traction power.

9.12.3 Before participating agency personnel operate on the trainway, the traction power shall be removed.

9.12.4 Traction power disconnect devices shall allow quick removal of power from power zones. Emergency shutoff of traction power shall be either by activation of traction power disconnect devices or by communication with OCC to request the traction power be disconnected.

9.12.5 When traction power is removed by activation of an emergency traction power disconnect switch, the OCC shall be contacted by telephone or radio and given the full name, title, agency, and reason for removal of the traction power by the person responsible.

9.12.6 When shutdown of traction power is no longer required by a participating agency, control of such power shall be released to the authority.

Chapter 10 Communications

10.1* General. A communication system shall be established in accordance with this chapter.

10.2 Operations Control Center (OCC) and Command Post Relationship.

10.2.1 During normal operations, the OCC shall be the primary control for the system.

10.2.2 During emergency operations, the command post established at the scene of the emergency shall be responsible for controlling, supervising, and coordinating personnel and equipment working to correct or alleviate the emergency.

10.2.3 The command post and OCC shall cooperate and coordinate to have an efficient operation.

10.2.4 The OCC shall be responsible for operation of the system except for the immediate emergency area.

10.3 Radio Communication.

10.3.1 A fixed guideway transit or passenger rail system shall have at least one radio network that is capable of two-way communication with personnel on trains, motor vehicles, and all locations of the system.

10.3.2 Wherever necessary for reliable communications, a separate radio network capable of two-way radio communication for fire department personnel to the fire department communication center shall be provided.

10.3.3 A radio network shall comprise base transmitters and receivers, antennas, mobile transmitters and receivers, portable transmitters and receivers, and ancillary equipment.

10.4 Telephone.

10.4.1 An emergency telephone (ETEL) shall be provided along the trainway at each blue light station and at other locations deemed necessary by the authority having jurisdiction.

10.4.2 The system shall have a telephone network of fixed telephone lines and handsets capable of communication with all stations, fire command centers, structures, offices, power stations and substations, control towers, ancillary rooms and spaces, and locations along the trainway in accordance with *NFPA 72*.

10.4.3 The location and spacing of telephones along the trainway shall be determined by the authority having jurisdiction.

10.4.4 Telephones along the trainway shall have distinctive signs or lights or both for identification.

10.4.5 Telephone locations shall be automatically identified in the OCC or other approved location.

10.5 Portable Telephones and Lines.

10.5.1 The authority shall maintain portable communications equipment and arrange for the dispatch to an emergency scene where required for emergency operations or requested by emergency responders.

10.5.2 The authority having jurisdiction shall approve the type of communications equipment.

10.6 Public Address (PA) System.

10.6.1 All stations, as determined by the authority having jurisdiction, shall have a PA system for communicating with passengers and employees. *(For communication requirements for vehicles, see 8.9.2.)*

10.6.2 The OCC shall have the capability of using the PA system to make announcements throughout stations.

10.6.3 Authority supervisory employees and emergency response personnel at stations shall have the capability of making announcements throughout public areas on the PA system.

10.6.4 During interruptions of train service or delays for any reason associated with an emergency, fire, or smoke, the passengers and employees shall be kept informed by means of the PA system.

10.6.5 At times of emergency, the PA system shall be used to communicate with passengers, employees, and participating agency personnel.

10.7 Portable Powered Speakers (Audiohailers). During emergency operations, portable powered speakers shall be made available by the authority where other forms of communication are not available.

Chapter 11 Control and Communication System Functionality, Reliability, and Availability

11.1 General.

11.1.1 Scope. This chapter defines requirements for the functionality, reliability and availability of control systems and communication systems when exposed to the effects of smoke and fire.

11.1.2 Application. These systems include the following:

(1) Train control (signaling systems) as described in 7.2.4, 8.9.2.3, and in this chapter
(2) Emergency communication systems as described in 6.4.2, 8.9.2.1, 8.9.2.2, 9.8.4, and 9.9
(3) Traction power systems as described in 6.4.2, 7.2.4, 9.12.4, and 9.12.5
(4) Supervisory control and data acquisition (SCADA) systems as they apply to fire emergencies

11.2 Train Control.

11.2.1* A reliability analysis shall be performed to consider the ability of control systems to maintain communications and the ability to reposition vehicles during a fire emergency.

11.2.2 Systems with and without an onboard operator shall be reviewed for the functionality, reliability, and availability of their control and communication systems during a fire incident.

11.2.3 For fixed guideway and passenger rail systems that do not have an operator on board, the controls shall accommodate the remote repositioning of trains.

11.2.3.1 If a train is immobile and on fire, the ability of the control system to move other trains away from the immobile train in a timely manner, addressing the concerns of passenger life safety, shall be accounted for as part of the overall system design.

11.2.3.2 If a train is exposed to an exterior fire, the ability of the control system to move the train away from the fire in a timely manner, addressing the concerns of passenger life safety, shall be accounted for as part of the overall system design.

11.2.4 For systems with an operator on board, procedures shall be developed to address train movement.

11.2.4.1 If a train is immobile and on fire, the ability of the control system to move other trains away from the immobile train in a timely manner, addressing the concerns of passenger life safety, shall be accounted for as part of the overall system design.

11.2.4.2 If a train is exposed to an exterior fire, the ability of the control system to move the train away from the fire in a timely manner, addressing the concerns of passenger life safety, shall be accounted for as part of the overall system design.

11.3 Functionality, Reliability, and Availability of Control Systems.

11.3.1* Functionality, reliability, and availability of control systems and communications systems during a fire incident shall be considered in addition to normal reliability and availability calculations.

11.3.2* To meet the goals for life safety of the occupants, the effects of single points of failure shall be considered.

11.3.3* In addition to physical protection from incidents, control, data, and communication cables and related components shall continue functionality during a fire and shall be protected from thermal exposure that would affect their function.

Chapter 12 Wire and Cable Requirements

12.1 General.

12.1.1 Scope. This chapter applies to wires and cables in all locations except in those vehicles addressed in Chapter 8.

12.1.2* All wiring materials and installations other than for traction power shall conform to the requirements of *NFPA 70* except as modified herein.

12.2 Flame Spread and Smoke Release.

12.2.1 All wires and cables used shall be listed as being resistant to the spread of fire and shall have reduced smoke emissions, by complying with one of the following:

(1) All wires and cables shall comply with the FT4/IEEE 1202 exposure requirements for cable char height, total smoke released, and peak smoke release rate of ANSI/UL 1685.
(2) Wires and cables listed as having adequate fire-resistant and low-smoke producing characteristics, by having a flame travel distance that does not exceed 1.5 m (5 ft) and generating a maximum peak optical density of smoke of 0.50 and a maximum average optical density of smoke of 0.15 when tested in accordance with NFPA 262, shall be permitted for use instead of the wires and cables specified in item (1).

12.3 Temperature, Moisture, and Grounding Requirements.

12.3.1 Wires and cables shall comply with both of the following temperature and moisture resistance characteristics:

(1) All insulations shall conform to *NFPA 70* and shall be a moisture- and heat-resistant type carrying a temperature rating of 90°C (194°F).
(2) All insulated conductors and cables shall be listed for wet locations.

12.3.2 Ground wires shall comply with the following:

(1) Ground wires installed in a metallic raceway shall be insulated.
(2) In underground stations and trainways, other ground wires shall be permitted to be bare.

12.4 Wiring Installation Methods.

12.4.1 Conduits, raceways, ducts, boxes, cabinets, and equipment enclosures shall be constructed of noncombustible materials. In stations, other materials when encased in concrete shall be acceptable.

12.4.2 All conductors, except radio antennas, shall be enclosed in their entirety in armor sheaths, conduits, or enclosed raceways, boxes, and cabinets except in ancillary areas.

12.4.3 Within the emergency ventilation air distribution system, the following wiring methods are acceptable:

(1) Type MI cable without an overall protected nonmetallic covering
(2) Type MC cable employing a smooth or corrugated impervious metal sheath without an overall nonmetallic covering
(3) Conductors in electrical metallic tubing, flexible metallic tubing, intermediate metal conduit, or rigid metal conduit all without an overall nonmetallic covering

12.4.4 The emergency power, emergency lighting, and emergency communications circuits shall be protected from physical damage by system vehicles or other normal system operations and from fires in the system for at least 1 hour, but not less than the time of tenability, when exposed to fire conditions corresponding to the time-temperature curve in the ASTM E 119 fire resistance test by any of the following:

(1) Circuits are embedded in concrete or protected by a fire barrier system in accordance with UL 1724. The cables or conductors shall maintain functionality at the temperature within the embedded conduit or fire barrier system.
(2) Circuits are routed outside the underground portion of the system.
(3) There is diversity in system routing (such as separate redundant circuits or multiple circuits separated by a fire barrier with a fire resistance rating so that a single fire or emergency event will not lead to a failure of the system).
(4) All circuits consist of listed fire-resistive cable systems with a fire resistance rating in accordance with 12.5.

12.5 Fire-Resistive Cables.

12.5.1 Fire-resistive cables shall be certified or listed as having been tested in a totally enclosed furnace using the ASTM E 119 time temperature curve.

12.5.2 The cables shall demonstrate functionality for no less than 1 hour as described in the ANSI/UL 2196 test standard.

12.5.3* The cables and systems shall comply with the following:

(1) Be tested as a complete system of conductors, cables, and raceways, as applicable, using a sample no shorter than 3.0 m (9.84 ft)
(2) For fire-resistive cables intended for installation in a raceway, be tested in the type of raceway in which they are intended to be installed
(3) Have installation instructions that describe the tested assembly, with only the components included in the tested assembly acceptable for installation

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 Vehicle maintenance facilities are not addressed by this standard because requirements for that occupancy are provided in other codes and standards. Where vehicle maintenance facilities are integrated or co-located with occupancies covered by this standard, special considerations beyond this standard shall be necessary.

A.1.1.3(6) A shelter stop is a location along a fixed guideway transit or passenger rail system for the loading and unloading of passengers that is located in a public way and is designed for unrestricted movement of passengers. A shelter stop can have a cover but no walls or barriers that would restrict passenger movement.

A.1.3.3 The nature of facility retrofitting should be assessed to determine the degree of applicability of the standard. For example, an upgrading retrofit might be undertaken as part of a due diligence initiative aimed at improving the level of compliance with the intent of the standard, while full compliance with all relevant requirements might not be achievable. Such retrofits should be permitted provided that, as a minimum, they maintain the existing performance level of the facility and specifically do not adversely affect the early warning and evacuation systems, fire separations, structural adequacy, or tenable environment in the facility.

A.1.4 Before a particular mathematical fire model or evaluation system is used, its purpose and limitations need to be known. Technical documentation should clearly identify any assumptions included in the evaluation. Also, it is the intent of this standard to recognize that future editions of this standard are a further refinement of this edition and earlier editions. The changes in future editions will reflect the continuing input of the fire protection/life safety community in its attempt to meet the purpose stated in this standard.

A.1.4.3 An equivalent method of protection provides an equal or greater level of safety. It is not a waiver or deletion of a requirement provided by a standard. The prescriptive provisions of this standard provide specific requirements for broad classifications of structures. These requirements are stated in terms of fixed values, such as maximum travel distance, minimum fire resistance ratings, and minimum features of required systems, such as detection, alarm, suppression, and ventilation, and not in terms of overall station, guideway, or vehicle system performance. However, the equivalency clause in 1.4.3 permits the use of alternative systems, methods, or devices to meet the intent of the prescribed provisions of a standard where approved as being equivalent. Equivalency provides an opportunity for a performance-based design approach. Through the rigor of a performance-based design, it can be demonstrated whether a station, guideway, or vehicle design is satisfactory and complies with the implicit or explicit intent of the applicable requirement provided by a standard. When the equivalency is used, it is important to clearly identify the prescriptive-based standard provision being addressed (scope), to provide an interpretation of the intent of the provision (goals and objectives), to provide an alternative approach (proposed design), and to provide appropriate support for the suggested alternative (evaluation of proposed designs). Performance resulting from proposed designs can be compared with the performance of the design features required by this standard. Using prescribed features as a baseline for comparison, it can then be demonstrated in the evaluation whether a proposed design offers the intended level of performance. A comparison of safety provided can be used as the basis for establishing equivalency.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Airflow Control Devices. Air curtains have been used to minimize tunnel airflow in transit systems. Barriers are similar to life rafts with inflatable rings or collars and could be used to minimize tunnel airflow. Brattices are parachute- or curtain-like devices that have been used in mine headings to minimize airflow. Doors have been used to minimize tunnel airflow in transit systems. Downstands and enclosures have been used to minimize airflow and smoke movement in rail stations. Gates are guillotine-type doors mounted at tunnel portals and have been used in passenger rail tunnels to minimize tunnel airflow.

A.3.3.5 Blue Light Station. The definition states the minimum functional requirements for a blue light station. The design provisions to accomplish those functions, as well as the need for other functions or equipments, should be determined based on emergency response planning for the system.

A.3.3.11 Concourse. A concourse is distinct from a platform because it can be more open, and passenger speeds can be different from those prescribed for a platform, platform stair, or escalator.

A.3.3.15 Engineering Analysis. *Engineering analysis* is a broad term that encompasses a range of different objectives and performance criteria. The complexity of the analysis and the factors requiring consideration are situation dependent and require the user to have sufficient understanding of the objectives, assumptions, and analysis tools being implemented.

General examples from within this document include analysis intended to provide justification for the modification of evacuation time/travel distance requirements, analysis to support the use of a concourse area as a point of safety, and analysis relative to the use of a nonmechanical ventilation system in lieu of a mechanical emergency ventilation system.

A written report of the analysis should be submitted to the authority having jurisdiction, indicating recommended fire protection method(s) that will provide a level of fire safety commensurate with this standard. The objectives, assumptions, sources of data, and degree of conservatism incorporated into the analysis should be addressed.

A.3.3.15.1 Fire Hazard Analysis. The term *fire hazard analysis* generally refers to analyses that are performed relative to the specific fire performance of materials, components, and assemblies for the purposes of addressing the subsequent contribution to the overall fire hazard and the resulting impact on occupant fire safety. A fire hazard analysis can provide an estimate of the potential severity of fires that can develop under defined fire scenarios. This analysis can encompass consideration of factors that include but are not limited to, quantities of materials, vulnerability of materials and components to ignition, propensity for flame spread, and smoke generation.

The formulation of a fire hazard analysis is subjective and dependent upon the expertise of the user. The material provided in Annex E, although specifically addressing fire hazard analysis for vehicles, provides additional guidance relative to the steps that might be involved in a fire hazard analysis. A written report of the analysis should be submitted to the authority having jurisdiction, indicating that a level of fire safety commensurate with this standard will be achieved.

A.3.3.20.1 Effective Fire Load. The effective fire load can include vehicle(s), luggage, fuel, and wayside facilities or structures, that, because of the fuel package configuration, separation, and combustion characteristics, would be expected to be released in a design fire incident.

A.3.3.20.2 Total Fire Load. The total fire load can include vehicle(s), luggage, fuel, and wayside facilities or structures.

A.3.3.27 Heat Release Rate (HRR). The heat release rate of a fuel is related to its chemistry, physical form, and availability of oxidant and is ordinarily expressed as Btu/sec or kilowatts (kW). [**921,** 2011]

A.3.3.44.2 Open Station. Direct dispersion is passing to atmosphere without ducting, without accumulation in occupied areas, and without entering or passing through another occupied level of the station.

A.4.2.1 The fire-life safety concepts in this standard are predicated and achieved by providing tenable conditions for evacuation of passengers described in this standard, as follows:

(1) Fire hazard control through use of fire-hardened materials in stations, tunnels, and trains
(2) Provision of fire detection, alarm notification, communication systems, and evacuation routes
(3) Natural ventilation or mechanical ventilation providing smoke control to maintain tenability
(4) Fire safety system reliability through system redundancy and increased safety in emergency system wires and cables that might be exposed to fire

The inclusion of automatic fire suppression systems in stations, tunnels, or trains provides an active system that can limit fire growth and thereby assist in reducing risk to life and property. Where such systems are provided, variations to requirements in this standard for materials, communications, systems, or reliability can be considered where supported by engineering analysis as permitted by Section 1.4 and in accordance with good fire protection engineering practice.

A.4.4 The standard was created to address the issue of entrapment and injury of large numbers of people who routinely use fixed guideway transit systems as a result of fire in the system. The document has evolved to now include passenger rail systems. The basis of the document — providing the minimum life safety from fire and fire protection requirements — still stands. It is not intended for the document to provide design basis for non-fire events such as explosions or other random acts of sabotage.

A.4.5 Freight operations are typically subject to regulation by others, and are beyond the scope of this standard. Freight operations can affect life safety from fire hazards due to concurrent operations.

The increased hazard includes the potential for rapid fire development to fire heat release rates that can exceed those of a non-freight vehicle, with combustible loads that might support fires that burn for days. The increased hazard also includes non-fire events involving release of materials hazardous to life. The design process should include information exchange and agreement among the freight operator, the passenger services operator and the authority having jurisdiction.

All concurrent freight and passenger uses should be given consideration. More detailed consideration of the relative life safety from fire hazards is strongly recommended when applied to underground facilities, where the confined nature of the space will magnify the hazards. Consideration should include implications of concurrent uses for freight systems operated through or adjacent to passenger stations and concurrent uses for freight systems operated through or adjacent to passenger trainways.

A.4.6 The location and size of a fire can greatly affect the degree of hazard to system occupants. Therefore, the system design must consider specific fire scenarios that could occur. Fire location and size are examples of factors that fire scenarios must consider:

(1) *Interior locations.* This scenario occurs from a fire that originates within a station or trainway or the interior passenger compartment of the vehicle. Examples of interior fire scenarios include the following:
    (a) Fire that begins from an incendiary ignition involving the use of accelerants
    (b) Trash fire
    (c) Electrical fire
    (d) Fire that occurs in a location used for food preparation
    (e) Luggage storage area fire
    (f) Fire that occurs from ignition by small open flame onto bedding in an unoccupied compartment in a vehicle that provides compartments for overnight sleeping
    (g) Fire that occurs where the vehicle rolls over onto its side and ignition occurs
(2) *Exterior locations.* This scenario occurs as a result of a fire originating outside the passenger compartment of the vehicle and penetrating the exterior of the vehicle. Examples of exterior fire scenarios include the following:
    (a) Electrical fire in the station, in the trainway, under the vehicle floor, or on the roof that burns through into the

passenger compartment or that causes the vehicle to stop between stations
   (b) Trash fire or other type of station, trainway, or under-vehicle equipment or floor fire
   (c) Fire that occurs from ignition of a fuel spill adjacent to the station, a trainway, or a vehicle involved in a collision
(3) *Operating environment.* Consequences can increase if a fire occurs when occupants are in the following locations:
   (a) In a station, trainway, or passenger-carrying vehicle that is in a stationary location and unable to move and where egress or rescue access could be hazardous (e.g., underground trainway or station)
   (b) In a passenger-carrying vehicle in motion between stations and at the maximum distance from any station, safe refuge, or point of safety

Fire scenarios that are appropriate for a particular system vehicle and operating environment could not be applicable to another system vehicle and operating environment.

A.4.7 The provisions of Section 4.7 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials.

A.4.7.1 Examples of such materials include steel, concrete, masonry, and glass.

A.4.8 Fire-life safety systems comprise interdependent mechanical, electrical, communications, control, fire protection, structural, architectural, and other elements, all of which must function as a system to achieve the designed result. It is critical that all primary and supporting elements are protected to a similar level of reliability for the design incident exposure.

A.5.1.2 This subsection is specifically intended to refer to features that normally would be required in the design and construction of stations. It is not intended to apply to trainways or to invoke requirements that normally would not be applicable in the design of a building similar in size or configuration to a station.

A.5.2.1.4 See A.6.3.4.3.

A.5.2.4.1(1) This requirement is intended to refer to stairs and escalators used for normal revenue service. Fire-separated exit stairs can also be required in order to satisfy the requirements of 5.3.3.7 for alternate egress or 5.3.5.5 for the proportion of escalators counted as means of egress.

A.5.2.4.2 The fire resistance rating of the required fire separation should be determined based on evaluation of such factors as the type of station configuration (open versus enclosed), fire suppression provided in the nonpublic areas, and NFPA *101* requirements for separation of similar occupancies.

A.5.2.4.4 The fire resistance rating of the required fire separation should be determined based on evaluation of such factors as the type of station configuration (open versus enclosed), fire suppression provided in the nonpublic areas, and NFPA *101* requirements for separation of similar occupancies.

A.5.2.4.5 Because of the difference in the potential level of hazard between various stations (e.g., open stations compared to enclosed stations), alternative methods to fire separation could be considered.

A.5.2.6.1 The fire hazard analysis should determine that the fire does not propagate beyond the component of fire origin and that a level of fire safety is provided within the station commensurate with this standard. Computer modeling, material fire testing, or full-scale fire testing should be conducted, as appropriate, to assess fire performance in potential fire scenarios.

A.5.2.6.2 Rubbish containers that are used in the station on a temporary basis (e.g., during cleaning operations) should be manufactured of noncombustible materials or of materials that comply with a peak heat release rate not exceeding 300 kW/m^2 (26.4 Btu/ft^2·sec) when tested in accordance with ASTM E 1354 at an incident heat flux of 50 kW/m^2 (4.4 Btu/ft^2·sec), in the horizontal orientation.

A.5.3 Annex C provides additional information and sample calculations relating to means of egress.

A.5.3.1 Where codes other than NFPA *101* are in effect, reference to NFPA *101* can be replaced by reference to relevant requirements in the locally applicable building code.

A.5.3.2.1 In that the peak ridership data are used to determine occupant load (and, consequently, required egress capacity), the basis for those data should be considered carefully.

The term *peak period* is intended to imply the time within the peak hour having the maximum passenger flow rate. For many systems, this period ranges between 10 minutes and 20 minutes in duration. Where peak hour ridership numbers are used, a surge factor should be applied as a distribution curve correction to account for the peak within the hour. Factors of 1.3 to 1.5 are typical for many systems. Other surge factors ranging from 1.15 to 2.75 have been reported.

In new systems, a survey of actual usage should be made within 2 years of completion of the project to verify design predictions. In operating systems, patronage levels should be projected to determine the need for expansion of the system or significant operating changes. Verification by survey should be made following any extension or significant operating change or at a maximum of 5-year intervals.

A.5.3.2.2 Consideration of control of the access to platforms might be necessary so that the station occupant load does not exceed the station egress capacity.

A.5.3.2.3(2) At multilevel, multiline, or multiplatform stations, it can be reasonable to consider only entraining (or entraining plus detraining) loads for nonincident levels for determining required egress capacity at points where egress troutes converge. Nonincident platform loads that do not adversely impact the egress route need not be considered.

A.5.3.2.5 The determination of maximum occupant load at a platform often requires comparison of calculations based on different peak periods. For example, to determine the maximum peak period platform occupant load for stations serving predominantly commuter ridership, the calculations described in 5.3.2.5(1) through 5.3.2.5(7) can be computed based on both the a.m. and the p.m. peak ridership for each platform and then compared to determine the maximum platform occupant load.

A.5.3.2.5(3) It is important that the load/headway capture the potential buildup of passengers that might occur before an emergency event is recognized as requiring evacuation. The determination of the appropriate accumulation factor should reflect system-specific characteristics such as the following:

(1) The type of system (e.g., automated/driverless vs. manually driven)
(2) The amount and type of surveillance
(3) The distance between stations and train headways

For systems with longer headways, a factor of two headways might be adequate to approximate accumulation and response time. For systems with very short headways, a fixed time (e.g., 5 minutes to 10 minutes) might be more appropriate to approximate the potential passenger buildup.

Consideration should also be given to whether the entraining and train loads should be subject to the same accumulation factor.

A.5.3.2.5(4) The nonincident service is not contributing detraining load.

A.5.3.3 The means of egress capacity factors and travel speeds are consistent with observed pedestrian movement within congested areas of passenger stations as represented by level of service E/F in *Pedestrian Planning and Design*, by Fruin. Patronage can vary for different user groups periodically or change over time. Modification could be warranted based on engineering analysis.

A.5.3.3.1 The stipulated time is intended as a baseline for determining the required capacity and maximum travel distances for platform egress routes. It is not intended that this calculation be required to account for delays due to products of combustion or debris along an egress route or delays due to the movement of those who are unable to achieve self-evacuation.

A.5.3.3.2 See A.5.3.3.1.

A.5.3.3.6 The determination of a common path of travel from the ends of a platform should consider the configuration (e.g., width and enclosure) of the platform versus the anticipated exposure to a train on fire at the platform. Where the platform is sufficiently wide to allow passengers to move away from the radiation effects of the train fire, it is reasonable to consider the egress from that platform as not creating a common path of travel.

A.5.3.3.7(1) This requirement is intended to replace the requirement in 7.3.1.1.2 of NFPA *101*, that the loss of one egress route must leave at least 50 percent of the egress capacity available. This approach is in recognition of the following design factors:

(1) Station design inherently requires primary circulation routes to be obvious and readily accessible such that preference for such routes would be anticipated in the event of an emergency evacuation.
(2) Requirements elsewhere in this standard (e.g., emergency ventilation in Chapter 7) require special protection of primary circulation routes from the effects of a train fire in enclosed stations.
(3) In the event of unavailability of one of the primary circulation routes due to another fire condition, the occupant load to be evacuated would be substantially less than that on which the size of the egress routes is determined, that is, the occupant load would not include the train link load.

A.5.3.3.8 Where automated spreadsheet calculations or computer-based software programs are used, the means of egress analysis should include documentation detailing all input parameters and algorithm(s).

A.5.3.4 Ramps are permitted in stations in accordance with NFPA *101* (and other applicable standards), which allows use of ramps with slopes up to 1:12 (8.33 percent)

A.5.3.4.1 The 2003 and previous editions of NFPA 130 required that exit corridors and ramps be a minimum of 1.73 m (5 ft 8 in.) wide. There is no technical basis for the previous minimum. The intent of 5.3.4.1 is to make NFPA 130 consistent with NFPA *101* relative to the minimum 1120 mm (44 in.) corridor width in the means of egress. NFPA 130 addresses means of egress conditions unique to transit/passenger rail facilities such as open platform edges. In NFPA *101*, means of egress facilities are based upon a function of the persons served (units of width/person served). NFPA 130 introduces a unit of time in determining the required egress width. This is necessary to demonstrate compliance with the performance requirements related to platform evacuation time and reaching a point of safety.

Assuming a 1120 mm (44 in.) wide side platform per 5.3.4.1 the effective platform width for egress is as follows:

$$1120\text{ mm} - 455\text{ mm }(\text{platform edge}) - 305\text{ mm }(\text{sidewall}) = 355\text{ mm}$$
$$[44\text{ in.} - 18\text{ in. (platform edge)} - 12\text{ in. (sidewall)} = 14\text{ in.}]$$

The capacity afforded by the effective 355 mm (14 in.) wide platform is:

$$355\text{ mm} \times 0.819\ \text{p/mm-min} = 29\ \text{p/min}$$
$$(14\text{ in.} \times 2.08\ \text{p/in.-min} = 29\ \text{p/min})$$

An effective 1120 mm (44 in.) wide corridor yields:

$$1120\text{ mm} \times 0.0819\ \text{p/mm-min} = 91\ \text{p/min}$$
$$(44\text{ in.} \times 2.08\ \text{p/in.-min} = 91\ \text{p/min})$$

It must be recognized that while strict interpretation of 5.3.4.1 indicates a station could be designed using a 1120 mm (44 in.) wide platform with an open edge and sidewall condition, it is impractical to do so, especially when one considers the other requirements of this standard that will affect the platform width, such as the travel distance to the point(s) of egress, the maximum 4-minute platform evacuation time, and the 6-minute point of safety time.

A.5.3.4.4 For ramps, various studies have reported that there were no statistically significant differences or measurable effect on walking speeds due to grades up to 5 or 6 percent, but that there is a gradual linear decline in speed for steeper grades.

A.5.3.4.5 See A.5.3.3 for clarification.

A.5.3.5.3 Where escalators having a nominal width of 1000 mm (40 in.) will be dedicated for operation in the direction of exit travel at speeds of at least 30 m/min (98 ft/min), such escalators can be permitted to be counted as having a capacity of 75 p/min. This should be considered appropriate only in conjunction with other provisions of this standard, such as the requirement to discount one escalator at each station level. Such escalators should also be connected to emergency power. This suggested speed is consistent with the maximum speed permitted in ASME A17.1/CSA B44, a bi-national standard. The suggested capacity is consistent with research reported in the *Elevator World* article “Escalator Handling Capacity” and in *Pedestrian Planning and Design*, by Fruin. Other codes regulating transit station design permit escalator capacity to be based on operating capacity (e.g., *Ontario Building Code*, Section 3.13, “Rapid Transit Stations,” and London Underground Ltd., *LUL Station Planning Guidelines*, which both permit a capacity of 100 p/min.). Designers are encouraged to research the latest available data. Unpublished research suggests that where the vertical rise exceeds 15 m (50 ft), the capacity and travel speed for stairs should be adjusted downward by approximately 30 percent to account for fatigue. Additionally, the design should provide enlarged landings to allow pedestrians to rest without impeding egress flow.

A.5.3.5.3(2) The vertical component of travel speed is calculated based on the vertical change in elevation between one station level and the next. [See Figure A.5.3.5.3(2).] See also *Application Guidelines for the Egress Element of the Fire Protection Standard for Fixed Guideway Transit Systems* and the example calculations in Annex C.

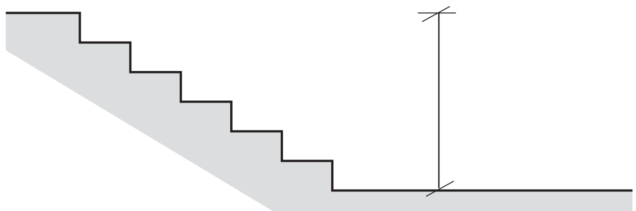

FIGURE A.5.3.5.3(2) Distance Measure for Walk Time Computation.

A.5.3.5.4 See A.5.3.4.1 for clarification.

A.5.3.5.6 Where multiple escalators are provided in the means of egress, the means of egress calculations should consider the potential of more than one escalator on any one level being out of service for repair and therefore impassible.

A.5.3.5.7(1) It is intended that escalators be as noncombustible as possible, with the understanding that certain components such as rollers or headrails might not currently be available in noncombustible materials. The authority having jurisdiction should review each installation proposal for compliance to the greatest extent possible.

A.5.3.5.7(2) The intent is to keep escalators running in the direction of egress in order to provide more efficient evacuation flow. Where escalators are an integral means of egress component in deep stations, the provision of emergency power for the escalators should be considered when supported by risk analysis.

A.5.3.5.7(4) Where required by accessibility regulations, visible message signs should be provided and designed to give pre-warning in accordance with the principles of this section.

A.5.3.6.2(2) Where a station has two elevators or fewer, this requirement should be interpreted as requiring that no elevators are counted as contributing to the available egress capacity.

A.5.3.6.2(3) Elevator capacity can be calculated as described in NIST IR 4730.

A.5.3.6.4(2) See B.4 of NFPA *101* and ASME A17.1/CSA B44 for additional guidance.

A.5.3.6.4(6) The design must also consider and provide for evacuation of other station levels.

A.5.3.6.4(7) Where supported by this analysis, the necessity for emergency recall should be considered.

A.5.3.7 For gates used as fare barriers, refer to 5.3.8. See Chapter 6 for requirements related to platform end gates.

A.5.3.7.1(2) The stated pedestrian capacity value assumes that the bi-parting doors and gates do not have mullions in the middle of the opening. The edge effect described in 5.3.4.2 need not be subtracted from the clear width. Where mullions are incorporated, the flow value for single-leaf doors should be used.

A.5.3.8.2 "Unimpeded travel in the direction of egress" means that any barriers in the equipment (such as paddles, gates, or turnstiles) either drop away to create a clear opening or swing or revolve freely in the direction of egress with no latching mechanism.

A.5.3.8.4(1) "Clear width" means the clear width between any protrusions with the fare gates open. The stipulated clear widths are appropriate where the length of the equipment console is less than 2500 mm in the egress direction. Where the equipment exceeds 2500 mm length, increased widths are recommended, which should be based on the anthropometric body sway data from NFPA *101*, as follows: Each unit should provide a minimum width of 560 mm (22 in.) clear width at and below a height of 1000 mm (39.5 in.) and 760 mm (30 in.) clear width above that height.

A.5.3.8.6 Refer to A.5.3.8.2.

A.5.3.9.1 Transit stations are unique in that many are constructed beneath and enveloped by adjacent buildings. The use of horizontal exits for up to 100 percent of the required capacity provided that not more than 50 percent is into a single building addresses conditions in stations that differ from those in NFPA *101*, which envisions a single building subdivision.

A.5.4.1 Where an underground station is part of another building complex, consideration should be given to creating a combined fire command center.

A.5.4.2.2 Discrete zone indications are desirable for unmanned stations.

A.5.4.2.6 Separate zones on the annunciator panel to monitor main control valves on standpipe systems should be established.

A.5.4.4.1 Escalators constructed of combustible stairs should be protected with an approved automatic sprinkler or fire suppression system installed in the truss area and designed to control or extinguish a fire.

A.5.4.5.1 The authority having jurisdiction might require additional 65 mm (2½ in.) hose connections to be equipped with a 65 mm × 40 mm (2½ × 1½ in.) reducer.

A.5.4.5.4 This requirement is intended to clarify that, with the approval of the local fire department, dry-type systems can be considered in stations regardless of the potential for freezing.

A.5.4.5.4(1) Calculations, including transit and fill times, should be submitted to the authority having jurisdiction to support this requirement.

A.6.1.1 The intent of the standard is to provide a reasonable level of life safety from fire and fire protection to passengers, transit system personnel, authorized visitors, and emergency responders. Generally, protective features such as egress routes in compliance with Chapter 6 are required for these areas, but see 6.4.6.2 for applicable ventilation requirements.

A.6.1.2.3 Locations requiring such signage may include, entrances to the trainway (e.g., station platforms and portals) and fences or barriers adjacent to the trainway.

A.6.2.1.6 See A.6.3.5.9.

A.6.2.2.1 Most tunnels exposed to prolonged fires are heavily damaged or collapse, resulting in service disruptions, significant structural damage, and most important, loss of lives (Both, Wolinsk & Breunese 2003, Khoury 2002, and Tatnall 2002). The structural concrete or shotcrete liner can be designed to withstand the fire load up to a certain period of time while accepting some minor repairable damage to the liner.

The fire resistance rating of the tunnel liners can be analyzed. Prompt operation of the ventilation system can mitigate damage to the liner.

A.6.2.4 The design of ancillary spaces adjacent to the trainway should be in accordance with the requirements of the local building codes except as specifically described in this standard. This would include requirements for egress from within the spaces and for heating, ventilation, and air-conditioning.

A.6.3.1.1 The trainway and the vehicle means of egress should be designed to be compatible. *(See Chapter 8.)*

A.6.3.1.4 Previous editions of NFPA 130 addressed this requirement by prescribing the maximum travel distance to an exit. The intent of this requirement was often misinterpreted. NFPA *101* requires, at a minimum, that two means of egress be provided within a building or structure and prescribes the maximum travel distance to an exit. This same requirement is applied in NFPA 130. Where two means of egress are required, the maximum travel distance to an exit occurs at the midpoint. For example, in a building with two exits, in the event of a fire adjacent to an exit rendering that exit unavailable, NFPA *101* recognizes that an individual in proximity to the affected exit must travel twice the prescribed exit travel distance to the alternative exit. Since two means of egress are required from any one point in an enclosed trainway, the exits cannot be more than twice the travel distance, or 762 m (2500 ft) apart.

A.6.3.1.6(2) The distance from the station should generally be measured to the end of the station platform. However, the distance can also be measured to an area of relative safety that is beyond the end of the platform, such as an exit stair or, where appropriate and based on evaluation of emergency ventilation airflow, a ventilation inlet.

A.6.3.1.6(7) The hazards to be considered include, but are not limited to, potential contact with live traction power distribution equipment.

A.6.3.2.1 Maintaining a clear space above the walking surface is important to ensure that projections do not encroach into the means of egress. The envelope created by the boundary limits defined by this paragraph is intended to gradually change from point to point. With respect to clearances to the vehicle, the measurements should be to the static vehicle envelope. *(See Figure A.6.3.2.1.)*

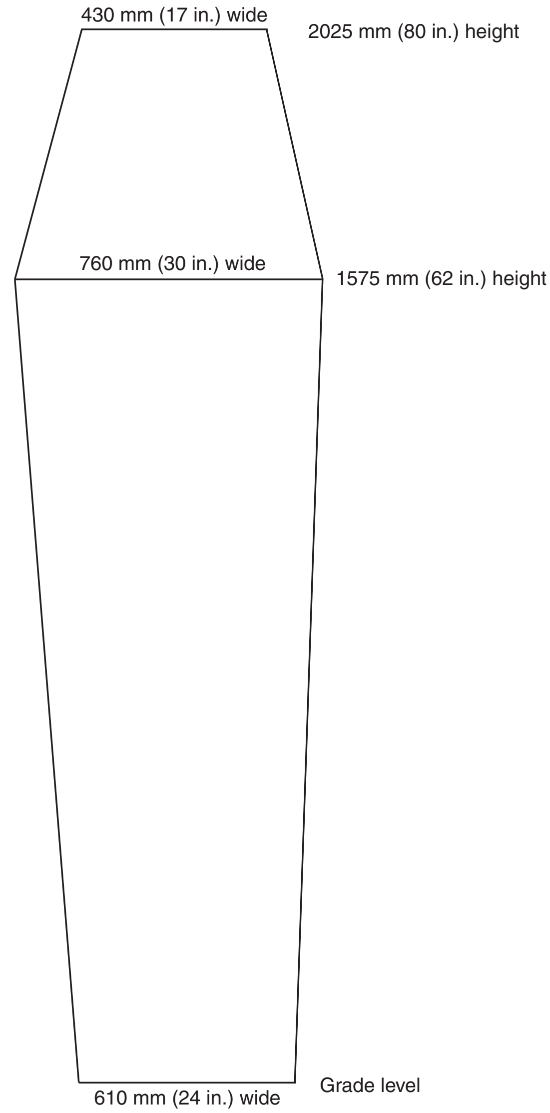

FIGURE A.6.3.2.1 Unobstructed Clear Width for Trainway Walkway.

A.6.3.2.3 With reference to NFPA *101*, Table 7.2.2.2.1.2(B) (where additional width is required for stairs serving an occupant load of 2000 people or more), exit stairs serving trainways are not required to exceed the minimum width, regardless of the occupant load. This is reasonable considering that evacuation flow from a tunnel would be essentially single file, and stairs do not normally converge with other egress routes.

A.6.3.2.4 The stipulated minimum width applies to all means of egress doorways, including those for cross-passages.

A.6.3.3 The egress provided should recognize that for multiple-track tunnels, there exists the possibility of having to evacuate simultaneously the incident train and a non-incident train(s) stranded on the adjacent track(s).

A.6.3.3.5 It is important that guards be configured so that they do not interfere with either the vehicle dynamic envelope or with egress from the train onto the walkway. For that reason, guards are not required on the trainway side of raised walkways, provided that the bottom of the trainway is closed by deck or grating so that persons could not fall through the bottom of the guideway.

A.6.3.3.8 It is important that handrails be configured so that they do not interfere with either the vehicle dynamic envelope or with egress from the train onto the walkway. For that reason, handrails are not required on the trainway side of raised walkways. Likewise, raised walkways located between trainways are not required to have handrails, provided they are a minimum width of 1120 mm (44 in.)

A.6.3.3.17 Where exit hatches are installed in spaces such as walkways or access areas, appropriate design features such as readily visible signs, markings, or bollards should be provided to prevent blockage of the exit hatch. In addition, provisions should be included in the design to protect the exterior side of the hatch, including the outside latch, from accumulation of ice and snow, which could render the hatch inoperable.

A.6.3.4.1 The primary hazards presented by the electrified third rail in the trainway are electrical shock to employees and other personnel in the trainway and the heat and smoke generated by the cable or third rail caused by combustion resulting from grounding or arcing.

The life safety and fire protection requirements for the traction power substations, tie breaker stations, and power distribution and control cabling are described in other parts of this standard.

A.6.3.5.9 This value is a minimum maintained point measured at any location on the walkway, taking into account the total light loss factor (dirt depreciation, lumen depreciation, etc.) that will be experienced by the luminaire. Required lighting levels should be read in the same manner as they would be in other codes or standards without consideration for obscuration by evacuees. The phrase "during a period of evacuation" is intended to clarify that continuous illumination is not required during normal operations.

A.6.3.5.11 Point illumination can be used to accentuate critical elements within the trainway such as change of walkway elevation, steps, and access points.

A.6.4.2.1 The placement of blue light stations at the ends of station platforms should be governed by specific characteristics of the transportation system and its emergency response procedures. For example, an at-grade system that has stations located on streets and overhead power supply might not need blue light stations at the ends of platforms.

A.6.4.4.2 The authority having jurisdiction might additionally require 65 mm (2½ in.) hose connections to be equipped with a 65 mm × 40 mm (2½ × 1½ in.) reducer.

A.6.4.4.4(1) Calculations, including transit and fill times, should be submitted to the authority having jurisdiction to support this requirement.

A.6.4.6.2 The intent of the standard is to provide a reasonable level of life safety for occupants. However, the risk faced in non-passenger areas where trains are merely stored or cleaned is significantly different from that in passenger areas (6.4.6.2 and 6.4.6.3 do not apply to maintenance and yards areas). This is because there are fewer ignition sources and fewer people, and the occupants will be either familiar with their surroundings (in the case of staff) or trained to react in hazardous locations (in the case of emergency responders). The standard continues to require ventilation and all other protective features, including compliant egress from these areas. Paragraphs 6.4.6.2 and 6.4.6.3 eliminate the requirement for the emergency ventilation system to meet the tenability criteria for other occupied areas. The standard permits tenability criteria in these areas to be reduced, provided that an engineering analysis shows that a fire in these areas will not impact areas occupied by passengers.

A.6.4.6.3 See A.6.4.6.2.

A.7.1.1 Separate ventilation systems for tunnels and underground stations can be provided but are not required. Annex B provides information on types of mechanical systems for normal and emergency ventilation of trainways and stations and information for determining a tenable environment.

A.7.1.2.2 Individual project geometries can impose constraints that make the length requirement of 7.1.2.2(2) onerous to meet. Proposals to the AHJ for relief based on engineering analysis might be made to address this. The following elements and performance goals should be considered in the development and justification of an alternative approach. A mechanical system intended for the purpose of emergency ventilation can be considered for waiver from an enclosed trainway if the length of the enclosed trainway is less than or equal to the length of that system's most prevalent train, provided that each vehicle within that most prevalent train permits a protected passenger egress route from each vehicle to the one (or two) adjoining vehicles. A rationale for selection and acceptance of the most prevalent train would be part of the justification. Conversely, a mechanical system intended for the purpose of emergency ventilation should not be waived in an enclosed trainway if the length of the enclosed trainway is equal to or greater than twice the NFPA recommendation *(see 6.2.2.2)* for the maximum distance that an evacuating passenger should have to travel before reaching an emergency exit stairway [381 m (1250 ft)]. The need for a mechanical system intended for the purpose of emergency ventilation should be analyzed further (as approved) if an enclosed trainway meets one of the following criteria:

(1) The length of the enclosed trainway is less than 762 m (2500 ft) but greater than that of the system's most prevalent train.
(2) The length of the enclosed trainway is less than that of the system's most prevalent train and each vehicle within that most prevalent train does not permit a protected passenger egress route from that vehicle to the one (or two) adjoining vehicle(s).

In the event that no analysis is performed or the justification is not approved, the default enclosed trainway design should include an emergency ventilation system.

A.7.2.1(3) The time frame required for achievement of the selected operating mode applies to the ventilation system equipment and not to the establishment of the resultant air flows in the tunnels and stations. This would be the time for the emergency ventilation system to achieve the required speed and direction for all related fans and to reach the required position for all dampers and related emergency devices.

A.7.2.5 Transition from fixed-block to moving-block (cab-based or communication-based) signaling is being made by many properties to increase train throughputs during rush hour operation. Ventilation zones are fixed elements, and the number of trains allowed in a single zone affects both ventilation plant requirements and the effectiveness of the ventilation response. Traction power blocks are fixed elements and affect the ability to extract non-incident trains from the incident ventilation zone. Signal system track circuits are fixed elements and affect the ability to determine the location of incident and non-incident trains in the incident ventilation zone. Signal system reversing capability and rapidness of executing a reversal in an emergency are key to the effective extraction of non-incident trains. Due to the potential for a valid incident ventilation response to move smoke past (and engulf) a non-incident train, the best protection to passengers is to allow no more than one train in a ventilation zone. Failing that, there should be a viable extraction capability to remove non-incident trains in the same time frame as the activation of the ventilation response. This extraction requires coordination of the three system elements in terms of design and operation. Non-incident trains should be capable of being located and removed from the incident area before the de-energization of the traction power prevents train movement for an extended period or the operation of the ventilation system in response to the fire incident involves the trains in the incident. Examples of the provisions necessary to accomplish this capability are the inclusion of traction power segmentation zones within ventilation zones and the inclusion of sufficiently short track signal circuit lengths to ensure all trains are accurately located.

A.7.2.6 The time of tenability should consider the possibility of one or more egress paths being blocked by fire or smoke (as may be demonstrated by analysis) and for other considerations that are not accounted for in the egress capacity calculations. *(See B.2.3 for additional information to be considered.)*

A.7.5.1 Factory approval acceptance testing prior to installation should be performed as follows:

(1) Ventilation equipment should comply with all the requirements of one of the applicable standards, which include those published by the Air Movement and Control Association International, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the International Organization for Standardization, and or UL (formerly, Underwriters Laboratories). If an appropriate standard does not exist, then a test procedure should be submitted for approval.
(2) Tests can consist of prototype testing or of production testing. Prototype testing should include those tests necessary to ensure that the design of the equipment is acceptable, including tests for design temperature exposure time. Production testing should include those tests necessary to ensure that the equipment as produced meets the requirements of the standard.

A.7.5.2 A test plan should be prepared and submitted to the owner and the AHJ for review and approval prior to the commissioning tests. The test plan should describe the method of testing and identify pass-fail criteria. As a minimum, the test plan should identify the following items:

(1) The commissioning tests should include individual equipment tests [as indicated in items (2) and (3)] and systemwide tests [as indicated in items (4) through (13)].
(2) The individual fans, dampers, and other devices should be operated to confirm their functionality. As a minimum, ventilation equipment operation should be initiated at the local primary location for fan operation such as an emergency management panel or fire management panel.
(3) The individual fan and ventilation plant airflows should be measured to confirm that the intended airflows are being delivered. At least one test should be made to measure the time required for the fan plant airflows to reach steady-state from a zero-flow start, and at least one test should be made to measure the time required for the fan plant airflows to reverse from full-forward to full-reverse operation. Subsequent tests should be conducted from Operations Central Control to verify remote fan and damper operation.
(4) The no-fire (or cold) station and tunnel airflows provided by the built mechanical ventilation system should be measured to confirm that the airflows meet the requirements determined by the analysis.
(5) The systemwide tests should be witnessed by the owner, the AHJ, the designer or the engineer of record, the contractor, and possibly the ventilation equipment suppliers.
(6) The systemwide testing should be done by a qualified airflow measurement specialist or contractor having previous experience in measuring airflows.
(7) Calibrated instruments providing an air velocity measurement accuracy of ±2.5 percent should be used. The number of points to be measured to convert air velocities to airflows should be determined either by the applicable standard used for the factory acceptance preinstallation testing (such as those published by the Air Movement and Control Association International, the American Society of Heating, Refrigerating and Air-Conditioning Engineers, the International Organization for Standardization or UL) or by a CFD analysis. The test data should be electronically recorded for future use.
(8) The fan(s) that are assumed to be operated and not operated by the analysis should be identified for each scenario being tested.
(9) At least one test should be performed to measure the time required for all the fans used in a fire scenario to reach full operating mode.
(10) The tunnel fire scenarios should be assessed and should include the design cases (i.e., those that determine the ventilation equipment functional capacities) and any other scenarios deemed appropriate. The train(s) should be located in the tunnel as per the scenario, and tunnel airflows upstream of the stopped trains should be measured. It is not necessary to test all scenarios.
(11) The station fire scenarios should be assessed and should include the design cases (i.e., those that determine the ventilation equipment's functional capacities) and any other scenarios deemed appropriate. The station geometry can preclude the necessity of locating trains in the station. Airflows through the station entrances and tunnels connected to the station should be measured. It is not necessary to test all scenarios.
(12) The airflows measured should be compared with the "cold flows" predicted by the analysis. If the measured airflows are less than the predicted airflows, the mechanical ventilation system or its operation should be changed and the test repeated until passing results are achieved. Negative tolerances in the results should not be accepted.
(13) The systemwide testing should be documented by one or more reports. The report should include a description of the scenario tested, the instrumentation used, the names and affiliations of those witnessing the tests, and all test results.

A.8.2 Federal Railroad Administration (FRA) requirements for passenger rail car and locomotive cab fire safety are contained in 49 CFR 238.

The requirements of 49 CFR 238, Section 103, are that interior materials be tested and meet certain flammability and smoke criteria and that floor fire endurance be tested. In addition, the requirements contain detailed fire safety analysis requirements for new equipment, to reduce the risk of personal injury and equipment damage caused by a fire to an acceptable level. The fire safety analysis requirements include the use of a formal safety methodology and written documentation of the analysis. In addition, the vehicle design and material selection are required to consider potential ignition sources; the type, quantity, and location of materials; and the availability of rapid and safe egress to the equipment exterior under conditions secure from fire, smoke, and other hazards. The ventilation system is required to not contribute to the lethality of a fire. Passenger railroads are also required to determine the extent to which overheat detection and fire suppression systems must be installed to ensure sufficient time for the safe evacuation of passengers and crew.

In addition to the specific fire safety requirements in 49 CFR 238, Section 103, other sections of the FRA requirements include fire safety–related provisions for passenger rail vehicles. Minimum requirements for fuel tanks for new passenger locomotives are intended to protect the fuel tanks against crushing and puncture in a collision or derailment. Requirements for passenger car electrical systems are also included. Conductor sizes must be selected on the basis of current carrying capacity, temperature, and other characteristics, and power dissipation resistors must be adequately ventilated to prevent overheating and be electrically insulated. The resistors and main battery system must be designed to prevent combustion. Such features can reduce the risk of fire ignition and spread in a collision or derailment and thus affect the necessity for and circumstances of emergency evacuation. Other CFR requirements are for passenger rail car and locomotive crashworthiness, as well as emergency exit and emergency responder access features. Annex E provides guidance relative to fire hazard assessments referenced in Section 8.3 through Section 8.10.

A.8.3.2 The purpose of this requirement is to isolate potential ignition sources from fuel and combustible material and to control fire and smoke propagation.

A.8.4.1 It is recommended that testing be conducted on production batches of materials intended to be used on the vehicle. A record of the performance of these materials should be retained by the authority.

It is recognized that the tests cited in 8.4.1 might not accurately predict the behavior of materials under hostile fire conditions. Therefore, the use of tests that evaluate materials in subassemblies and full-scale configurations is encouraged where such tests are more representative of foreseeable fire sources, heat flux levels, and surface area-to-volume ratios found in vehicles designed in conjunction with this standard.

The key fire property measured in the ASTM D 3675 and ASTM E 162 tests is the radiant panel index (or I_s).

A.8.4.1.1 ASTM E 162 might not be suitable for materials that exhibit flaming running or flaming dripping because the test apparatus is not designed to accommodate this kind of burning behavior. A fire hazard analysis seeking to demonstrate the acceptability of such materials as permitted in 8.4.2 should include not only the contribution to the generation of heat and smoke at the original ignition site but also any contribution resulting from burning material that melts and/or flows away from that site. The fire hazard analysis also should address the risk of spread to and ignition of other car components from either of these potential ignition sources.

A.8.4.1.3 The test methods in ASTM E 1537 [for upholstered furniture, 19 kW/(65 KBtu/hr) exposure] and ASTM E 1590 [for mattresses, 18 kW/(61 KBtu/hr) exposure] are deemed to be adequate procedures for testing individual items of upholstered furniture or mattresses for purposes of fire hazard assessment in some public occupancies. However, such individual stand-alone (not fixed in place) items are not normally found in rail transportation vehicles. Thus, the applicability of the test methods to rail transportation vehicles has not been validated, and they probably are not sufficiently representative of the situation and might require some modifications for better applicability. The use of alternative ignition sources (by varying the location, the gas flow intensity, or the exposure time) for ASTM E 1537 or ASTM E 1590 might be a means of addressing some very high challenge fire scenarios that could potentially occur in rail transportation vehicles. Examples of more powerful ignition sources that could be used include a 50 kW gas burner [Hirschler, 1997], shown to be relevant to detention mattresses or the oil burner used for aircraft seat cushions [FAR 25.853(c)], but the measurements should involve the same fire properties as in ASTM E 1537 or ASTM E 1590. If the ignition source used for a test method is inadequate, the result can be misleading; it has been shown that upholstered furniture and mattresses that are totally consumed when using the appropriate ignition source appear to perform well when using the ignition sources in ASTM E 1537 and ASTM E 1590, respectively.

A.8.4.1.10 If the surface area of any individual small part is less than 100 cm^2 (16 in.^{2}) in end use configuration, materials used to fabricate such a part should be permitted to be tested in accordance with ASTM E 1354 as an alternative to both the ASTM E 162 flammability test procedure or the appropriate flammability test procedure otherwise specified in Table 8.4.1 and the ASTM E 662 smoke generation test procedure. Testing should be at 50 kW/m^2 (4.4 Btu/sec·ft^2) applied heat flux in the horizontal orientation with a retainer frame. Materials tested in accordance with ASTM E 1354 should meet the performance criteria of a 180-second average heat release rate of q''_{180} < 100 kW/m^2 (8.8 Btu/sec·ft^2) and test average smoke extinction area of (F_f) < 500 m^2/kg (2441.2 ft^2/lb).

The typical way in which smoke obscuration test results are reported in the cone calorimeter (ASTM E 1354) is as specific extinction area.

A.8.4.1.14 Only one specimen need be tested. A proportional reduction can be made in the dimensions of the specimen, provided the specimen represents a true test of the ability of the structural flooring assembly to perform as a barrier against undervehicle fires.

A.8.4.1.15 ASTM E 2061 and APTA RP PS-005-01a both describe and discuss passenger-carrying vehicle fire scenarios. *(See also Annex E.)*

A.8.4.2 The greater the anticipated effect of the material on fire performance, the more complex the analysis is likely to be.

A.8.5.1.3.2(1) Computer models typically utilize passenger-carrying vehicle fire heat release rate data to predict the size of a vehicle fire that will occur after an interior fire reaches flashover. Vehicle interior fire computer models assume either that a fire is started on the inside of a vehicle or that an undercar fire penetrates into the vehicle interior, igniting any combustible material in the area of penetration. Typically, a floor fire resistance test is conducted only for the approved length of time. Consideration should be given to extending the floor fire exposure until failure. If a test is conducted until failure, it will give designers a better idea as to the length of time it will take for a fire to penetrate into a vehicle and ignite any combustible materials on the vehicle interior.

A.8.5.1.3.2(2) For determination of the minimum floor exposure time, the operating environment should be considered in addition to the time necessary to evacuate passengers from the vehicle. Typical issues that should be considered are the time necessary to shut down power to the affected portion of the trainway, distance to a cross-passageway, distance to an emergency exit, and availability of adequate light to perform a safe evacuation.

A.8.5.1.3.3(2) Since smoke generation is a factor that has a direct effect on a passenger's ability to evacuate a vehicle, observations should be noted during the length of the floor fire exposure as to the origin and quantity of smoke generated from the fire test sample. These observations should be recorded in the fire test report.

A.8.6.2.2 In selecting air clearance distances, special consideration should be given to the presence of contaminants encroaching on the air clearances.

A.8.6.2.3.2 Appropriate creepage distances can be selected from Annex F.

A.8.6.5.1 Resistors dissipate heat at elevated temperatures and are frequently separated by noncombustible shields to avoid ignition of combustible train materials. Direct contact with combustibles is a fire hazard and minimum spacing should be established if combustible materials are required to be used. The clear spacing will vary depending on location, orientation, and fire characteristics of the combustible train materials.

A.8.6.7.1.3 The electrical properties of data and communication cables should comply with requirements for category cable or local electrical requirements. Different system authorities specify data and communication cables that have specific electrical requirement other than voltage.

A.8.8.1 Since 1980, the Federal Railroad Administration (FRA) has required that each rail passenger car be provided with at least four emergency window exits. In 1999, the FRA issued a passenger equipment rule that required each intercity and commuter rail car to be equipped with a minimum number of two side doors per car and at least four emergency window exits for each main level. Each sleeping compartment must also be provided with an emergency window exit. Because fixed guideway vehicles historically have been provided with at least two sets of bi-leaf side doors, one on each side, emergency exit windows usually are not provided.

A.8.8.1.1 After a collision or derailment, the vehicle might come to a rest in an orientation other than upright. When designing alternative means of emergency egress, consideration should be given to reaching the emergency egress, regardless of vehicle orientation. This can be accomplished by the utilization of fixed appurtenances in the vehicle, ladders, or ramps.

A.8.8.3.1 The level of emergency lighting illumination was previously required to meet the requirements of NFPA *101*. However, research conducted by the John A. Volpe Transportation Systems Center (Volpe Center) for the Federal Railroad Administration (FRA), U.S. Department of Transportation, determined that the level of illumination required by NFPA *101* might not be necessary due to the more limited size [25.9 m (85 ft) long and 3.1 m (10 ft) wide)] and configuration of passenger rail vehicles (and by extension, fixed guideway transit vehicles). The Volpe Center performed numerous detailed measurements of illumination levels provided by emergency light facilities installed on many types and ages of intercity and commuter rail vehicles. The majority of fixed guideway transit and passenger rail vehicle emergency lighting systems use fluorescent light fixtures. However, some systems used incandescent fixtures. While the fluorescent light fixtures typically emit higher levels of illumination and are thus preferred, some incandescent light fixtures (depending on their type, power output and location, and pattern) also provide sufficient illumination to allow passengers to identify, reach, and operate emergency egress facilities.

The Federal Aviation Administration (FAA) has conducted many research studies relating to emergency lighting illumination levels for passenger aircraft. The FAA requires different illumination levels at floor level doors and emergency window locations and along the center aisle. The center aisle illumination levels are measured at the armrest height. Due to the different armrest heights exhibited by passenger rail vehicles, the Volpe Center research resulted in the recommendation for a uniform height of 635 mm (25 in.) above the floor height to perform the aisle measurements.

Accordingly, the FRA issued a passenger equipment regulation on May 12, 1999, that specified the Volpe-recommended minimum illumination level for egress door floor locations, minimum illumination average along the center aisle, and a minimum illumination at any point along the aisle for new equipment.

Moreover, the American Public Transportation Association (APTA) standard APTA SS-E-013 addresses passenger rail vehicle emergency lighting. The APTA standard requires minimum emergency lighting levels for new intercity passenger and commuter rail vehicles that are identical to FRA requirements and contains additional guidance in performing the illumination measurements. The APTA emergency lighting standard was updated in 2007 to provide a detailed test methodology. The APTA standard provides guidance that could be applied to fixed guideway transit vehicles.

A.8.8.3.3 Depending on the location of the train, the time necessary to initiate and complete the evacuation of passengers from the fixed guideway transit or passenger rail vehicle to a point of safety can exceed 1 hour. The minimum period of time for the vehicle emergency lighting system power supply is consistent with NFPA *101*, APTA SS-E-013, and the FRA regulation.

A.8.8.4 Until the 2003 edition, NFPA 130 did not address the manual operation of emergency egress (or access) facilities for the vehicle interior or exterior, the interior and exterior marking of the egress/access facility location, or instructions for the use of the emergency egress/access facilities. Several emergency incidents occurred that demonstrated the necessity of providing passengers with a means to manually operate, without tools, means of emergency egress in the event of a power failure. Operational issues to be considered include the need to discourage use under nonemergency conditions while permitting effective passenger use in an emergency, particularly if members of the train crew are injured or otherwise unavailable.

• **A.8.8.5** The FAA requires the installation of independently powered floor proximity path marking to delineate the path to emergency exits. APTA also has issued a standard that requires this same concept of marking to be installed in intercity and commuter rail cars.

The FRA issued a rule in 1998 that required marking and instructions for the operation of emergency exit windows and doors used for emergency egress. Although the FRA requires that the marking be conspicuous and legible, specific objective performance criteria were not included.

APTA has issued a standard that contains extensive provisions for the marking of and instructions for emergency egress facilities that are operated from inside the vehicle. These minimum performance criteria include letter height, color contrast, and luminance levels.

The APTA standard requires that marking and instructions use either electrically powered or high-performance photo luminescent (HPPL) material. The HPPL material must be charged with adequate light [54 lx (5 ft-candles) for at least 1 hour] but offers the advantage of providing a far greater luminance (brightness) over a far longer time period while not being dependent on emergency power. HPPL material has been certified by the FAA for use as floor proximity path marking on certain aircraft.

A.8.11.1 Annex D provides additional information on the fire hazards associated with burning vehicles and the impact of a burning vehicle on the evacuation of passengers and crew.

A.8.11.2 Section 4.3 includes specific objectives necessary to achieve desired goals. Further guidance relative to the engineering analysis option for compliance could include explanatory material regarding performance-based compliance in other documents, such as NFPA *101.*

A.9.2.4 The following standards might be applicable for training qualification and competency assessment: NFPA 1006, NFPA 472, and NFPA 1670.

A.9.4 Tunnels more than 610 m (2000 ft) in length should be equipped with emergency tunnel evacuation carts (ETECs) at locations to be determined by the authority having jurisdiction.

ETECs should be capable of carrying a capacity of at least four stretchers and a total weight capacity of at least 453.5 kg (1000 lb). ETECs should be constructed of corrosion-resistant materials, be equipped with a "deadman" brake, and safely operate on the rail tracks in the tunnel.

A.9.5 The agencies and their names might vary depending on the governmental structure and laws of the community.

A.9.6.9 Fan units serving train control and communications rooms should be protected by fire detection, protection, and extinguishing equipment so that there will be early detection and extinguishment of any fire involving these units.

A.9.8.1 The command post should be located at a site that is convenient for responding personnel, easily identifiable, and suitable for supervising, coordinating, and communicating with participating agencies.

A.9.8.5 Signs should be designed to be visible day and night and under bad weather conditions.

A.9.9 Any emergency response agency can establish an auxiliary command post to assist with the supervision and coordination of personnel and equipment. This activity is in addition to providing a liaison at the command post.

A.10.1 Comprehensive and dependable communications are essential for an effective and efficiently operated fixed guideway transit system during emergencies.

A.11.2.1 It is desirable that passengers are evacuated directly to a station platform, rather than to a trainway, to avoid the complications of a trainway evacuation.

A.11.3.1 Different situations that can render a system unavailable include data overloads, both intentional or unintentional; loss of data; loss of a control room due to fire; loss of battery power; and circuits shorted or open.

A.11.3.2 Single points of failure that will affect life safety during fires and the mitigation of those single points of failure should be considered during conceptualization.

A.11.3.3 When it is essential that a control, data, or communication system continue to function during a fire, both thermal and physical protection are likely to be required, since a fire resistance–rated element intended to protect the control, data, or communication system might not offer the expected thermal protection to the unexposed side for the duration of the fire resistance rating.

A.12.1.2 The life safety and fire protection requirements for the traction power substations, the breaker station's power distribution, and control cabling are described in other parts of this standard.

A.12.5.3 When selecting a fire-resistive cable, it is important to understand how it will be installed and if it was tested as a complete system, including splices. Cables that are exposed (not embedded in concrete) should be protected by either a raceway or an armor/sheath *(see 12.4.1)*. There are two basic configurations of fire-resistive cables. Cables enclosed by a metallic sheath or armor, such as Type MI or Type MC, are installed without raceways. Cables that are installed in a raceway, such as Type RHW-2, Type TC, or Type CM are tested as a complete system. Regardless of the fire test standard used to evaluate fire-resistive cables that will be installed in a raceway, it is important to consider that the cables are only one part of the system. Other components of the system include but are not limited to: the type of raceway, the size of raceway, raceway support, raceway couplings, boxes, conduit bodies, splices where used, vertical supports, grounds, and pulling lubricants. Each cable type should be tested to demonstrate compatibility. Only those specific types of raceways tested should be acceptable for installation. Each cable type that is intended to be installed in a raceway should be tested in both a horizontal and vertical configuration while demonstrating circuit integrity.

Annex B Ventilation

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 General. The purpose of this annex is to provide guidelines for the potential compatibility of the emergency ventilation system with the system employed with normal ventilation of trainways and stations. This annex does not present all factors to be considered in the normal ventilation criteria. For normal ventilation, refer to the *Subway Environmental Design Handbook* (*SEDH*) and the ASHRAE handbooks *Fundamentals*, *Applications*, and *Systems and Equipment*.

Current technology is capable of analyzing and evaluating all unique conditions of each property to provide proper ventilation for normal operating conditions and for pre-identified emergency conditions. The same ventilating devices might or might not serve both normal operating conditions and pre-identified emergency requirements. The goals of the subway ventilation system, in addition to addressing fire and smoke emergencies, are to assist in the containment and purging of hazardous gases and aerosols such as those that could result from a chemical/biological release.

B.2 Tenable Environments.

B.2.1 Environmental Conditions. Some factors that should be considered in maintaining a tenable environment for periods of short duration are defined in B.2.1.1 through B.2.1.5.

B.2.1.1 Heat Effects. *(See also H.1.2.11.)* Exposure to heat can lead to life threat in three basic ways:

(1) Hyperthermia
(2) Body surface burns
(3) Respiratory tract burns

For use in the modeling of life threat due to heat exposure in fires, it is necessary to consider only two criteria: the threshold of burning of the skin and the exposure at which hyperthermia is sufficient to cause mental deterioration and thereby threaten survival.

Note that thermal burns to the respiratory tract from inhalation of air containing less than 10 percent by volume of water vapor do not occur in the absence of burns to the skin or the face; thus, tenability limits with regard to skin burns normally are lower than for burns to the respiratory tract. However, thermal burns to the respiratory tract can occur upon inhalation of air above 60°C (140°F) that is saturated with water vapor.

The tenability limit for exposure of skin to radiant heat is approximately 2.5 kW·m^{-2}. Below this incident heat flux level, exposure can be tolerated for 30 minutes or longer without significantly affecting the time available for escape. Above this threshold value, the time to burning of skin due to radiant heat decreases rapidly according to Equation B.2.1.1a.

$$t_{Irad} = 106q^{-1.35} \qquad \textbf{(B.2.1.1a)}$$

where:
t = time in minutes
q = radiant heat flux (kW/m^2)

As with toxic gases, an exposed occupant can be considered to accumulate a dose of radiant heat over a period of time. The fraction equivalent dose (FED) of radiant heat accumulated per minute is the reciprocal of t_{Irad}.

Radiant heat tends to be directional, producing localized heating of particular areas of skin even though the air temperature in contact with other parts of the body might be relatively low. Skin temperature depends on the balance between the rate of heat applied to the skin surface and the removal of heat subcutaneously by the blood. Thus, there is a threshold radiant flux below which significant heating of the skin is prevented but above which rapid heating occurs.

Based on the preceding information, it is estimated that the uncertainty associated with the use of Equation B.2.1.1a is ±25 percent. Moreover, an irradiance of 2.5 kW·m^{-2} would correspond to a source surface temperature of approximately 200°C, which is most likely to be exceeded near the fire, where conditions are changing rapidly.

Calculation of the time to incapacitation under conditions of exposure to convected heat from air containing less than 10 percent by volume of water vapor can be made using either Equation B.2.1.1b or Equation B.2.1.1c.

As with toxic gases, an exposed occupant can be considered to accumulate a dose of convected heat over a period of time. The fraction equivalent dose (FED) of convected heat accumulated per minute is the reciprocal of t_{Iconv}.

Convected heat accumulated per minute depends on the extent to which an exposed occupant is clothed and the nature of the clothing. For fully clothed subjects, Equation B.2.1.1b is suggested:

$$t_{Iconv} = \left(4.1\times10^{8}\right)\ T^{-3.61} \qquad \textbf{(B.2.1.1b)}$$

where:
t_{Iconv} = time in minutes
T = temperature (°C)

For unclothed or lightly clothed subjects, it might be more appropriate to use Equation B.2.1.1c:

$$t_{Iconv} = \left(5\times10^{7}\right)\ T^{-3.4} \qquad \textbf{(B.2.1.1c)}$$

where:
t_{Iconv} = time in minutes
T = temperature (°C)

Equations B.2.1.1b and B.2.1.1c are empirical fits to human data. It is estimated that the uncertainty is ±25 percent.

Thermal tolerance data for unprotected human skin suggest a limit of about 120°C (248°F) for convected heat, above which there is, within minutes, onset of considerable pain along with the production of burns. Depending on the length of exposure, convective heat below this temperature can also cause hyperthermia.

The body of an exposed occupant can be regarded as acquiring a "dose" of heat over a period of time. A short exposure to a high radiant heat flux or temperature generally is less tolerable than a longer exposure to a lower temperature or heat flux. A methodology based on additive FEDs similar to that used with toxic gases can be applied. Provided that the temperature in the fire is stable or increasing, the total fractional effective dose of heat acquired during an exposure can be calculated using Equation B.2.1.1d:

$$FED = \sum_{t_1}^{t_2}\left(\frac{1}{t_{Irad}}+\frac{1}{t_{Iconv}}\right)\Delta t \qquad \textbf{(B.2.1.1d)}$$

Note 1: In areas within an occupancy where the radiant flux to the skin is under 2.5 kW · m^{-2}, the first term in Equation B.2.1.1d is to be set at zero.

Note 2: The uncertainty associated with the use of this last equation would be dependent on the uncertainties with the use of the three earlier equations.

The time at which the FED accumulated sum exceeds an incapacitating threshold value of 0.3 represents the time available for escape for the chosen radiant and convective heat exposures.

As an example, consider the following:

(1) Evacuees lightly clothed
(2) Zero radiant heat flux
(3) Time to FED reduced by 25 percent to allow for uncertainty in Equations B.2.1.1b and B.2.1.1c.
(4) Exposure temperature constant
(5) FED not to exceed 0.3

Equations B.2.1.1c and B.2.1.1d can be manipulated to provide:

$$t_{exp} = \left(1.125\times10^{7}\right)T^{-3.4}$$

where:
t_{exp} = time of exposure (min.) to reach a FED of 0.3

This gives the values in Table B.2.1.1.

Table B.2.1.1 Maximum Exposure Time

Exposure Temperature °C	Exposure Temperature °F	Without Incapacitation (min.)
80	176	3.8
75	167	4.7
70	158	6.0
65	149	7.7
60	140	10.1
55	131	13.6
50	122	18.8
45	113	26.9
40	104	40.2

B.2.1.2 Air Carbon Monoxide Content. An exposed occupant can be considered to accumulate a dose of carbon monoxide over a period of time. This exposure to carbon monoxide can be expressed as a fractional effective dose, according to Equation B.2.1.2a; see B.2.1.2.1, reference [1] [page 6, equation (2)]:

$$FED_{CO} = \sum_{t_1}^{t_2} \frac{[CO]}{35000} \Delta t$$

where:

Δt = time increment in minutes

$[CO]$ = average concentration of CO (ppm) over the time increment Δt

It has been estimated that the uncertainty associated with the use of Equation B.2.1.2a is ±35 percent. The time at which the FED accumulated sum exceeds a chosen incapacitating threshold value represents the time available for escape for the chosen carbon monoxide exposure. As an example, consider the following:

(1) Time to FED reduced by 35 percent to allow for the uncertainty in Equation B.2.1.2a
(2) Exposure concentration constant

This gives the values in Table B.2.1.2 for a range of threshold values.

Table B.2.1.2 Maximum Carbon Monoxide Exposure

Time (min)	Tenability Limit AEGL 2	0.3	0.5
4	–	1706	2844
6	–	1138	1896
10	420	683	1138
15	–	455	758
30	150	228	379
60	83	114	190
240	33	28	47

A value for the FED threshold limit of 0.5 is typical of healthy adult populations [1], 0.3 is typical in order to provide for escape by the more sensitive populations [1], and the AEGL 2 limits are intended to protect the general population, including susceptible individuals, from irreversible or other serious long-lasting health effects [2].

The selection of the FED threshold limit value should be chosen appropriate for the fire safety design objectives. A value of 0.3 is typical. More conservative criteria may be employed for use by especially susceptible populations. Additional information is available in references [1] and [3].

B.2.1.2.1 The following references are cited in B.2.1.2:

(1) "Life threat from fires — Guidance on the estimation of time available for escape using fire data." ISO/DIS 13571, International Standards Organization, 2006.
(2) "Acute Exposure Guideline Levels for Selected Airborne Chemicals, Volume 8," Committee on Acute Exposure Guideline Levels, Committee on Toxicology, National Research Council. National Academies Press, Washington DC, 2010.
(3) Kuligowski, E. D., "Compilation of Data on the Sublethal Effects of Fire Effluent," Technical Note 1644, National Institute of Standards and Technology, 2009.

B.2.1.3 Smoke Obscuration Levels. Smoke obscuration levels should be maintained below the point at which a sign internally illuminated at 80 lx (7.5 ft-candles) is discernible at 30 m (100 ft) and doors and walls are discernible at 10 m (33 ft).

B.2.1.4 Air Velocities.

B.2.1.4.1 Air velocities in enclosed stations and trainways should be greater than or equal to 0.75 m/sec (150 fpm).

B.2.1.4.2 Air velocities in enclosed stations and trainways that are being used for emergency evacuation or by emergency personnel should not be greater than 11.0 m/sec (2200 fpm).

B.2.1.5 Noise Levels. Noise levels should be a maximum of 115 dBa for a few seconds and a maximum of 92 dBa for the remainder of the exposure.

B.2.2 Geometric Considerations. Some factors that should be considered in establishing a tenable environment in stations are as follows:

(1) The evacuation path requires a height clear of smoke of at least 2 m (6.6 ft). For low-ceiling areas, selection of the modeling method and the criteria to be achieved should address the limitations imposed by ceiling heights below 3 m (9.84 ft). At low-ceiling areas in an evacuation path, beyond the immediate vicinity of a fire, smoke should be excluded to the greatest extent practicable.
(2) The application of tenability criteria at the perimeter of a fire is impractical. The zone of tenability should be defined to apply outside a boundary away from the perimeter of the fire. This distance will be dependent on the fire heat release rate, the fire smoke release rate, local geometry, and ventilation and could be as much as 30 m (100 ft). A critical consideration in determining this distance will be how the resultant radiation exposures and smoke layer temperatures affect egress. This consideration should include the specific geometries of each application, such as vehicle length, fire location, platform width and configuration, and ventilation system effectiveness, among others, and how those factors interact to support or interfere with access to the means of egress.
(3) The beneficial effects of an emergency ventilation system during a fire incident will not become completely available until the system is operated and reaches full capacity. During the time between initiation of a fire incident and the desired ventilation response achieving its full capacity, the smoke can spread into the intended zone of tenability. The ventilation system should have sufficient capacity to counter this

pre-ventilation smoke spread. Whenever possible, the design of the space geometry should consider arrangements to minimize the pre-ventilation smoke spread. The overall extent of pre-ventilation smoke spread should also be considered with respect to its potential effect on egress.

(4) During the emergency ventilation response, short-term transient events due to step-like changes in geometry can momentarily provide a significant boost to the fire heat and smoke release rates. Examples include vehicle doors opening or the failure of vehicle windows. The ventilation system should have sufficient capacity to counter such short-term transients affecting smoke spread.

B.2.3 Time Considerations. Some factors that should be considered in establishing the time of tenability are as follows:

(1) The time for fire to ignite and become established
(2) The time for fire to be noticed and reported
(3) The time for the entity receiving the fire report to confirm existence of fire and initiate response
(4) The time for all people who can self-rescue to evacuate to a point of safety
(5) The time for emergency personnel to arrive at the station platform
(6) The time for emergency personnel to search for, locate, and evacuate all those who cannot self-rescue
(7) The time for fire fighters to begin to suppress the fire

B.2.4 Modeling Accuracy. Where modeling is used to determine factors such as temperature, visibility, and smoke layer height, an appropriate sensitivity analysis should be performed.

B.3 Configurations. Configurations can vary among properties, but engineering principles remain constant. The application of those principles should reflect the unique geometries and characteristics of each property.

Enclosed stations and trainways might be configured with the following characteristics:

(1) High or low ceilings
(2) Open or doored entrances
(3) Open or screened platform edges
(4) End-of-station or midtunnel fan shafts
(5) End-of-station or midtunnel vent shafts
(6) Single, double, or varying combinations of tracks in tunnels
(7) Intersecting tunnels
(8) Multilevel stations
(9) Multilevel tunnels
(10) Varying depths below the surface
(11) Varying grades and curvatures of tracks and tunnels
(12) Varying blockage ratios of vehicles to tunnel cross-section
(13) Varying surface ambient conditions
(14) Varying exit points to surface or points of safety

B.4 Draft Control.

B.4.1 For patron comfort in stations, the air velocities induced by train motion should be evaluated carefully by designers. Infrequent exposure to higher velocities can be tolerated briefly but are to be avoided wherever possible. Refer to the *Subway Environmental Design Handbook* (*SEDH*), the *ASHRAE Handbook — Fundamentals,* and the *Beaufort Scale.*

B.4.2 Draft control can be achieved by the placement of shafts along the tunnel length between stations. Shafts can be arranged with the fan shafts at the ends of stations, with vent shafts midtunnel if required or with vent shafts at the ends of stations and fan shafts midtunnel. End-of-station shaft configurations should be related to the station geometries in the consideration of patron comfort in the station relative to train piston draft effects.

B.5 Temperature Control.

B.5.1 Temperature control for patron comfort in the station can be achieved by circulating ambient air in moderate climates or by providing heating and/or cooling in more extreme regions. Preferred temperature goals should be defined in the criteria developed for the design of an individual property relative to the local climate and the length of station occupancy, such as train headways specific to the property during which the patron would be exposed to the station temperatures.

B.5.2 Temperature control and ventilation for ancillary areas housing special equipment should reflect the optimum operating conditions for the specific equipment to ensure the availability of critical equipment and should also give consideration for intermittent occupancy by maintenance personnel. These systems should be separate from the emergency ventilation system for stations and tunnels and should be considered in the design of the emergency ventilation system.

B.6 Under-Platform Ventilation System.

B.6.1 An under-platform ventilation system should be considered for the extraction of heat from traction and braking devices. Intakes should be provided below the platform level and should be situated relative to the heat-producing devices on a train berthed in a station.

B.6.2 Ceiling ventilation, by powered or gravity design, to aid in the removal of smoke and/or heat should be considered.

B.7 Platform Edge and Screen Doors.

B.7.1 Platform edge doors and platform screen doors are sometimes incorporated into stations for various reasons, such as climate control, separation between passengers and trainway hazards (especially in driverless systems), and ventilation control in enclosed trainways. When used, these system walls and doors should provide resistance rating structural strength relative to the train and ventilation system pressures.

B.7.2 In a tunnel-to-station evacuation scenario, access to the platform level from the trainway should be considered.

B.8 Non-Emergency Ventilation for Enclosed Trainways.

B.8.1 Congested Operations. Where trains might be stopped or delayed in an enclosed trainway for a period of time, the vehicle ventilation system should be capable of maintaining an acceptable level of patron comfort. If not operating in a fire or other emergency scenario, the emergency ventilation fans can be used to augment the vehicle system capability.

B.8.2 Maintenance Activities. Maintenance activities within station and tunnel areas can include heat-, dust-, or fume-producing operations such as grinding, welding, or painting; operation of fuel-powered vehicles or equipment; and other operations that affect tunnel air quality or temperature. If not operating in a fire or other emergency scenario, the tunnel ventilation fans can be used to address the safety and comfort of employees working in the affected tunnel and station areas. In such cases, velocities should consider the comfort levels of employees required to be in the tunnels.

B.8.3 Tunnels in Gassy Ground. Tunnels in gassy ground could be subject to ingress of flammable or other hazardous gases. Gases of concern include hydrogen sulfide (H_2S) and methane (CH_4). The ventilation system should be designed to satisfy two objectives:

(1) To avoid pockets of gases forming
(2) To achieve dilution of gas inflows through a design crack

The ventilation design should be coordinated with the gas detection and alarm system type and the activation levels selected. The design should consider two general conditions:

(1) Ongoing or periodic ventilation requirements to meet expected average gas ingress rates
(2) Reaction to potential abrupt increases in gas ingress, such as might result from future construction, climate events, or seismic activity

Annex C Means of Egress Calculations for Stations

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Station Occupant Load. The station platform dimensions are a function of the length of trains served and the train load. Thus the length of a platform at an outlying station might be equal to those of central business district transit stations where the train loads are significantly higher. Consequently, the platform and station occupant loads are a function of the train load and the simultaneous entraining load. This concept differs from that of NFPA *101*, in which the occupant load is determined by dividing the floor area by an occupant load factor assigned to that use. Applying the NFPA *101* approach to determine the station platform occupant load is inappropriate.

C.1.1 Calculating Occupant Load. Projected ridership figures serve as the basis for determining transit system design. Per this standard, the methodology used to determine ridership figures must also include peak ridership figures for new transit systems and existing operating systems. Events at stations such as civic centers, sports complexes, and convention centers that establish occupant loads not included in normal passenger loads must also be included. These ridership figures serve as the basis for calculating train and entraining loads and the station occupant load. The methodology used for determining passenger ridership figures can vary by transit system. The use of statistical methods for determining *calculated train loads* and *calculated entraining loads* will provide a more accurate indication of the required means of egress facilities within a station.

C.1.2 Calculating Evacuation Time. The total evacuation time is the sum of the walking travel time for the longest exit route plus the waiting times at the various circulation elements. The trainway can be considered as an auxiliary exit from the station under certain fire scenarios.

The waiting time at each of the various circulation elements is calculated as follows:

(1) For the platform exits, by subtracting the walking travel time on the platform from the platform exits flow time
(2) For each of the remaining circulation elements, by subtracting the maximum of all previous element flow times

The symbols used in the sample calculations in this annex represent the walking times, flow times, and waiting times as follows:

T = total walking travel time for the longest exit route

T_p = walking travel time on the platform

T_X = walking travel time for the Xth segment of the exit route

F_p = platform exits flow time

F_{fb} = fare barrier flow time

F_c = concourse exits flow time

F_N = flow time for any additional circulation element

$W_p = F_p - T_p$ = waiting time at platform exits

$W_{fb} = F_{fb} - F_p$ = waiting time at fare barriers

$W_c = F_c - \max(F_p \text{ or } F_{fb})$ = waiting time at concourse exits

$W_N = F_N - \max(F_c, F_{fb}, \text{ or } F_p)$ = waiting time at any additional circulation element

Note that the waiting time at any circulation element cannot be less than zero.

C.1.3 Center-Platform Station Sample Calculation. The sample center-platform station is an elevated station with the platform above the concourse, which is at grade *(see Figure C.1.3)*. The platform is 183 m (600 ft) long to accommodate the train length. The vertical distance from the platform to the concourse is 9.1 m (30 ft).

The sample station has one paid area separated from the outside by a fare array containing four electronic fare gates and one 1220 mm (48 in.) handicapped/service gate. In addition, two 1830 mm (72 in.) wide emergency exits are provided. Six open wells communicate between the platform and the concourse. Each well contains one stair or one escalator. Station ancillary spaces are located at the concourse level.

Elevators (not shown in Figure C.1.3) are provided for use by handicapped persons or service personnel. Open emergency stairs are provided at each end of the platform and discharge directly to grade through grille doors with panic hardware.

Escalators are nominal 1220 mm (48 in.) wide. Stairs regularly used by patrons are 1830 mm (72 in.) wide, and emergency stairs are 1220 mm (48 in.) wide. Gates to emergency stairs are 1220 mm (48 in.) wide.

The station occupant load is 2314 persons.

Table C.1.3 lists the data for the exiting analysis of the sample center-platform station.

Test No. 1. Evacuate platform occupant load(s) from platform(s) in 4 minutes or less.

$$F_p \text{ (time to clear platform)} = \frac{\text{Platform occupant load}}{\text{Platform exit capacity}}$$

$$F_p = \frac{2314}{609}$$

$$F_p = 3.80 \text{ minutes}$$

In Test No. 1, the time to clear the platform is found to be 3.80 minutes. This meets the requirement of 5.3.3.1.

Test No. 2. Evacuate platform occupant load from most remote point on platform to a point of safety in 6 minutes or less.

W_p (waiting time at platform exits) $= F_p - T_1$

$W_p = 3.80 - 1.09 = 2.71$ minutes

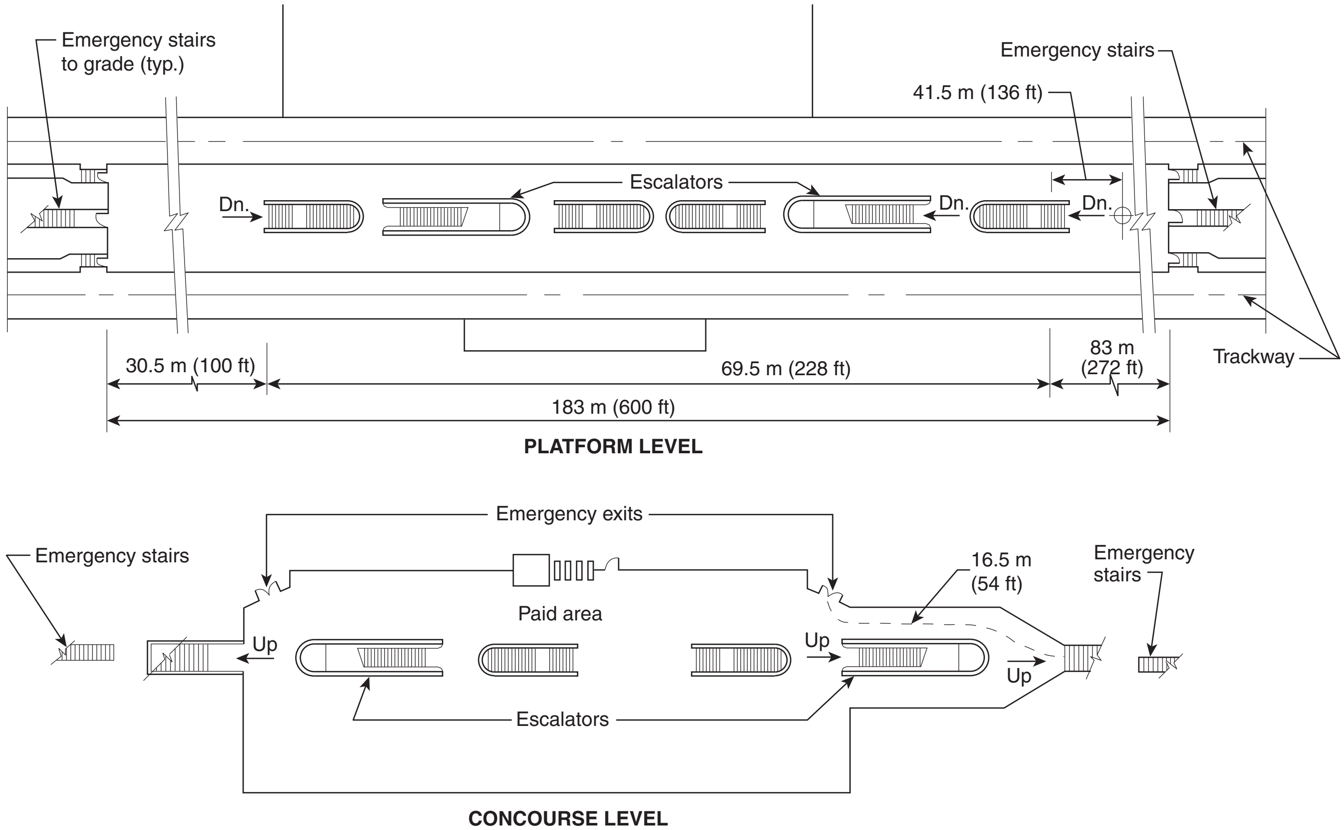

FIGURE C.1.3 Center-Platform Station.

Concourse occupant load = Platform occupant load – (F_p × emergency stair capacity)

Concourse occupant load = 2314 – 513 = 1801 persons

W_{fb} (waiting time at fare barriers) = $F_f - F_p$

$$F_{fb}\left(\text{fare barrier flow time}\right) = \frac{\text{Concourse occupant load}}{\text{Fare barrier exit capacity}}$$

$$F_{fb} = \frac{1801}{560} = 3.22 \text{ minutes}$$

$W_c = F_{fb} - F_p$

$W_{fb} = 3.22 - 3.80 = 0.000$ minutes

W_c (waiting time at concourse exits) = $[F_c - \max\,(F_{fb} \text{ or } F_p)]$

$$F_c\left(\text{concourse exit flow time}\right) = \frac{\text{Concourse occupant load}}{\text{Concourse exit capacity}}$$

$$F_c = \frac{1801}{0} = 0.000 \text{ minutes}$$

$W_c = F_c - \max(F_{fb} \text{ or } F_p)$

$W_c = 0.000 - 3.80 = 0.000$ minutes

Total exit time = $T + W_p + W_{fb} + W_c$

Total exit time = 2.23 + 2.71 + 0.000 + 0.000

Total exit time = 4.94 minutes

In Test No. 2, the time to reach a point outside any enclosing structure is found to be 4.94 minutes. This meets the requirement of 5.3.3.2.

If the concourse of this station is considered to meet the point of safety definition by the authority having jurisdiction, the calculation for Test No. 2 would be modified. The time to reach a point of safety would include the walking travel time from the remote point on the platform to the concourse only, plus the waiting time at the platform exits. The area of the concourse would have to be large enough to accommodate the concourse occupant load calculated in Test No. 2.

C.1.4 Side-Platform Station Sample Calculation. The sample side-platform station is an enclosed station with a concourse above the platform level but below grade. *(See Figure C.1.4.)* The platform is 183 m (600 ft) long to accommodate the train length. The vertical distance from grade to concourse is 8 m (26 ft). The concourse is 5.5 m (18 ft) above the platform.

The sample station has two entrances normally used by patrons, each containing one escalator and one stair. The entrances are covered at grade level to a point 3.05 m (10 ft) beyond the top of the stairs.

The concourse is divided into two free areas and one paid area separated by fare arrays. Each fare array contains 12 fare gates of the turnstile type and one swinging service gate, 1220 mm (48 in.) wide, equipped with panic hardware for use by handicapped persons and service personnel.

Three open wells, containing two stairs and one escalator, communicate between each platform and the concourse.

Elevators are provided from grade level to concourse and from the concourse to each platform for use by handicapped persons and service personnel. Station ancillary spaces are located at concourse level.

Enclosed emergency stairs that discharge directly to grade are provided at both ends of each platform. Escalators are nominal

Table C.1.3 Sample Calculations — Center-Platform Station

Egress Element	mm	in.	p/mm-min	pim	p/min
Platform to concourse (downward)					
Stairs (4)	7320	288	0.0555	1.41	406
Escalators (2*)	1220	48	0.0555	1.41	68
Emergency stairs (2)	2440	96	0.0555	1.41	135
Escalator test: 8.67% (Not > 50%)					609
Through fare barriers					
Fare gates (4) (capacity = 50 per gate)					200
Service gates (1)	1 gate	1 gate	60p/gate/min	60p/gate/min	60
Emergency exit doors (2 x double doors)	3660	144	0.0819	2.08	300
					560
Fare barriers to safe area (fare barriers discharge to outside)					
Stairs	0	0	0.0555	1.41	0
Escalators	0	0	0.0555	1.41	0
Emergency stairs	0	0	0.0555	1.41	0
Escalator test: 0.00% (Not > 50%)					0
Walking Time for Longest Exit Route	**m**	**ft**	**m/min**	**fpm**	**min**
Platform to safe area					
On platform, T_1	41.5	136	37.7	124	1.09
Platform to concourse, T_2	9.1	30	14.6	48	0.62
On concourse, T_3	16.5	54	37.7	124	0.44
Concourse to grade, T_4	0	0	14.6	48	0
On grade to safe area, T_5	3.05	10	37.7	124	0.08
Total walking time, $T = T_1 + T_2 + T_3 + T_4 + T_5$					2.23

*One escalator discounted.

1220 mm (48 in.) wide. Stairs regularly used by patrons are 1830 mm (72 in.) wide. Emergency stairs are 1220 mm (48 in.) wide. Doors to emergency stairs are 1220 mm (48 in.) wide.

The station occupant load is 1600 persons, 228 on the outbound platform and 1372 on the inbound platform.

Table C.1.4 lists the data for the exiting analysis of the sample side-platform station.

The egress capacity from platform to concourse meets the criteria of 5.3.3.1 in Test No. 1, where the time to clear the platform is found to be 3.38 minutes for the inbound platform and 0.56 minute for the outbound platform.

In Test No. 2, the total exit time (i.e., the maximum exit time for the two paths examined) is found to be 5.85 minutes. This meets the criteria of 5.3.3.2.

Evacuate platform occupant load(s) from platform(s) in 4 minutes or less.

Inbound platform:

$$F_{p-i}\left(\text{time to clear platform}\right) = \frac{\text{Platform occupant load}}{\text{Platform egress capacity}}$$

$$F_{p-i} = \frac{1372}{406}$$

$$F_{p-i} = 3.38 \text{ minutes}$$

Outbound platform:

$$F_{p-o}\left(\text{time to clear platform}\right) = \frac{\text{Platform occupant load}}{\text{Platform egress capacity}}$$

$$F_{p-o} = \frac{228}{406}$$

$$F_{p-o} = 0.56 \text{ minutes}$$

F_p for inbound and outbound occupant loads satisfies the criterion of 4 minutes.

Test No. 2. Evacuate platform occupant load from most remote point on platform to a point of safety in 6 minutes or less.

Inbound platform:

W_{p-i} (waiting time at platform egress elements) = $F_{p-i} - T_{1_{p-i}}$

$W_{p-i} = 3.38 - 1.33 = 2.05$ minutes

Concourse occupant load = Platform occupant load – (F_{p-i} × emergency stair capacity)

Concourse occupant load = 1372 – 456 = 916 persons

Outbound platform:

W_{p-o} (waiting time at platform egress elements) = $F_{p-o} - T_{1_{p-o}}$

$W_{p-o} = 0.56 - 0.49 = 0.07$ minute

Concourse occupant load = Platform occupant load – (F_{p-o} × emergency stair capacity)

Concourse occupant load = 228 – 76 = 152 persons

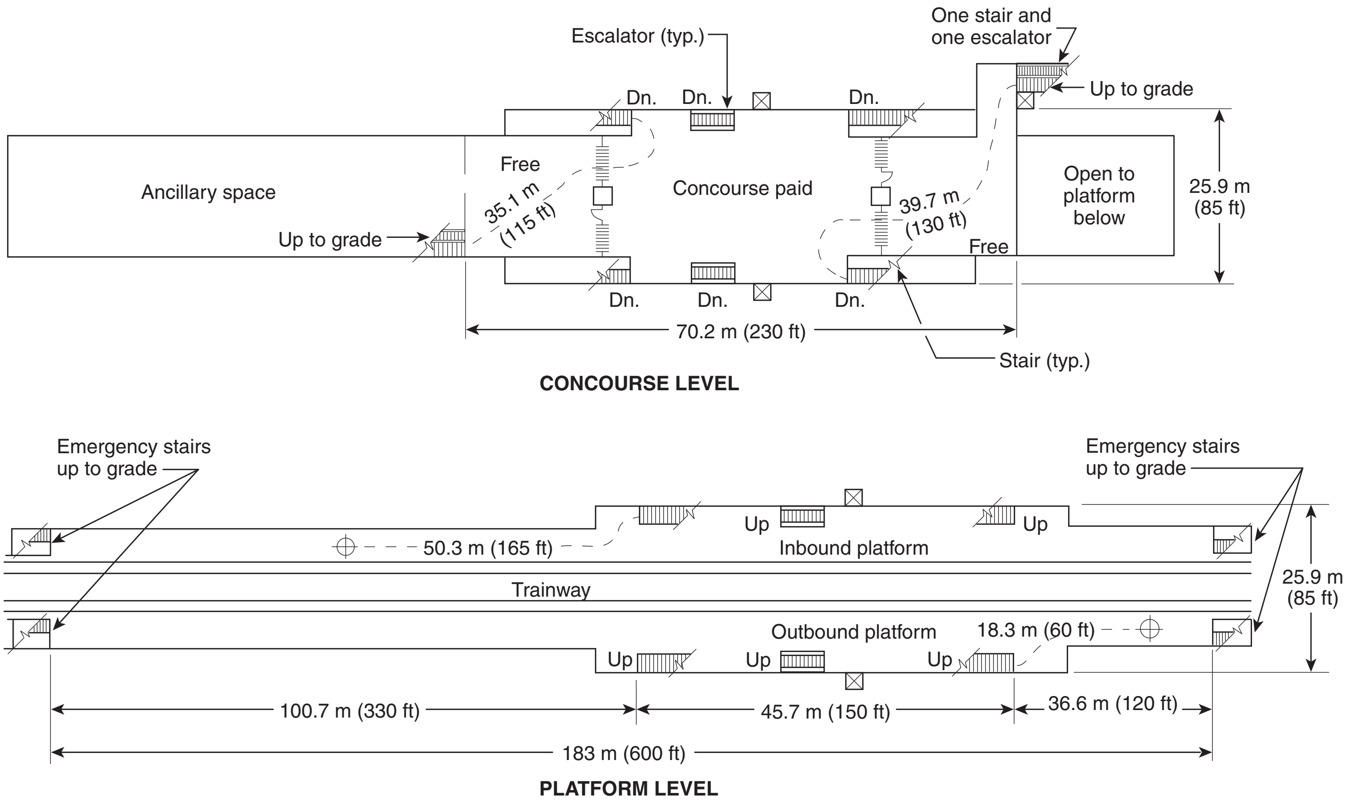

FIGURE C.1.4 Side-Platform Station.

Total concourse occupant load = Concourse load (inbound) + Concourse load (outbound)

Total concourse occupant load = 916 – 152 = 1068 persons

Inbound platform:

W_{fb} (waiting time at fare barriers) = $F_{fb} - F_{p-i}$

$$F_{fb} = \frac{\text{Concourse occupant load}}{\text{Fare barrier egress capacity}}$$

$$F_{fb} = \frac{533}{399}$$

F_{fb} = 1.34 minutes

$W_{fb} = F_{fb} - F_{p-i}$

W_{fb} = 1.34 – 3.66 = 0.00 minutes

W_c (waiting time at concourse egress elements) = $F_c - \max(F_{fb} \text{ or } F_{p-i})$

$$F_c\left(\text{concourse flow time}\right) = \frac{\text{Concourse occupant load}}{\text{Concourse egress capacity}}$$

$$F_c = \frac{533}{94}$$

F_c = 5.68 minutes

$W_c = F_c - \max(F_{fb} \text{ or } F_{p-i})$

W_c = 5.68 – 3.66 = 2.02 minutes

Outbound platform:

W_{fb} (waiting time at fare barriers) = $F_{fb} - F_{p-o}$

$$F_{fb} = \frac{\text{Concourse occupant load}}{\text{Fare barrier egress capacity}}$$

$$F_{fb} = \frac{533}{399}$$

F_{fb} = 1.34 minutes

$W_{fb} = F_{fb} - F_{p-o}$

W_{fb} = 1.34 – 0.61 = 0.73

W_c (waiting time at concourse egress elements) = $F_c - \max(F_{fb} \text{ or } F_{p-o})$

$$F_c = \text{(concourse flow time)} = \frac{\text{Concourse occupant load}}{\text{Concourse egress capacity}}$$

$$F_c = \frac{533}{156}$$

F_c = 3.42 minutes

$W_c = F_c - \max(F_{fb} \text{ or } F_{p-o})$

W_c = 3.42 – 1.34 = 2.08 minutes

Total egress time = $T + W_p + W_{fg} + W_c$

Inbound platform:

Total = 3.49 + 2.32 + 0.00 + 2.02

Total = 7.83 minutes

Outbound platform:

Total = 2.76 + 0.12 + 0.73 + 2.08

Total = 5.69 minutes

Table C.1.4 Sample Calculations — Side-Platform Station

Egress Element	mm	in.	p/mm-min	pim	p/min
Inbound platform to concourse (upward)					
Stairs (2)	3660	144	0.0555	1.41	203
Escalators (1*)	1220	48	0.0555	1.41	68
Emergency stairs (2)	2440	96	0.0555	1.41	135
					406
Walking Time for Longest Exit Route	**m**	**ft**	**m/min**	**fpm**	**min**
Inbound platform					
On platform, T_1	50.3	165	37.7	124	1.33
Platform to concourse, T_2	5.5	18	14.6	48	0.38
On concourse, T_3	35.1	115	37.7	124	0.94
Concourse to grade, T_4	7.9	26	14.6	48	0.54
On grade to safe area, T_5	3.05	10	37.7	124	0.08
Total walking time, $T = T_1 + T_2 + T_3 + T_4 + T_5$					3.26
Element	**mm**	**in.**	**p/mm-min**	**pim**	**p/min**
Outbound platform to concourse (upward)					
Stairs (2)	3660	144	0.0555	1.41	203
Escalators (1*)	1220	48	0.0555	1.41	68
Emergency stairs (2)	2440	96	0.0555	1.41	135
					406
Walking Time for Longest Exit Route	**m**	**ft**	**m/min**	**fpm**	**min**
Outbound platform					
On platform, T_1	18.2	60	37.7	124	0.49
Platform to concourse, T_2	5.5	18	14.6	48	0.38
On concourse, T_3	39.6	130	37.7	124	1.05
Concourse to grade, T_4	7.9	26	14.6	48	0.54
On grade to safe area, T_5	3.05	10	37.7	124	0.08
Total walking time, $T = T_1 + T_2 + T_3 + T_4 + T_5$					2.54
Concourse:					
Throughfare barriers					
Turnstiles (12) capacity = 25 p/min					300
Service gate (1)	1 gate	1 gate	60p/gate/min	60p/gate/min	60
					360
Fare barriers to safe areas					
Stairs (2)	3660	72	0.0555	1.41	204
Escalator (2*)	1220	48	0.0555	1.41	68
					272

*One escalator discounted (5.3.6).

C.1.5 Multilevel-Platform Stations. The procedures for calculating exiting times for multilevel platform stations are similar to the sample calculations in C.1.3 and C.1.4. The changes in the exiting calculations are for multilevel-platform stations primarily a function of the concurrent occupant load determinations for the two platform levels.

The step-by-step procedure relating to the occupant load calculations generally is recommended as follows:

(1) Calculate the occupant load for each platform level as in the appropriate examples in C.1.3 and C.1.4 for the same assumed time(s) of day. Refer also to 5.3.2.3(2) and A.5.3.2.3(2).

(2) If the fire is on the upper-level platform (for an underground station), an assumption can be made as to the percentage of occupants who might be expected to evacuate the lower level through the normal egress routes versus the percentage who might be expected to exit via emergency stairs. These assumptions will be unique for each system as a function of various parameters, including physical configuration of stations, means of egress, and location of emergency exits; communications facilities to advise passengers, both verbal and signing; level of transit personnel working in stations; and transit personnel emergency procedure responsibilities established for the transit operating authority.
(3) The upper-level occupant load is increased by the people evacuating from the lower level through the normal egress routes in accordance with C.1.5(2).
(4) For a fire on the lower level, appropriate assumptions relative to the distribution of the occupant loads to the available means of egress are calculated in a fashion similar to the procedures described above.

The remainder of the exiting calculations essentially are unchanged from the other sample calculations in C.1.3 and C.1.4.

C.2 Escalators. ANSI/ASME A17.1/CSA B44 is generally recognized as the standard governing the installation and maintenance of escalators.

However, considering the critical operational nature of the escalators in stations, specially designed units with additional safety features should be provided.

The number of flat steps at the upper landings should be increased in proportion to the vertical rise of the escalator. For a rise up to 6.1 m (20 ft), there should be two flat steps, the ANSI/ASME A17.1/CSA B44 minimum number of flat steps; from 6.1 m (20 ft) to 18.3 m (60 ft) rise, three flat steps; and over 18.3 m (60 ft) rise, four flat steps.

A remote monitoring panel should be provided in the station that displays the following for each escalator:

(1) Direction of travel
(2) Operating speed (if more than one)
(3) Out-of-service status
(4) Flashing light that indicates the escalator is stopped because of activation of a safety device

Annex D Rail Vehicle Fires

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Introduction. This annex provides additional information on the hazards associated with burning vehicles and the impact of a burning vehicle on the evacuation of passengers and crew to a point of safety. Emergency evacuation from a vehicle containing a fire could include exiting a vehicle containing the fire to an adjacent vehicle, exiting the train into the operating environment (station, tunnel, etc.) where the train is located, and moving through the operating environment to the point of safety. Chapter 8 contains minimum prescriptive requirements that are intended to provide sufficient time for passengers and crew to safely evacuate from a train containing a fire. This annex provides guidance for designing and evaluating train fire performance. A fire involving a train will have an impact on the conditions in the operating environment, and this type of fire is often used to design emergency systems in operating environments. Chapters 5 through 7 provide requirements on design of the operating environment to ensure that passengers can safely egress to a point of safety.

D.2 Initial Fire Development Inside Vehicles. The development of a fire inside a vehicle is dependent on the fire performance of interior finish materials, the size and location of the initiating fire, the size of the enclosure where the fire is located, and the ventilation into the enclosure.

D.2.1 Material fire performance is most often considered in the evaluation of fire performance of the vehicle. Material fire performance is measured in terms of ignitibility, heat release rate, and smoke and toxic gas production. Flame spread and fire development are dependent on the material's ignitibility and heat release rate as well as the severity of the initiating fire and surrounding environment.

D.2.1.1 The ignitibility, heat release rate, and smoke and toxic gas production can be measured in the ASTM E 1354 cone calorimeter. It is recommended that all combustible materials on a train be tested in the cone calorimeter. At a minimum, tests should be conducted at a heat flux of 50 kW/m^2 in duplicate. For a more detailed evaluation of the material performance, cone calorimeter tests should be performed at three different heat fluxes where the material ignites (e.g., 25, 50, and 75 kW/m^2). The cone calorimeter can also be used to measure the critical heat flux of the material, which is the lowest heat flux at which the material will ignite. The critical heat flux can be used to determine the ignition temperature of the material. Analysis to predict flame spread along materials will require the more detailed set of cone calorimeter data along with the critical heat flux of the material.

D.2.1.2 In Chapter 8, the minimum fire performance of many interior finish materials is required to be measured using the ASTM E 162 flame spread test. Though this downward flame spread test will screen out many poorly performing materials, the test does not provide a measure of wind-aided flame spread (i.e., upward flame spread or flame spread along a ceiling). Wind-aided flame spread is the fastest type of flame spread and is the type of flame spread that will cause the maximum surface area of material to become involved in the fire. The amount of upward flame spread is affected by the size of the initiating fire and the material fire performance. Some materials might not exhibit any flame spread when exposed to a small fire (e.g., a newspaper fire), but when exposed to something slightly larger (e.g., burning bag of trash with paper and plastic) will readily spread flame.

D.2.1.3 Smoke and toxic gas production can have an impact on the operating environment through which passengers will need to evacuate. Some materials naturally produce more smoke and toxic gases. Some fire-retardant additives can cause more smoke and toxic gases to be produced compared to untreated materials. The amount of smoke and toxic gas produced will be a function of the amount of material burning. Therefore, limiting fire propagation on materials will also help limit the amount of smoke and toxic gas production.

D.2.2 The size and location of the initiating fire will have a significant impact on whether materials become ignited and spread flame. Materials exposed to higher levels of heat (heat fluxes) will ignite more readily, release more heat, and usually will result in more flame spread. Research has shown that increasing the physical size and the heat release rate of the fire will increase the heat flux produced by the initiating fires. Increasing the heat release rate of the fire will also increase the flame height, which will expose larger areas of material to the high heat fluxes in the flaming region. The location of the initiating fire will also affect the heat fluxes produced by the fire. For the same size fire, higher heat fluxes are produced when the fire is located in a corner instead of against a flat wall.

D.2.3 The gas temperature inside of the enclosure containing a fire can have a significant impact on the growth rate of the fire. Elevated gas temperatures will pre-heat unignited material and will potentially accelerate flame spread across the material. Gas temperatures in an enclosure can be affected by the size of the enclosure, the ventilation into the enclosure, and the heat release rate of the fire. The gas temperature will increase when the enclosure size is decreased and the heat release rate is increased.

D.3 Fire Development Outside Vehicles. Outside a vehicle, flames can spread along continuous pieces of combustible materials or ignite adjacent materials if exposed to sufficient heat. Underneath vehicles, combustible items that are adequately spaced will prevent the spread of fire. If the car is moving, flames can be longer, making safe separation distances longer. It might also be possible for flames from fires underneath vehicles to extend out to the sides and ends of the vehicle. These undercar fires can ignite and initiate flame spread along combustible materials on the sides and ends of the vehicle. Combustible materials on the sides and ends of the vehicle might also be vulnerable to other types of fires that could occur on the exterior of the vehicle.

D.3.1 An increasing amount of the exterior vehicle body is being manufactured of fiber-reinforced resin composite materials. End caps have been made of composite materials for years, and other vehicle body components are being constructed of composite materials to make vehicles lighter in weight. Even if these materials meet the ASTM E 162 requirement in Chapter 8, they can ignite and flames can spread up the height of the vehicle exterior.

D.3.2 Initiating fires on the exterior of the vehicle could range from a small trash fire to a vehicle fire. Although the trash fire might be small, it could be possible for it to ignite combustible components on the exterior and for flames to spread up the vehicle. Some trains are operated in close proximity to automobiles. Automobile fires can become quite large (~5 MW) and can include fuel spills. If such a fire occurred close to a train, the fire could ignite nearby combustible exterior components on the vehicle.

D.3.3 Connections between vehicles can be particularly vulnerable to exterior fires. Some vehicles are connected by articulating bellows, which are constructed of relatively thin, flexible, combustible materials. The materials used for these components should be carefully screened to ensure that exterior fires do not extend into the vehicle before passengers have been safely evacuated.

D.3.4 Spread of fire from one vehicle to an adjacent vehicle can cause the total heat release rate of the train fire to significantly increase. This could occur if the fire on the outside of one vehicle radiates enough heat to ignite the combustible components of the adjacent vehicle. Vehicle-to-vehicle spread could also occur if a fire inside a vehicle has reached flashover and flames extending outside of the vehicle through windows or doors are able to ignite the nearby vehicle.

D.4 Vehicle Fire Heat Release Rate History. The heat release rate history of a vehicle fire should include the heat release rate during all stages of the fire. Fires inside of vehicles that are allowed to grow sufficiently large can reach flashover, where all of the items inside of the vehicle ignite. The largest heat release rates are expected after flashover occurs (i.e., postflashover). The heat release rate during postflashover is particularly important since many tunnel and station smoke control system designs are based on the maximum expected heat release rate. The heat release rate of the vehicle fire will also affect the heat that passengers could be exposed to during evacuation. The magnitude of the heat release rate during postflashover will be a function of the amount of air drawn into the vehicle, the material fire properties, and the potential heat release rate of the burning fuels inside of the vehicle.

D.4.1 The fire properties of a material will determine the impact of the material on the postflashover fire conditions. The postflashover fire is a balance of heat gains and heat losses. As a result, the ratio between the material heat of combustion and heat of gasification is particularly important. The heat of combustion is the amount of energy produced per gram of material burned (heat gain), while the heat of gasification is the energy required to convert solid material into gas (heat loss). If this ratio is high (heat of combustion several times greater than the heat of gasification), then the material will contribute more heat to the fire compared with the amount it takes to produce the gas. This scenario will result in a more intense fire. As the ratio becomes closer to 1, the fire will burn with less intensity. Depending on the conditions, materials with a ratio close to 1 might not be able to self-support a postflashover fire environment.

D.4.2 The amount of air drawn into a postflashover fire will be a function of the number of ventilation openings. Initially, this could be doors or windows where passengers have evacuated from the train. Many vehicles will contain mostly polycarbonate windows. As the fire continues to burn, polycarbonate windows will thin and begin to develop holes (Strege et al.). Glass windows will crack, shatter, and fall out. Eventually, these areas will be completely open to allow air in and smoke to exhaust from the vehicle fire.

D.4.2.1 The impact of additional ventilation openings is dependent on the heat losses and gains to the vehicle fire. Additional openings will allow more energy to be lost from the vehicle fire through radiation and convection. However, the additional air into the vehicle fire allows more heat to be released inside the vehicle. If the fuels inside the vehicle can produce a heat release rate, then the fire will burn at that higher heat release rate. It is also possible that when the windows fail, the energy losses might outweigh the heat that can be produced by the materials, and the fire will begin to diminish in size. This also happens when the fire begins to go into the decay stage: the fire inside of the vehicle can no longer produce sufficient heat to outweigh the heat losses.

D.4.3 The heat release rate of the train fire will also affect the amount of heat the passengers are exposed to during the evacuation. Larger heat release rate fires will produce longer flames that could extend out of the vehicle openings. If the vehicle is inside a tunnel, these flames could impinge on the ceiling and extend down away from the burning vehicle. Radiation from these flames to nearby evacuating passengers could be significant.

D.5 Volume of Smoke Produced by Burning Vehicles.

D.5.1 The volume of smoke produced by a fire is dependent on the entrainment into the smoke plume. The entrainment into the smoke plume varies depending on the geometry. For example, a free-burning circular pool fire will produce a different volume of smoke compared with the same heat release rate fire burning in a line. Natural or ventilation-induced air currents can have an impact on entrainment.

D.5.2 Volume of smoke from fires inside of vehicles will be exhausted out of the vehicle through open doors or window openings. As a result, the volume of smoke produced by a vehicle fire will be the smoke volume produced by a series of window plumes. The volume of smoke produced will be dependent on how high the gases are allowed to rise before they impinge on the ceiling or reach the upper smoke layer interface.

D.5.3 Volume of smoke from undercar fires or fires involving the outside of the vehicle can be modeled by assuming that the fire is a line fire. The volume of smoke produced will be dependent on how high the gases are allowed to rise before they impinge on the ceiling or reach the upper smoke layer interface.

Annex E Fire Hazard Analysis Process

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 Introduction. This annex was prepared to provide expanded understanding of the process required to conduct a fire hazard analysis for fixed guideway and passenger rail vehicles. NFPA *101* [1] and other cited references provide more complete information.

E.2 Fire Hazard Analysis. The prescriptive-based vehicle fire performance requirements in Chapter 8 of this standard are based on individual material tests. With the use of the fire hazard analysis process, it should be possible to ascertain the fire performance of vehicle materials and assemblies in the context of actual use. The result of such a fire hazard analysis should be a clear understanding of the role of materials, geometry, and other factors in the development of fire in the specific vehicles studied. By identifying when or if specific conditions are reached such that materials begin to contribute to the fire hazard, fixed guideway transit and passenger rail systems vehicle designers and authorities having jurisdiction will have a better foundation on which to base appropriate vehicle and system design and the evaluation of the fire performance of such vehicle designs. By showing the relative contribution of a particular design feature or material, it is possible to make a more realistic assessment of the necessity for specific vehicle design requirements to meet fire/life safety objectives and criteria.

The *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* [2] provides a framework for these assessments. Other useful references include ASTM E 2061 [3] and APTA RP PS-005-01a [4]. On May 12, 1999, the Federal Railroad Administration (FRA) issued a rule containing passenger rail equipment fire safety regulations [5]. The FRA issued a clarification/revision of the fire safety regulations on June 25, 2002 [6]. 49 CFR 238.103 requires that materials used for passenger rail cars and locomotive cabs meet certain fire safety performance criteria and that fire safety (e.g., hazard) analysis be conducted for all new and existing rail passenger equipment.

In addition, scenarios are used to assess the adequacy of vehicle designs considered and ultimately selected. Accordingly, initiating events as referenced from the ASTM rail fire assessment guide [3] are specified for analysis. Although developed for the analysis of existing equipment, the APTA-recommended fire safety practice provides a framework and resources for the application of fire hazard analysis in vehicles that might be applicable to new or retrofitted equipment.

Finally, it is important to note that the fire hazards relating to the vehicle-operating environment must be considered.

If the outcome predicted by assessment of the scenarios evaluated is bound by the performance criteria stated, then the objectives will have been met, and the life safety characteristics of a proposed vehicle design can be considered to be consistent with the goals of this standard. It must be assumed that if a design fails to comply with the life safety goals and objectives and associated performance criteria, the design must be changed and reassessed iteratively until satisfactory performance levels are attained.

On June 25, 2002, the FRA published a Federal Register Notice that clarified several items relating to the fire tests and performance criteria, and revised certain parts of the fire safety analysis requirements [6].

Documentation of assessment parameters, such as those used with scenarios, is critical. The approval and acceptance of a fire/life safety design is dependent on the quality of the documentation used in this process.

E.3 Overview of Fire Hazard Analysis Process for Vehicles. The information in this section is based on a research study sponsored by the FRA. Additional details of the research program are available [7].

ASTM E 2061 [3] provides resources and references for the application of fire hazard analysis techniques to rail vehicles but is not intended to provide a specific prescriptive standard or method. Part of the purpose of NFPA 130 is to provide such a specific method for the application of fire hazard analysis tools and the ASTM guide when applied to specific vehicle designs.

Traditionally, fire hazard analysis techniques involve a four-step process for the evaluation of a product or products in a specific scenario. The four steps are as follows:

(1) Define the context.
(2) Define the scenario.
(3) Calculate the hazard.
(4) Evaluate the consequences. [8]

For the analysis of vehicles, this process limits the evaluation to the contribution of specific materials and products without providing an overall assessment of the fire performance of the entire system.

The traditional four-step evaluation process can be extended to better reflect the minimum appropriate performance of the overall vehicle system while maintaining the evaluation of a specific design compared against the required baseline. For this systems-based analysis, the process is also conducted in four steps, as follows:

(1) Define vehicle performance objectives and design.
(2) Calculate vehicle fire performance.
(3) Evaluate specific vehicle fire scenarios.
(4) Evaluate vehicle car design suitability.

Steps 1 and 4 are largely subjective and depend on the expertise of the user. Step 2 can involve hand calculations or some use of computer modeling software. The heart of Step 2 is a sequence of procedures to calculate the development of hazardous conditions over time, to calculate the time needed by occupants to escape under those conditions, and to estimate the resulting effects on the vehicle occupants, based on tenability criteria. In addition to evaluating the hazard resulting from specific materials and components used in the vehicle design, Step 2 determines the worst-case fire that allows the overall vehicle system to meet chosen design criteria. Step 3 evaluates the specific fires that are likely to occur. Step 4 compares the results of Steps 2 and 3 and evaluates the appropriateness of the calculations performed, as well as determines whether the proposed design meets the performance objectives and design established in Step 1. The procedure in Table E.3 shows each step in the process tailored for rail vehicle design.

E.3.1 Step 1: Define Vehicle Performance Objectives and Design. Both the proposed performance objectives and the vehicle design must be defined. Clear goals and objectives with well-defined acceptance criteria quantify the minimum acceptable performance that must be met in the final vehicle design. These will all be provided by the responsible fixed guideway transit or passenger railroad system, by the authorities having jurisdiction, and by expert engineering judgment based on the performance of the existing acceptable vehicle designs and the operating environment. For example, an objective might be to provide life safety for passengers in the event of a fire or to minimize damage to property. Performance criteria are more specific and might include limits on temperature of materials, gas temperatures, smoke concentration or obscuration levels, concentration of toxic gases, or radiant heat flux levels, to allow for sufficient time to evacuate occupants to a point of safety.

The analysis requires a detailed understanding of the geometry (e.g., configuration) of the system being considered, including construction materials, sizes, and connections for all compartments, typical furnishings, and other design parameters that might affect the fire. Such parameters might include fire detection or suppression systems, ventilation systems, and emergency exits and procedures.

E.3.2 Step 2: Calculate Vehicle Fire Performance. The second step determines the response of the vehicle system to a range of chosen design fires. This response can be expressed in the form of one or more fire performance graph(s), which present the calculated design criterion as a function of the size of the fire. In addition, the minimum acceptable performance criteria are determined by calculation or specification. For example, a fire performance graph might show the available egress time as a function of the fire size in a vehicle, and the minimum acceptable performance criterion might be the time necessary for passengers to safely evacuate the vehicle. These criteria can be specified by the fixed guideway transit or passenger railroad system, by authorities having jurisdiction, or by expert engineering judgment based on the performance of the existing acceptable designs.

Table E.3 System of Vehicle Fire Hazard Analysis Steps

Step 1: Define vehicle performance objectives and design.	(a) Clearly define fire performance objectives. (b) Determine the geometry of the vehicle. (c) Include other design parameters that might have an impact on a possible fire, such as a tunnel operating environment, material controls, fire detection and suppression, or other system procedures.
Step 2: Calculate vehicle fire performance.	(a) Determine minimum acceptable performance criteria based on the vehicle design. (b) Establish standard design fires. (c) Use predictive calculation and/or model calculations, to determine the fire performance of the proposed design for a range of design fires. (d) Create a fire performance graph.
Step 3: Evaluate specific vehicle fire scenarios.	(a) Examine relevant fire incident experience with same/similar applications. (b) Identify the likely role/involvement of application contents in fire. (c) Ask which fires are most common/likely? Most challenging? (d) Quantify the burning behavior for chosen scenarios from available fire test data or appropriate small- and large-scale tests.
Step 4: Evaluate suitability of vehicle design.	(a) Estimate through expert judgment, regulatory guidance, and, when needed, complementary small- and large-scale tests the effects of unknowns not accounted for in the fire performance graphs. (b) Establish the sensitivity of the fire performance graph to known inputs. (c) Set appropriate design margins. (d) Determine the acceptability of the design.

Once the detailed problem has been defined, this information can be used as input to a hand calculation or computer fire model to predict conditions within each compartment of the vehicle as a function of time. For this analysis, these conditions include temperature, hot gas layer position (typically termed *interface height*), visibility, and toxic gas concentrations throughout the car. These conditions are used to calculate tenability within the car. Conditions are considered untenable when there is a threat to passenger life safety, evaluated as an elevated temperature, products of combustion exposure, or a combination of the two. The time at which conditions within the vehicle become untenable for each design fire are plotted as a function of the size of the design fire to produce a fire performance graph for each application.

The calculation of minimum necessary egress time, whether from a building or a vehicle, involves many assumptions. Several models can be used to increase the confidence in the egress time calculation. It is important to remember that the minimum necessary egress time does not include panic, scattered luggage in a postcrash vehicle, or bodily injury to occupants prior to evacuation commencement. An appropriate design margin applied to the model time should account for such limitations. Typically, a factor of 2 is used as a design margin [9].

E.3.3 Step 3: Evaluate Specific Vehicle Fire Scenarios. Step 3 evaluates possible vehicle fire scenarios in order to place the fire performance curves in context and to allow the designer to adopt reasonable design margins in the final vehicle design evaluation in Step 4. A significant amount of information relevant to scenario definition can be obtained from historical fire incident experience [10, 11]. Databases such as the National Fire Incident Reporting System (NFIRS) contain relevant vehicle data, normally segregated into specific categories [12].

Representative fire scenarios include the following:

(1) Ignition under a seat by a small source (e.g., crumpled newspaper)
(2) Ignition source on top of a vandalized seat (e.g., crumpled newspaper)
(3) Overheated equipment (e.g., electrical, HVAC)

The location of the train must be also considered in the analysis. For example, the fire risk to occupants is greater if the train is located between stations or within a tunnel.

More detailed information describing passenger-carrying vehicle fire scenarios is contained in the ASTM guide and the APTA recommended practice cited earlier in Section E.2. Relevant data describing specific fires appropriate for the vehicle application are defined and used as input to the same fire model used in Step 2. The results of these model calculations can be compared to the design fires used in Step 2 to define appropriate design margins for analysis.

E.3.4 Evaluate Suitability of Vehicle Design. Taking into account the results of the calculations and using engineering judgment, experience, and the requirements of the authorities having jurisdiction, an appropriate design margin is decided upon and applied to the minimum acceptable criteria. If the worst-case vehicle fire scenarios are all less hazardous than the minimum criteria multiplied by the design margin, then the vehicle design is said to be acceptable.

Finally, the results of any analysis should be challenged by the user's common sense and experience. Results that violate these should be questioned and resolved. Comparisons should be made to data from similar experiments or actual passenger train fires wherever possible. If such data are not available, it might be advisable to conduct verifying tests in situations where public safety is at risk.

The outcome of the fire hazard analysis will be a statement of whether the vehicle design under consideration constitutes a threat above acceptable limits. Further analysis can ascertain whether compartmentation, detection and suppression systems, and other intervention strategies can further minimize the fire hazard.

E.4 References. The following references are cited in this annex.

(1) NFPA *101*, *Life Safety Code*, Quincy, MA: NFPA, 2012.
(2) *SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings*, Bethesda, MD: Society of Fire Protection Engineers, 2000.
(3) ASTM E 2061, *Guide for Fire Hazard Assessment of Rail Transportation Vehicles*. West Conshohocken, PA: ASTM International, 2003.
(4) APTA RP PS-005-01, *Recommended Practice for Fire Safety Analysis of Existing Passenger Rail Equipment*, Washington, DC: American Public Transportation Association, August 2000.
(5) Federal Railroad Administration, 49 CFR, Transportation, Parts 216, 223, 229, 231, 232, and 238, "Passenger Equipment Safety Standards: Final Rule." *Federal Register*, Vol. 64, No. 91, May 12, 1999, 25540–25705. Washington, DC: National Archives and Records Administration.
(6) Federal Railroad Administration, 49 CFR, Transportation, Parts 216, 223, 229, 231, 232, and 238, "Passenger Equipment Safety Standards: Final Rule." *Federal Register*, Vol. 67, No. 102, June 25, 2002, 42892-42912. Washington, DC: National Archives and Records Administration.
(7) Peacock, R. D., et al. *Fire Safety of Passenger Trains, Phase II, Application of Fire Hazard Analysis Techniques*. Prepared for Federal Railroad Administration (FRA), U.S. Department of Transportation (USDOT). National Institute of Standards and Technology (NIST) Interim Report, Report No. DOT/FRA/ORD 01/16, December 2001, and NISTIR 6525, December 2002.
(8) Bukowski, R. W., et al. *Fire Hazard Assessment Method*, NIST Handbook 146, Gaithersburg, MD: NIST, 1989.
(9) Fleming, J. M., "Code Official's View of Performance-Based Codes," *Research and Practice: Bridging the Gap*, Proceedings, Fire Suppression and Detection Research Application Symposium, NFPA Research Foundation, Orlando, FL, February 12–14, 1997, pp. 234–251.
(10) Gross, D. "The Use of Fire Statistics in Assessing the Fire Risk of Products," *Interflam 1985 Conference Workbook*, No. 26–28, March 1985, pp. 11–18.
(11) Karter, M. J., Jr. "Fire Loss in the United States During 1984," *Fire Journal*, Vol. 79, No. 3: 67–70, 73, 75–76, September 1985.
(12) Aherns, M., *U.S. Vehicle Fire Trends and Patterns for Rail Transport Vehicle Fires: U.S. Rail Passenger or Diner Car Fires* 1986–1997. Quincy, MA: NFPA, 1999.

Annex F Creepage Distance

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

F.1 Table F.1 lists the minimum creepage distance for transit vehicles.

Table F.1 Minimum Creepage Distance for Transit Vehicles

Class		Low Energy		Ordinary (Enclosed Environment with Breathing)		Underfloor Exposed Environment		Highly Exposed (No External Protection)	
Application		Electronic and Protected Electronic Devices (½ Amp Where Max.)		Control and Power Devices Mounted in Control Group Enclosures (Short Circuit Limits)		Power Resistors Open Disconnect Devices Mounted Outside Protective Enclosures		Third Rail Shoe Beams and Current Collection Devices (Short Circuit Unlimited by Onboard Devices)	
Nominal Voltage	Surface	mm	in.	mm	in.	mm	in.	mm	in.
37.5	Horizontal	1.6	1⁄16	3.2	⅛	19.1	¾	N/A	N/A
	Vertical	1.6	1⁄16	3.2	⅛	12.7	½	N/A	N/A
74	Horizontal	3.2	⅛	6.5	¼	40	1 9⁄16	N/A	N/A
	Vertical	3.2	⅛	6.5	¼	25	1	N/A	N/A
230	Horizontal	8.3	⅜	15.9	⅝	76.2	3	101.6	4
	Vertical	8.3	⅜	15.9	⅝	50.8	2	57.2	2¼
600	Horizontal	19.1	¼	31.8	1¼	177.8	7	254	10
	Vertical	19.1	¼	31.8	1¼	127	5	152.4	6
750	Horizontal	*	*	40	1 9⁄16	*	*	*	*

* Where no value is given or for nonstandard values, the creepage distance should be agreed upon between the supplier and the AHJ. EN 50124-1, while not as conservative as the requirements of this standard, provides a basis for discussion of alternative requirements.

Annex G On-board Fire Suppression System

G.1 On-board fire suppression systems (e.g., mist systems), while relatively new in the passenger rail and fixed guideway industry have been successfully used on a number of passenger rail and diesel powered light rail systems outside of the United States. The applications for this type of system can range from protection of diesel engine compartments to the interior of passenger rail vehicles. The use of a fire suppression system may save lives in the incident vehicle during a fire condition; minimize damage to the train, tunnel and the station which it has entered; reduce or eliminate potential use of station sprinklers; reduce or eliminate the need for downstands; significantly reduce the impact of designing for fire emergencies on station architecture; reduce tunnel ventilation capacities by approximately 40 percent; reduce the number and/or diameter of emergency ventilation fans at each end of each station and within the tunnels, thus reducing structure sizes; decrease shaft airflow cross section areas by approximately 40 percent; and decrease tunnel ventilation shaft portal areas that correspond to the required fans sizes/velocities. When considering the addition of a fire suppression system, several design challenges should be met by the rail vehicle manufacturer. These challenges include the type of extinguishing medium used, which all must be approved by the AHJ the size and number of medium canisters and where on the vehicle to place them for easy access for maintenance; the resultant increased energy consumption caused by the increase in weight of the suppression system; the maintenance intervals; the cost of the system; the testing and commissioning of the system; and the cost and difficulties associated with retrofitting vehicles.

Annex H Informational References

H.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

H.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2012 edition.

NFPA 472, *Standard for Competence of Responders to Hazardous Materials/Weapons of Mass Destruction Incidents*, 2013 edition.

NFPA 1006, *Standard for Technical Rescuer Professional Qualifications*, 2013 edition.

NFPA 1670, *Standard on Operations and Training for Technical Search and Rescue Incidents*, 2009 edition.

H.1.2 Other Publications.

H.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI/ASME A17.1, *Safety Code for Elevators and Escalators*, 1993.

H.1.2.1.1 Bothe C., Wolinski G.M. & Breunese A.J. 2003. Spalling of concrete tunnel linings in fire, (Re) Claiming the Underground Space, Sauver, Swets & Zeitlinger Lisse, 227–231.

Khoury, G.A. 2002. Passive protection against fire. Tunnels and Tunneling International. November, 40–42.

Tatnall, P.C. 2002. Shotcrete in Fires: Effects of Fibers on Explosive Spalling, Shotcrete American Shotcrete Association, Farmington Hills, Michigan, 10-12.

H.1.2.2 APTA Publications. American Public Transportation Association, 1666 K Street NW, Washington, DC 20006.

APTA RP PS-005-01a, *Recommended Practice for Fire Safety Analysis of Existing Passenger Rail Equipment*, 2001.

APTA SS-E-013-99, Rev 1, *Standard for Emergency Lighting Design for Passenger Cars*, 1999, revised 2007.

H.1.2.3 ASHRAE Publications. ASHRAE, 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.

ASHRAE Handbook Series.

ASHRAE Handbook — Fundamentals, 2005.

H.1.2.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 3675, *Standard Test Method for Surface Flammability of Flexible Cellular Materials Using a Radiant Heat Energy Source*, 2011.

ASTM E 162, *Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source*, 2012a.

ASTM E 662, *Standard Test Method for Specific Optical Density of Smoke Generated by Solid Materials*, 2009.

ASTM E 1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2011b.

ASTM E 1537, *Standard Test Method for Fire Testing of Upholstered Furniture*, 2012.

ASTM E 1590, *Standard Test Method for Fire Testing of Mattresses*, 2002.

ASTM E 2061, *Standard Guide for Fire Hazard Assessment of Rail Transportation Vehicles*, 2012.

H.1.2.5 EN Publications. CENELEC, 35, Rue de Stassartstraat, B-1050, Brussels, Belgium.

EN 50124, *Railway Applications. Insulation Coordination, Basic Requirements. Clearances and Creepage Distances for All Electrical and Electronic Equipment*, 2001.

H.1.2.6 FAA Publications. U.S. Federal Aviation Administration, U.S. Government Printing Office, Washington, DC 20402.

FAR 25.853(c), *Oil Burner Test for Seat Cushions.*

H.1.2.7 FTA Publications. Federal Transit Administration, 400 7th Street SW, Washington, DC 20590.

Subway Environmental Design Handbook, 1975.

H.1.2.8 NIST Publications. National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899-1070.

NIST IR 4730, *Routine for Analysis of the People Movement Time for Elevator Evacuation*, Klote and Alvord, 1992.

H.1.2.9 SFPE Publications. Society of Fire Protection Engineers, 7315 Wisconsin Avenue, Suite 1225 W, Bethesda, MD 20814.

SFPE Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings, 2000.

H.1.2.10 TDC Publications. Transit Development Corporation, Inc., 1666 K St. NW, Washington, DC 20006.

Subway Environmental Design Handbook: *Vol. 1, Principles and Applications*, 2nd edition, 1976. Associated Engineers: A joint venture by Parsons Brinckerhoff Quade & Douglas, Inc.; Deleuw, Cather and Company; and Kaiser Engineers under the direction of TDC, Inc.

H.1.2.11 Other Publications. Aherns, M., *U.S. Vehicle Fire Trends and Patterns for Rail Transport Vehicle Fires: U.S. Rail Passenger or Diner Car Fires 1986–1997*. Quincy, MA: NFPA, 1999.

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Fruin, J. J. *Pedestrian Planning and Design*. 1979 (revised ed.). Mobile, AL: Elevator World Inc., Educational Services Division, 354 Morgan Avenue, Mobile, AL, 36606.

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Karter, M. J., Jr. "Fire Loss in the United States During 1984," *Fire Journal*, Vol. 79, No. 3: 67–70, 73, 75–76, September 1985.

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H.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

BS EN 50129, *Railway Applications. Communication, Signaling and Processing Systems. Safety-Related Electronic Systems for Signaling*, 2003.

Friedman, R. "An International Survey of Computer Models for Fire and Smoke," *SFPE Journal of Fire Protection Engineering*, 4(3), 1992, pp. 81–92.

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MIL-STD 882D, *Standard Practice for System Safety,* 2000.

Smith, Edwin E., Phase I Report, *Transit Vehicle Material Specification Using Release Rate Tests for Flammability and Smoke*, October 1976.

NFPA *Fire Protection Handbook*, 20th edition, 2008.

H.3 References for Extracts in Informational Sections.

NFPA 921, *Guide for Fire and Explosion Investigations*, 2011 edition.

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NFPA® 140

Standard on

Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations

2013 Edition

This edition of NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*, was prepared by the Technical Committee on Motion Picture and Television Industry. It was issued by the Standards Council on November 27, 2012, with an effective date of December 17, 2012, and supersedes all previous editions.

This edition of NFPA 140 was approved as an American National Standard on December 17, 2012.

Origin and Development of NFPA 140

The 1999 edition of NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages and Approved Production Facilities*, was the first standard developed by the Technical Committee on Motion Picture and Television Industry. It closely paralleled a standard in effect in the state of California.

The 2004 edition incorporated minor reformatting mandated by the *Manual of Style for NFPA Technical Committee Documents*.

The 2008 edition was expanded to include requirements for production locations (i.e., “shooting on location”), and the title was changed to reflect that inclusion.

Revisions to the 2013 edition include new requirements that soundstage audiences be provided with instructions relative to location of exits and means that will be used to notify them in the event of fire or other emergency; use, mixing, dispensing, or storage of flammable and combustible liquids must be per fire code; hydrants, standpipes, and fire department connections must not be blocked, obstructed, or rendered inoperative; and grounding must by bonded per *NFPA 70®*, *National Electrical Code®*, where power from both mobile generators and site electrical services are used to energize equipment.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the hazards associated with practices, processes, materials, and facilities associated with motion picture and television production.

NFPA 140

Standard on

Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations

2013 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall address fire protection, property protection, and life safety in motion picture and television industry soundstages, approved production facilities, and production locations.

1.1.2 Practices, processes, materials, and facilities that are addressed by other NFPA standards shall be governed by those standards unless modified herein.

1.2 Purpose. The purpose of this standard shall be to provide minimum requirements for the design, construction, operation, and maintenance of soundstages and approved production facilities, as well as the use of production locations, for motion picture and television industry productions.

1.3 Application.

1.3.1 This standard shall apply to the following:

(1) New buildings, or portions thereof, used as soundstages or approved production facilities in motion picture and television industry productions
(2) Existing buildings, or portions thereof, used as soundstages or approved production facilities in motion picture and television industry productions to the extent specifically required by other portions of this document
(3) Additions to buildings used as soundstages or approved production facilities in motion picture and television industry productions
(4) Alterations, modernizations, or renovations of existing buildings used as soundstages or approved production facilities in motion picture and television industry productions
(5) Existing buildings, or portions thereof, upon change of occupancy for use as soundstages or approved production facilities in motion picture and television industry productions
(6) Production locations used in motion picture and television industry productions

1.3.2 That portion of the standard dealing with operating features shall apply to new and existing soundstages, approved production facilities, and production locations. *(See Chapter 6.)*

1.3.3 Existing soundstages, approved production facilities, and production locations that are in conformance with requirements of the authority having jurisdiction at the time of the adoption of this standard shall be permitted to remain in use under the following conditions:

(1) The occupancy classification and use remain the same.
(2) No serious hazards to life safety exist that would constitute an imminent threat.

1.3.4 This standard shall not apply to facilities or locations used exclusively for radio broadcasts, theaters and auditoriums, live broadcasts of news or sporting events, and postproduction facilities.

1.4 Equivalency. Nothing in this standard shall be intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety as alternatives to those prescribed by this standard, provided that technical documentation is submitted to the authority having jurisdiction to demonstrate equivalency, and the system, method, or device is approved for the intended purpose.

Chapter 2 Referenced Publications

2.1* General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2011 edition.

NFPA 30, *Flammable and Combustible Liquids Code,* 2012 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes,* 2013 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2009 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2011 edition.
NFPA 70®, *National Electrical Code®*, 2011 edition.
NFPA *101®*, *Life Safety Code®*, 2012 edition.
NFPA 160, *Standard for the Use of Flame Effects Before an Audience,* 2011 edition.
NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages,* 2013 edition.
NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films,* 2010 edition.
NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience,* 2011 edition.

2.3 Other Publications.

2.3.1 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 1573, *Standard for Stage and Studio Luminaires and Connector Strips*, 2003, Revised 2010.

UL 1640, *Standard for Portable Power-Distribution Equipment,* 2000, Revised 2010.

UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes,* 2006.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.
NFPA 70®, *National Electrical Code®*, 2011 edition.
NFPA *101®*, *Life Safety Code®*, 2012 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents.*

3.3 General Definitions.

3.3.1 Approved Production Facility. An existing building, portion of a building, or group of buildings renovated, modified, or reconstructed for use by the entertainment industry and approved by the authority having jurisdiction for the purposes of motion picture, television, or commercial production.

3.3.2 Motion Picture Production Studio. See 3.3.5, Production Studio.

3.3.3 Platform. The raised area within a building used for the presentation of music, plays, or other entertainment. [***101,*** 2012]

3.3.4 Production Location. Any site other than a soundstage or approved production facility used for the purpose of motion picture, television, or commercial production.

3.3.5 Production Studio. A building, a portion of a building, or a group of buildings designed and constructed for use by the entertainment industry for the purpose of motion picture, television, or commercial productions, or broadcasting television programs utilizing a soundstage.

3.3.6 Set. A structure built or assembled for the purpose of motion picture, television, or commercial productions.

3.3.7 Soundstage. A building or a portion of a building, usually insulated from outside noise and natural light, used by the entertainment industry for the purpose of motion picture, television, or commercial productions.

3.3.8 TV Production Studio. See 3.3.5, Production Studio.

Chapter 4 Soundstages and Approved Production Facilities

4.1 General. This chapter shall apply to new and existing motion picture and television soundstages and approved production facilities.

4.2 Permits. Where required by the AHJ, a permit shall be obtained for any of the activities that follow:

(1) Use of pyrotechnic special effects
(2) Use of open flames
(3) Welding
(4) Use of flammable or combustible liquids or gases

(5) Use of aircraft
(6) Presence of motor vehicles within a building
(7) Productions with live audiences
(8)*Change of use or change of occupancy classification

4.3 Pyrotechnic Special Effects and Open Flames.

4.3.1* The use of pyrotechnic special effects and open flames shall be subject to the approval of the AHJ.

4.3.2 When an audience is present, NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, shall be used to regulate any pyrotechnic use.

4.3.3 When an audience is present, NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, shall be used to regulate any flame effects use.

4.4 Standby Fire Personnel.

4.4.1 Where required by the AHJ, standby fire personnel shall be provided for soundstages and approved production facilities where pyrotechnic special effects are used.

4.4.2 Other Hazards. Where required by the AHJ, standby fire personnel shall be provided for hazardous operations other than pyrotechnic special effects.

4.5 Decorative Materials.

4.5.1 Foamed plastic materials used for decorative purposes, scenery, sets, or props shall have a heat release rate not exceeding 100 kW where tested in accordance with UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or where tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.

4.5.2 Combustible drapes, drops, and any other similar combustible hangings or vertically placed materials shall comply with one of the following options:

(1) The materials meet the requirements of NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films.*
(2) The materials exhibit a heat release rate not exceeding 100 kW when tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.
(3) The materials are present in such limited quantity that a hazard of fire development or spread is minimal.
(4)*The materials are considered by the AHJ to exhibit acceptable fire performance.
(5)*Approved interim measures are provided for the period during which the combustible materials are present.

4.5.3 Cut greens shall be treated with an approved or listed fire retardant, and the process shall be repeated as often as necessary to maintain its effectiveness.

4.6 Smoking.

4.6.1 Smoking shall be prohibited on soundstages and in approved production facilities unless otherwise provided in 4.6.2 or 4.6.3.

4.6.2 Smoking shall be permitted when it is a necessary part of a performance, and only when the smoker is a member of the cast.

4.6.3 Except where prohibited by the AHJ, smoking shall be permitted where all of the following conditions are met:

(1) The smoking area is outdoors.
(2) Hazardous materials are not present.
(3) Approved ash trays or receivers are provided.

4.7 Structural Loads.

4.7.1 Approved production facilities and soundstages shall be designed, constructed, or altered to sustain all structural load combinations in accordance with the local building code.

4.7.2 Where the anticipated loads exceed those specified in the local building code for the purpose of suspending sets, ceilings, backings, and other heavy production set pieces, the building shall be designed and constructed for the additional loads.

4.8 Electrical Requirements.

4.8.1 Electrical equipment shall be in accordance with *NFPA 70, National Electrical Code.*

4.8.2* Soundstages and approved production facilities shall be provided with a minimum of 35 W/ft^2 (377 W/m^2) dedicated for production lighting and power.

4.8.3 The electrical distribution equipment used shall comply with UL 1640, *Standard for Portable Power-Distribution Equipment*, and the provisions of Article 530 of *NFPA 70, National Electrical Code.*

4.8.4 The wiring method to electrical distribution equipment shall comply with the provisions of Article 530 of *NFPA 70, National Electrical Code.*

4.8.5 The location of portable, mobile, or stationary power-generating equipment shall be subject to the approval of the AHJ.

4.8.6 Exterior penetrations shall be located near the predesignated location for portable and mobile power-generating equipment.

4.8.7 Auxiliary power cables supplied from mobile generators or adjacent buildings shall not be routed through fire-rated windows and doors.

4.8.8 Portable feeder cables shall be permitted to temporarily penetrate fire-rated walls, floors, or ceilings provided that all of the following apply:

(1) The opening is of noncombustible material.
(2) When in use, the penetration is sealed with a temporary seal of a listed firestop material.
(3) When not in use, the opening shall be capped with a material of equivalent fire rating.

[**70:**530.18(C)]

4.8.9 Where the penetration utilizes a conduit, metal-threaded caps shall be attached to the pipe by means of chain or cable and shall effectively cap the conduit when not in use.

4.8.10 The lighting equipment used shall comply with UL 1573, *Standard for Stage and Studio Luminaires and Connector Strips*, and the provisions of Article 530 of *NFPA 70, National Electrical Code.*

4.9 Fire Department Access. Fire department access shall be maintained as required by the AHJ.

4.10 Means of Egress.

4.10.1 Means of egress shall be in accordance with NFPA *101, Life Safety Code*, unless otherwise modified by 4.10.2 through 4.10.6.

4.10.2 The maximum travel distance to an exit within the soundstage shall be 150 ft (45 m).

4.10.3 Soundstages and approved production facilities shall have an aisle along the perimeter of the soundstage or facility as approved by the AHJ unless otherwise provided in 4.10.3.2.

4.10.3.1 A clear unobstructed aisle height of 7 ft (2.1 m) shall be maintained.

4.10.3.2 A soundstage or approved production facility with a gross area not exceeding 1500 ft^2 (139 m^2) shall be exempt from the perimeter aisle requirement of 4.10.3 provided there is a minimum of two means of egress.

4.10.4 Emergency lighting shall be provided for the means of egress in accordance with NFPA *101*, *Life Safety Code*.

4.10.5 Any door in a required means of egress from an area having an occupant load of 100 or more persons shall be permitted to be provided with a latch or lock only if it is panic hardware or fire exit hardware.

4.10.6 Means of egress shall be kept clear of obstructions and tripping hazards.

4.10.7 Emergency Instructions to Audience. When an audience is present, an announcement shall be made notifying the audience of the following:

(1) The location of exits to be used in case of fire or other emergency
(2) The means that will be used to notify the audience of fire or other emergency

4.11 Fire Protection.

4.11.1 Extinguishment Requirements.

4.11.1.1 Existing soundstages and existing approved production facilities equipped with automatic sprinkler systems shall maintain those systems in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

4.11.1.2 A new soundstage or new approved production facility shall be equipped with an approved, supervised automatic sprinkler system.

4.11.1.3 The automatic sprinkler system required by 4.11.1.2 shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, unless otherwise provided in 4.11.1.3.1 or 4.11.1.3.2.

4.11.1.3.1* The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed.

4.11.1.3.2* The requirements of NFPA 13 prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2.

4.11.1.4 The automatic sprinkler system required by 4.11.1.2 shall be maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*.

4.11.1.5 Portable fire extinguishers shall be installed and maintained in accordance with NFPA 10, *Standard for Portable Fire Extinguishers*.

4.11.2 Fire Alarm System. Fire alarm system notification appliances within soundstages and approved production facilities shall be permitted to be deactivated with the approval of the AHJ during videotaping, filming, or broadcasting of programs, provided the following conditions exist:

(1) In the event of alarm system activation, notification appliances shall activate at a location that is constantly attended during the videotaping, filming, or broadcasting of programs.
(2) The attendants of the location identified in 4.11.2(1) shall be provided with a means of communicating with the fire command center for the building, where one is provided, and with the occupants of the soundstage to initiate emergency action.
(3) Deactivation of notification appliances shall cause activation of a visual signal at an approved location, which shall remain illuminated while notification appliances on the soundstage are deactivated.
(4) The visual signal shall be identified by a sign that shall read, "When Illuminated, Soundstage Fire Alarm System Notification Appliances Are Deactivated."

4.12 Air Conditioning, Heating, and Ventilating. Air-conditioning, heating, and ventilating ductwork and related equipment shall be in good working order and in compliance with the requirements of the AHJ.

Chapter 5 Production Locations

5.1 General. This chapter shall apply to production locations.

5.2 Permits. A permit shall be obtained, unless waived by the AHJ, for any of the following activities:

(1)*Use of the site as a production location
(2) Use of pyrotechnic special effects
(3) Use of open flames
(4) Welding
(5) Use of flammable or combustible liquids or gases
(6) Use of aircraft
(7) Presence of motor vehicles within a building

5.3 Pyrotechnic Special Effects and Open Flames.

5.3.1 The use of pyrotechnic special effects and open flames shall be subject to the approval of the AHJ.

5.3.2 When an audience is present, NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, shall be used to regulate any pyrotechnic use.

5.3.3 When an audience is present, NFPA 160, *Standard for the Use of Flame Effects Before an Audience*, shall be used to regulate any flame effects use.

5.4 Standby Fire Personnel.

5.4.1 Pyrotechnics. Standby fire personnel shall be required for production locations where pyrotechnic special effects are used, unless otherwise waived by the AHJ.

5.4.2 Other Hazards. Where required by the AHJ, standby fire personnel shall be provided for hazardous operations other than pyrotechnic special effects.

5.5 Foamed Plastic Materials. Foamed plastic materials used for decorative purposes, scenery, sets, or props shall have a heat release rate not exceeding 100 kW where tested in accordance with UL 1975, *Standard for Fire Tests for Foamed Plastics Used for Decorative Purposes*, or where tested in accordance with NFPA 289, *Standard Method of Fire Test for Individual Fuel Packages*, using the 20 kW ignition source.

5.6 Smoking.

5.6.1 Smoking shall be prohibited in production location buildings unless otherwise provided in 5.6.2 or 5.6.3.

5.6.2 Smoking shall be permitted when it is a necessary part of a performance, and only when the smoker is a member of the cast.

5.6.3 Except where prohibited by the AHJ, smoking shall be permitted where all of the following conditions are met:

(1) The smoking area is outdoors.
(2) Hazardous materials are not present.
(3) Approved ash trays or receivers are provided.

5.7 Structural Loads.

5.7.1 Sets, scenery, and other equipment shall not impact the structural integrity of existing buildings.

5.7.2 Additional loads applied onto the building shall require the approval of the AHJ.

5.8 Electrical Requirements.

5.8.1 Electrical power connections made to the site electrical service shall be made by an approved electrician under permit from the AHJ.

5.8.2 Portable cables shall be positioned to allow for emergency egress as approved by the AHJ.

5.8.3* Auxiliary power cables supplied from mobile generators or adjacent buildings shall be permitted to be routed through fire-rated windows and doors with the approval of the AHJ.

5.8.4 Where power from both mobile generators and site electrical services are used to energize equipment in the same proximate location at production locations, grounds for the two systems shall be bonded in accordance with *NFPA 70, National Electrical Code.*

5.9* Fire Department Access. Fire department access shall be maintained as required by the AHJ.

5.10* Means of Egress. The production location shall be provided with means of egress appropriate for the intended use as approved by the AHJ.

5.11 Fire Protection.

5.11.1* Building areas used as production locations shall be designed, constructed, and maintained to protect the occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

5.11.2 Where an automatic sprinkler system is provided for compliance with 5.11.1, the automatic sprinkler system shall be installed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, unless otherwise provided in 5.11.4 or 5.11.5.

5.11.3 In any production location building protected by an existing automatic sprinkler system, where solid- or hard-ceiling sets or platforms are introduced and create an obstruction to sprinkler discharge, the provisions of 5.11.4 or 5.11.5 shall be met.

5.11.4* The requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, prohibiting obstructions to sprinkler discharge shall not be applicable if approved mitigation is employed.

5.11.5* The requirements of NFPA 13, *Standard for the Installation of Sprinkler Systems*, prohibiting obstructions to sprinkler discharge shall not be applicable if the building sprinkler system meets the design criteria for Extra Hazard, Group 2.

5.11.6 Automatic sprinkler systems, where provided, shall be maintained in accordance with NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.*

5.11.7 Portable fire extinguishers shall be provided as required by the AHJ.

5.11.8 Fire Hydrants and Fire Appliances. Hydrants, standpipes, and fire department connections (FDCs) shall not be obstructed, blocked, or rendered inoperable unless approved by the AHJ.

Chapter 6 Operating Features

6.1 Waste or Refuse. Waste or refuse shall not be allowed to accumulate in any area or in any manner that creates a fire hazard.

6.2 Flammable or Combustible Liquids.

6.2.1 The use, mixing, dispensing, and storage of flammable or combustible liquids shall be in accordance with the fire code as adopted by the AHJ and the following codes, as applicable, unless otherwise permitted by 6.2.2:

(1) NFPA 30, *Flammable and Combustible Liquids Code*
(2) NFPA 58, *Liquefied Petroleum Gas Code*

6.2.2 Approved flammable or combustible liquids and liquefied petroleum gases used for special effects shall be permitted.

6.3 Welding. Welding shall be in accordance with NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, and NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work.*

6.4* Audience Life Safety. When an audience is present during productions, provisions for life safety and means of egress shall be subject to the approval of the AHJ.

6.5 Emergency Services Notification. The production company shall provide a procedure acceptable to the AHJ for notifying the public emergency services of emergency incidents.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 The entertainment industry occasionally depicts actions, situations, equipment installations, or construction that are violations of recommended standards and codes but do not reflect actual entertainment industry safety practices.

A.2.1 The Motion Picture and Television Industry Committee recognizes that it is sometimes not practical to continually upgrade existing buildings or installations to comply with all the requirements of the referenced publications.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.4.2(8) An example of a *change of use* would be a soundstage with audience facilities for 50 persons being used for a preview party for 500 persons. An example of a *change of occupancy classification* would be a soundstage without audience facilities being used for a preview party for 500 persons.

A.4.3.1 Particular attention needs to be given to combustible materials used in close proximity to pyrotechnic and open-flame special effects. On-site verification of the fire retardant properties of set components, furnishings, props, and other combustible materials is essential to ensure the safety of pyrotechnic and open-flame special effects. The provisions of Section 4.5 address the need to render drapes, greens, foamed plastics, and other combustible materials fire retardant.

A comprehensive safety meeting should be conducted to define the intended scope of a special effect and establish appropriate safe areas. The safe areas need to be sized in consideration of the variable predictability of the materials used in the special effect. The safety meeting should include the participation of all persons who will be present during the special effect. The meeting discussion should also include consideration of the following:

(1) Conducting a test in an approved location of all devices and materials intended to be used in the special effect
(2) Excluding nonessential persons from the area of the effect until special effects personnel and a representative of the AHJ declare the area to be safe
(3) Evaluating the potential impact of the special effect on the uninvolved public
(4) Establishing an emergency plan that includes initial actions to take if the special effect exceeds its intended size, intensity, or duration
(5) Maintaining safe escape routes from the special effects area
(6) Developing methods of communication to be used during the special effect
(7) Identifying the individuals authorized to require that emergency actions be taken
(8) Specifying the licensing requirements for the individuals initiating the special effect
(9) Specifying the clothing to be worn by all special effects and safety personnel
(10) Evaluating the assignments and required abilities of all special effects and safety personnel
(11) Assigning the appropriate number of safety personnel to implement the plan
(12) Determining adequate and appropriate fire protection tailored to the materials used
(13) Establishing primary and backup methods of requesting additional fire suppression resources
(14) Identifying a definitive point when the special effect is complete

A.4.5.2(4) It is important that combustible drapes, drops, and similar materials exhibit adequate fire performance. The AHJ might be able to make a judgment of adequate fire performance without requiring testing of the materials.

A.4.5.2(5) Examples of interim measures that could be approved by the AHJ include, but are not limited to, the following:

(1) Providing a fire watch
(2) Removing the combustible materials at the end of the day's filming
(3) Keeping lighting and other heat-producing sources away from the combustible materials
(4) Providing baffles around heat-producing sources

A.4.8.2 This requirement does not prohibit the use of mobile generators for auxiliary power.

A.4.11.1.3.1 Paragraphs 4.11.1.3.1 and 4.11.1.3.2 recognize motion picture and television industry practices that require sets to change constantly and that sets are "temporary" construction not subject to building codes or standards. Solid ceilings that obstruct the stage sprinklers are "flown" (moved) in or out to permit special shooting angles or lighting requirements, often on a scene-by-scene basis. With temporary walls and ceilings, it would be impractical to install a sprinkler system in a constantly changing structure. Therefore, one or more of the following mitigation techniques should be used to compensate for the areas shielded from sprinkler spray by solid or hard ceilings or platforms:

(1) Approved and listed heat detectors or smoke detectors can be installed beneath such solid or hard ceilings in excess of 600 ft^2 (55.7 m^2) in area and platforms in excess of 600 ft^2 (55.7 m^2) in area and 3 ft (0.9 m) in height. Detectors should be connected to an approved and listed central, proprietary, or remote station service or to a local alarm that will provide an audible signal (i.e., a bell or horn) at a constantly attended location. The detector system, including the alarm panel, is defined as a portable system because it is intended to be reinstalled when platforms or sets are changed. The detectors that are secured to standard outlet boxes and the listed fire alarm panels can be temporarily supported by sets, platforms, or pedestals. Spacing of detectors should be per manufacturers' requirements.

(2) The ceiling can be positioned to allow for the operation of the building's automatic fire sprinkler system after videotaping, filming, or broadcasting of programs has been completed for the day.
(3) A fire watch should be provided when the set is not in use.
(4) No combustible materials should be stored under any platforms. Consideration should be given to secure such covered areas with screen wire or other materials that will permit visual inspection and emergency access.
(5) Approved/listed fire retardants can be applied beneath combustible platforms.
(6) Approved/listed fire retardants can be applied to scenery, props, framework and deck of combustible platforms, and the hard ceilings of combustible sets.

A.4.11.1.3.2 See A.4.11.1.3.1.

A.5.2(1) The AHJ might waive the production location permit provided the AHJ is notified that the site is to be used as a production location.

A.5.8.3 The AHJ might approve the routing of power cables through fire-rated windows or doors if standby fire personnel or other approved safeguards are provided during such periods.

A.5.9 The AHJ, when granting a permit to a production company to film on location, should consider the placement of the support equipment. Typically, the production support vehicles are numerous, and unregulated placement of these vehicles could impede emergency access or egress. Additionally, the types of support vehicles need to be arranged so that a hazardous operation (e.g., fueling or special effects) is distant from sources of ignition and crew gathering areas (e.g., catering locations). The location permit should include a plot plan so the AHJ can adequately assess potential problems.

A.5.10 Where a production company films *on location*, such activity might interfere with, or prevent, the normal use of the facility or area. As such, the facility being occupied as a production location is often used for a purpose different from that of its normal use. Where the production company filming causes the facility or area to curtail normal operations, the facility should not be required to meet the life safety provisions applicable to the normal occupancy. Rather, life safety features should be maintained consistent with provisions required for the temporary use. For example, consider a single story assembly occupancy building with occupant load of 600 persons that has three exits for compliance with the provision of NFPA *101*, *Life Safety Code*, that requires a minimum of three exits where the occupant load of a floor exceeds 500 persons. The assembly occupancy building is used as a production location for a total of 200 persons. The production crew presents, for approval of the AHJ, a plan to block off one of the three exits while maintaining compliance with the requirements for egress width, travel distance, common path of travel, and dead-end corridors. The AHJ approves the proposed means of egress as appropriate for the intended use as required by Section 5.10.

A.5.11.1 The phrase "intimate with the initial fire development" refers to the person(s) at the ignition source or first materials burning, not to all persons within the same room or area.

The occupant protection requirement of 5.11.1 is the same as that required for all occupancies by NFPA *101*, *Life Safety Code*. The activities associated with filming at a production location without an audience are characteristic of the occupancy classification of industrial occupancy. Industrial occupancies are not required by NFPA *101* to be sprinklered. The objective of protecting occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place is accomplished for industrial occupancies by prescriptive provisions not dependent on sprinkler protection.

Where production location filming occurs in a building area not provided with the life safety systems required for industrial occupancies (e.g., in a tower with a single means of egress provided by an unenclosed stair), sprinklers, a fire alarm system, or other mitigation techniques acceptable to the AHJ will need to be employed for compliance with 5.11.1. Where sprinklers are provided, see 5.11.2 and 5.11.6.

A.5.11.4 See A.4.11.1.3.1.

A.5.11.5 See A.4.11.1.3.1.

A.6.4 Special attention should be focused on any possible obstructions to the means of egress. The means of egress and the marking of it might be confusing to the audience due to the numerous bright lights, scenery, video and film cameras, and other equipment in and around the soundstage.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2012 edition.

B.1.2 Other Publications. (Reserved)

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections. (Reserved)

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NFPA®150

Standard on

Fire and Life Safety in Animal Housing Facilities

2016 Edition

This edition of NFPA 150, *Standard on Fire and Life Safety in Animal Housing Facilities*, was prepared by the Technical Committee on Animal Housing Facilities. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

This edition of NFPA 150 was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 150

After a series of disastrous fires in racetrack stables in 1975, NFPA established the Committee on Firesafety in Racetrack Stables. This committee began its work in 1976 with the establishment of three working subcommittees covering construction, occupancy requirements, and fire protection. NFPA 150, *Standard on Firesafety in Racetrack Stables*, was first published in 1979. In the 1985 edition, minor changes were made to the standard that included the printing of Table 3 from NFPA 220, *Standard on Types of Building Construction*, in Appendix A. Changes to both the 1991 and 1995 editions consisted of editorial improvements and clarifications of the existing text.

The 2000 edition added a section on equivalency and essentially revised other portions of the text to reflect the *Manual of Style for NFPA Technical Committee Documents* for use of mandatory language.

In 2004, the scope of NFPA 150 expanded to include life and safety requirements for both humans and animals in all types of animal housing facilities. In July of 2004, the Standards Council approved the expansion and changed the name of the document to *Standard on Fire and Life Safety in Animal Housing Facilities*. The expanded NFPA 150 provided better guidance to authorities having jurisdiction by addressing all types of animal housing facilities and made possible the consistent treatment of such facilities from jurisdiction to jurisdiction.

The 2009 edition included several updates related primarily to the referenced codes and standards and to some of the extracted text. A new provision allowing the use of the room-corner test from NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* was introduced to allow an alternative test protocol to evaluate interior finish materials. These refinements continued and a new chapter on performance-based design approaches was added for the 2013 edition. Other changes for that edition included supplemental provisions for the built-in fire protection systems that are mandated by the standard.

Changes for the 2016 edition include several clarifications and additions, including scoping criteria with regard to how the standard should be applied to existing buildings, classification of all agricultural animals in the Category B scheme for protection purposes, and a provision that extends automatic sprinkler and smoke control systems into all facilities that board or house horses.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the loss of animal and human life and property from fire in animal housing facilities, including, but not limited to the following: barns; stables; kennels; animal shelters; animal hospitals; veterinary facilities; zoos, special amusement parks; agricultural facilities; laboratories; and racetrack stable and kennel areas including those stable and kennel areas, barns, and associated buildings at state, county, and local fairgrounds. This Committee does not cover building code or life safety code requirements that are handled by other committees.

NFPA 150

Standard on

Fire and Life Safety in Animal Housing Facilities

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall provide the minimum requirements for the design, construction, fire protection, and classification of animal housing facilities.

1.1.2 Animal housing facilities shall be designed, constructed, and maintained in accordance with the adopted building, fire, and life safety codes and the requirements herein.

1.1.3 Where requirements of this standard differ from the adopted fire prevention, life safety, and building codes, the requirements of this standard shall govern the protection of the animal occupants and animal handlers.

1.2 Purpose. The purpose of this standard shall be to prevent the loss of animal life, human life, and property from fire or other emergencies by providing the minimum requirements for the design, construction, operation, and maintenance of facilities where animals are housed, including but not limited to rest, feed, work, exercise, and production areas.

1.3 Application.

1.3.1* This standard shall apply to animal housing facilities that are subject to local, state, or federal licensing or permitting requirements, including but not limited to the following:

(1) Barns and stables
(2) Kennels
(3) Racetrack stable/kennel areas, including those stable/kennel areas, barns, and associated buildings at state, county, and local fairgrounds
(4) Animal shelters
(5) Animal hospitals and veterinary facilities
(6) Zoos and special amusement parks
(7) Laboratories
(8) Agricultural facilities
(9) Mercantile or business occupancies with animals

1.3.2 This standard shall apply to new animal housing facilities.

1.3.3* This standard shall also apply to existing facilities where any one of the following conditions applies:

(1) A change of use or occupancy classification occurs where animals are introduced.
(2) A change is made in the subclassification or category of the animals housed.
(3) An extensive modification, reconstruction, or addition is made.
(4) A building or structure with an animal housing facility is relocated.
(5) A building with an animal housing facility is considered damaged, unsafe, or a fire hazard.
(6) A property line that affects compliance with any provision of this standard is created or relocated.

1.3.4* This standard shall apply to temporary structures housing animals solely for the purposes of developing a disaster/emergency management program in accordance with 4.3.4.

1.4 Retroactivity. The provisions of this standard provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 This standard shall apply to existing installations that are determined by the AHJ to constitute imminent danger to animal occupant or animal handler safety.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5.3 Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this standard.

1.6 Units.

1.6.1 SI Units. Metric units in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.6.2 Primary and Equivalent Values. If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value might be approximate.

1.7 Enforcement. This standard shall be administered and enforced by the authority having jurisdiction designated by the governing authority. *(See Annex B for sample wording for enabling legislation.)*

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 1, *Fire Code,* 2015 edition.
NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.
NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.
NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2011 edition.
NFPA 54/ANSI Z223.1, *National Fuel Gas Code,* 2015 edition.
NFPA 58, *Liquefied Petroleum Gas Code,* 2014 edition.
NFPA 70®, National Electrical Code®, 2014 edition.
NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.
NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.
NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2015 edition.
NFPA 92, *Standard for Smoke Control Systems,* 2015 edition.
NFPA *101®, Life Safety Code®,* 2015 edition.
NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances,* 2013 edition.
NFPA 220, *Standard on Types of Building Construction,* 2015 edition.
NFPA 286, *Standard Methods of Fire Tests for Evaluating Contribution of Wall and Ceiling Interior Finish to Room Fire Growth,* 2015 edition.
NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment,* 2015 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.
NFPA 1144, *Standard for Reducing Structure Ignition Hazards from Wildland Fire,* 2013 edition.
NFPA 1600®, Standard on Disaster/Emergency Management and Business Continuity Programs, 2013 edition.
NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

2.3 Other Publications.

2.3.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Material*, 2014.

ASTM E1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*, 2007.

2.3.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 723, *Standard for Test of Surface Burning Characteristics of Building Material*, 2008, with revisions through September 13, 2010.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Addition. An increase in the building area, aggregate floor area, building height, or number of stories of a structure. [**5000,** 2015]

3.3.2 Animal. For the purposes of this standard, an air-breathing vertebrate.

3.3.2.1* ***Confined Animals.*** Animals housed such that human intervention is required for their release and evacuation in case of emergency.

3.3.3* Animal Handler. A person responsible for the handling, grooming, and care of confined animals, or reasonably expected to assist in their handling and evacuation in case of emergency.

3.3.4* Animal Housing Facility. Area of a building or structure, including interior and adjacent exterior spaces, where animals are fed, rested, worked, exercised, treated, exhibited, or used for production.

3.3.5 Building Height. The vertical distance from the grade plane to the average elevation of the highest roof surface. [**5000,** 2015]

3.3.6 Cage. A box or enclosure from which an animal or animals cannot normally escape without human intervention.

3.3.7 Confined Animals. See 3.3.2.1.

3.3.8 Feed Room. See 3.3.20.1.

3.3.9 Fire Resistance Rating. The time in minutes or hours that materials or assemblies have withstood a fire exposure, as established in accordance with the tests or methods based on tests prescribed by this standard. [**5000,** 2015]

3.3.10 General Public. People who do not have an intimate knowledge of the layout of the building or structure, or the general behavior of the animals at the facility, and are not intended personnel.

3.3.11 Halter. A piece of equipment, composed of rope or straps and buckles, that fits securely around the head of an animal such as a horse or cow, used in handling and leading animals from place to place.

3.3.12 Intended Personnel. People working in the animal housing facility with an intimate knowledge of the layout of the building or structure and the general behavior of the animals at the facility, such as employees or students, who are not considered the general public.

3.3.13 Lead. A rope, chain, or strap of suitable length with a clasp at one end used for handling and leading animals by a halter, collar, or harness.

3.3.14 Mechanical Equipment Room. See 3.3.20.2.

3.3.15 Modification. The reconfiguration of any space, the addition or elimination of any door or window, the addition or elimination of load-bearing elements, the reconfiguration or extension of any system, or the installation of any additional equipment. [**5000,** 2015]

3.3.16 Occupancy. The purpose for which a building or other structure, or part thereof, is used or intended to be used. [**ASCE/SEI 7:**1.2]

3.3.17* Protection. A device, material, or system that provides a specified level of safety to achieve a desired outcome.

3.3.18 Reconstruction. The reconfiguration of a space that affects an exit, or a corridor shared by more than a single tenant; or reconfiguration of space such that the rehabilitation work area is not permitted to be occupied because existing means of egress and fire protection systems, or their equivalent, are not in place or continuously maintained. [**5000,** 2015]

3.3.19 Renovation. The replacement in kind, strengthening, or upgrading of elements, materials, equipment, or fixtures that does not result in a reconfiguration of the building or spaces within. [**5000,** 2015]

3.3.20 Room.

3.3.20.1 ***Feed Room.*** Room used to store feed and feed supplies for animals.

3.3.20.2 ***Mechanical Equipment Room.*** Room that contains mechanical, electrical, air conditioning, or other equipment.

3.3.20.3 ***Storage Room.*** Enclosed room within a building containing tack and equipment used for animal handling, capture, restraint, grooming, training, care, and upkeep of the animal facility.

3.3.20.4 ***Tack Room.*** A storage area for tack and stable equipment.

3.3.21 Stall. A room or compartment that normally houses one or more animals.

3.3.22 Storage Room. See 3.3.20.3.

3.3.23 Tack. Stable gear; also harnesses, bridles, saddles, and other accessories used in riding or driving horses.

3.3.24 Tack Room. See 3.3.20.4.

3.3.25 Trainer. A person responsible for the care and training of animals.

Chapter 4 General Requirements

4.1* Goals and Objectives.

4.1.1* Goals. The primary goals of this standard shall be safety and facility usability for both human and animal occupants, including property protection as it relates to the primary goals.

4.1.2* Objectives. To achieve the goals stated in 4.1.1, the goals and objectives of 4.1.3 and 4.1.4 shall be satisfied.

4.1.3 Safety. The intent of the safety goal of this standard shall be to reduce the probability of injury or death to both animal and human occupants from fire, similar emergencies, and facility use.

4.1.3.1 Safety from Fire.

4.1.3.1.1* Safety-from-Fire Goals. The fire safety goals of this standard shall be as follows:

(1) To provide an environment for human occupants inside an animal housing facility that is reasonably safe from fire and similar emergencies
(2) To provide an environment for animal occupants inside or adjacent to a structure that is reasonably safe from fire and similar emergencies
(3) To provide reasonable safety for fire fighters and emergency responders during search and rescue operations for animal and human occupants
(4) To attempt to minimize loss of property and interruption of facility operations from fire and similar emergencies

4.1.3.1.2 Safety-from-Fire Objectives.

4.1.3.1.2.1 Facilities shall be designed and constructed to protect human and animal occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

4.1.3.1.2.2* Facilities shall be designed and constructed to provide reasonable safety for fire fighters and emergency responders during search and rescue operations for animal and human occupants.

4.1.3.1.2.3 Facilities shall be designed and constructed to provide reasonable access to the structure for emergency responders.

4.1.3.1.2.4 Facilities shall be designed and constructed to reasonably protect adjacent persons, animals, and structures from injury, death, or substantial damage as a result of a fire.

4.1.3.2 Safety During Facility Use.

4.1.3.2.1* Safety-During-Facility-Use Goal. The safety-during-facility-use goal of this standard shall be to provide an environment for both the human and animal occupants of the facility that is reasonably safe during the normal use of the facility.

4.1.3.2.2 Safety-During-Facility-Use Objectives.

4.1.3.2.2.1 Facilities shall be designed and constructed to provide for reasonably safe animal and crowd movement during emergency and nonemergency conditions.

4.1.3.2.2.2 Facilities shall be designed and constructed to provide reasonable safety for animal and human occupants and workers during construction and demolition.

4.1.3.2.2.3* Facilities shall be designed and constructed to provide reasonable and appropriate notification to occupants during emergency situations.

4.1.3.2.2.4 Facilities shall be designed and constructed to provide reasonable signage to identify hazards, means of egress, and other building safety features.

4.1.4 Usability Goal. The intent of the usability goal of this standard shall be to ensure that the facility is capable of functioning at the level for which it was designed.

4.1.4.1 Function.

4.1.4.1.1* Function Goal. The intent of the function goal of this standard shall be to ensure that a facility and its systems, features, and construction, throughout its life, provide reasonable capability of operation to satisfy the other goals of this standard.

4.1.4.1.2* Function Objective. Facilities shall be designed and constructed to provide reasonable assurance that its systems, features, and construction are capable of performing their intended use to satisfy the objectives of this standard.

4.2 Fundamental Fire and Life Safety Requirements.

4.2.1 Multiple Safeguards.

4.2.1.1 The design of every facility intended for animal and human occupancy shall be such that reliance for property protection and safety to life does not depend solely on any single safeguard.

4.2.1.2 Additional safeguard(s) shall be provided for property protection and life safety in case any single safeguard is ineffective due to inappropriate animal or human actions, building failure, or system failure.

4.2.2 Appropriateness of Safeguards. Every facility shall be provided with means of egress and other fire and life safety safeguards of the kinds, numbers, locations, and capacities appropriate to the individual facility, with due regard to the following:

(1) Character of the occupancy, including fire load
(2) Characteristics and capabilities of both human and animal occupants and their responses to fire protection safeguards
(3) Number of animals and persons exposed
(4) Fire protection available
(5) Height and type of construction of the facility
(6) Other factors necessary to provide animal and human occupants with a reasonable degree of safety
(7) Other factors necessary to protect the facility and contents from unacceptable damage

4.2.3 Means of Egress. The minimum number of means of egress for human and animal occupants shall be in accordance with Chapter 8.

4.2.4* Occupant Notification. In every facility of such size, arrangement, or occupancy that a fire itself might not provide adequate occupant warning, fire alarm systems shall be provided where necessary to warn occupants of the existence of fire.

4.2.5 System Design and Installation. Any fire protection system, building service equipment, feature of protection, or safeguard provided for fire and life safety shall be designed, installed, and approved in accordance with applicable NFPA codes and standards.

4.2.6 Limiting Fire Spread.

4.2.6.1 The interior surfaces of the facility shall not contribute to an unacceptable rate and magnitude of fire spread and generation of heat and smoke.

4.2.6.2 The construction of concealed spaces shall not contribute to an unacceptable rate of the spread of fire, hot gases, and smoke to areas of the facility remote from the fire source and shall limit their spread beyond the immediate area of the origin of the fire.

4.2.6.3 The facility shall be compartmented, as appropriate, by walls and floors, including their associated openings with proper closures, to limit the spread of fire, hot gases, and smoke to an acceptable area beyond the immediate area of fire origin.

4.2.7 Structural Integrity. The facility's structural members and assemblies shall be provided with the required degree of fire resistance to limit structural damage, damage to the building and its contents, and damage to adjacent buildings and property.

4.3 General Requirements.

4.3.1 Authority Having Jurisdiction.

4.3.1.1 The authority having jurisdiction (AHJ) shall determine whether the provisions of this standard are met.

4.3.1.2 Where it is evident that a reasonable degree of safety is provided, any requirement shall be permitted to be modified if, in the judgment of the AHJ, its application would be hazardous under normal occupancy conditions.

4.3.1.3* Where it is evident that special circumstances not specifically addressed in this standard exist in the design, construction, use, or operation of the facility, the AHJ shall be permitted to require additional safeguards such that a reasonable degree of safety is provided.

4.3.2 Provisions in Excess of Standard Requirements. Nothing in this standard shall be construed to prohibit a superior type of building construction, an additional means of egress, or an otherwise safer condition than that specified by the minimum requirements of this standard.

4.3.3 Maintenance and Testing.

4.3.3.1 Where any device, equipment, system, condition, arrangement, or level of protection, or any other feature, is required for compliance with the provisions of this standard, such device, equipment, system, condition, arrangement, level of protection, or other feature shall thereafter be continuously maintained in accordance with applicable NFPA requirements or as directed by the AHJ.

4.3.3.2 Equipment requiring periodic testing or operation to ensure its maintenance shall be tested or operated as specified elsewhere in this standard or as directed by the AHJ.

4.3.3.3 Maintenance and testing shall be under the supervision of a responsible person who shall ensure that testing and maintenance are made at specified intervals in accordance with applicable NFPA standards or as directed by the AHJ.

4.3.4 Disaster/Emergency Management Program.

4.3.4.1 General. Disaster/emergency management programs shall be required in all animal housing facilities to protect and ensure the safety of the animal and human occupants during fire or other similar emergencies.

4.3.4.2 Program Requirements.

4.3.4.2.1* Disaster/emergency management programs shall be developed in accordance with *NFPA 1600* and shall include the procedures for reporting emergencies; the occupant and staff response to emergencies; the design and conduct of disaster/emergency drills; the type and coverage of building fire protection systems; and other items required by the AHJ.

4.3.4.2.2 Required disaster/emergency management programs shall be submitted to the AHJ for review and approval.

4.3.4.2.3 Disaster/emergency management programs shall be reviewed and updated annually.

4.3.4.2.4 Revised plans shall be submitted for review and updates shall be provided whenever changes are made in the occupancy or physical arrangement of the building or fire protection systems or features.

4.3.4.2.5 Floor plans shall be provided to the AHJ, as requested.

4.3.4.2.6 In accordance with the disaster/emergency management program, equipment designated as necessary for the evacuation or relocation of animals shall be readily accessible at all times.

4.3.5* Disaster/Emergency Drills.

4.3.5.1 Disaster/emergency drills conforming to the provisions of this standard shall be conducted in cooperation with the local authorities and as specified by this standard or by the AHJ.

4.3.5.2 Drill Frequency.

4.3.5.2.1 Where required by this standard or the AHJ, disaster/emergency drills shall be held to familiarize occupants with the drill procedure and to establish conduct of the drill as a matter of routine.

4.3.5.2.2* Disaster/emergency drills shall include procedures to ensure that all persons subject to the drill participate.

Chapter 5 Performance-Based Design Option

5.1* General Requirements.

5.1.1 Application. The requirements of this chapter shall apply to buildings or structures, portions of buildings or structures, or building systems designed in accordance with the performance-based option permitted by Section 4.3.

5.1.2 Goals and Objectives. The performance-based design shall meet the goals and objectives of Section 4.1.

5.1.3* Independent Review. The authority having jurisdiction shall be permitted to require an approved, independent third party to review the proposed design and provide an evaluation of the design to the authority having jurisdiction at the expense of the owner.

5.1.4 Sources of Data. Data sources shall be identified and documented for each input data requirement that must be met using a source other than a design scenario, an assumption, or a building design specification. The degree of conservatism reflected in such data shall be specified, and a justification for the source shall be provided.

5.1.5* Final Determination. The authority having jurisdiction shall make the final determination as to whether the performance objectives have been met.

5.1.6* Maintenance of Design Features.

5.1.6.1 The design features required for the building to continue to meet the performance goals and objectives of this standard shall be maintained for the life of the building. Such performance goals and objectives shall include complying with all documented assumptions and design specifications. Any variations shall require the approval of the authority having jurisdiction prior to the actual change.

5.1.6.2 Whenever or wherever any device, equipment, system, condition, arrangement, level of protection, or other feature is required to meet the goals, objectives, or performance criteria of this standard, approved procedures for the operation and maintenance of such device, equipment, system, condition, arrangement, level of protection, or other feature shall be prepared, and an approved system of inspection, maintenance, and testing shall be included in an operations and maintenance manual developed as part of the performance-based design.

5.1.7 Special Definitions. See Section 3.3.

5.2 Safety-from-Fire Goals.

5.2.1 The fire safety goals of this standard shall be as follows:

(1) To provide an environment for human occupants inside an animal housing facility that is reasonably safe from fire and similar emergencies
(2) To provide an environment for animal occupants inside or adjacent to a structure that is reasonably safe from fire and similar emergencies
(3) To provide reasonable safety for fire fighters and emergency responders during search and rescue operations for animal and human occupants
(4) To attempt to minimize loss of property and interruption of facility operations from fire and similar emergencies

5.2.2 Safety-from-Fire Objectives.

5.2.2.1 Facilities shall be designed and constructed to protect human and animal occupants not intimate with the initial fire development for the time needed to evacuate, relocate, or defend in place.

5.2.2.2* Facilities shall be designed and constructed to provide reasonable safety for fire fighters and emergency responders during search and rescue operations for animal and human occupants.

5.2.2.3 Facilities shall be designed and constructed to provide reasonable access to the structure for emergency responders.

5.2.2.4 Facilities shall be designed and constructed to reasonably protect adjacent persons, animals, and structures from injury, death, or substantial damage as a result of a fire.

5.2.3 Safety During Facility Use.

5.2.3.1* Safety-During-Facility-Use Goal. The safety-during-facility-use goal of this standard shall be to provide an environment for both the human and animal occupants of the facility that is reasonably safe during the normal use of the facility.

5.2.3.2 Safety-During-Facility-Use Objectives.

5.2.3.2.1 Facilities shall be designed and constructed to provide for reasonably safe animal and crowd movement during emergency and nonemergency conditions.

5.2.3.2.2 Facilities shall be designed and constructed to provide reasonable safety for animal and human occupants and workers during construction and demolition.

5.2.3.2.3* Facilities shall be designed and constructed to provide reasonable and appropriate notification to occupants during emergency situations.

5.2.3.2.4 Facilities shall be designed and constructed to provide reasonable signage to identify hazards, means of egress, and other building safety features.

5.2.3.3 Glass or other similar frangible construction material shall be installed in such a manner that, if occupants come into contact with such material, one of the following occurs:

(1) The material resists impact without breaking.
(2) The material breaks in such a manner that it does not cause injury.
(3) The material is protected from occupant impact.

5.2.4 Uncontrolled Moisture.

5.2.4.1 Where critical to the operation and use of the animal housing facility, uncontrolled moisture shall be controlled in accordance with 5.2.4.1.1 through 5.2.4.1.3.

5.2.4.1.1 The exterior envelope of the building shall be designed to control the entry of precipitation into the building.

5.2.4.1.2 The exterior walls, attics, crawl spaces, and other concealed or enclosed building elements that constitute the building envelope shall be designed to control the accumulation of water vapor or its condensation in such quantities and physical state that contact of water vapor or its condensation with the building insulation or building materials will not result in conditions that adversely affect the health of the building occupants.

5.2.4.1.3 Building materials located in areas within the building that are subject to exposure from water discharges or leaks in quantities and durations that cause exterior moisture to accumulate for extended periods of time, thus resulting in conditions that adversely affect the health of the building occupants, shall be designed to control penetration of, or direct contact with, water or shall be protected from such exposure.

5.3 Retained Prescriptive Requirements. The design shall comply with the requirements of Section 5.3 in addition to the performance criteria of Section 5.2 and the methods of Sections 5.4 through 5.8.

5.3.1 Systems and Features. All fire protection systems and features of the building shall comply with applicable NFPA standards for those systems and features.

5.3.2 Means of Egress. Means of egress shall comply with Chapter 8.

5.4* Performance-Based Design Characteristics and Assumptions.

5.4.1 General.

5.4.1.1 Design characteristics and assumptions used in the performance-based design shall be clearly stated and shown to be realistic and sustainable.

5.4.1.2 Each design characteristic and assumption used in the design shall be accurately translated into input data specifications, as appropriate for the calculation method or model to be used.

5.4.1.3 Design characteristics and assumptions that the design analyses do not explicitly address or incorporate and that are, therefore, omitted from input data specifications shall be identified, and a sensitivity analysis of the consequences of that omission shall be performed.

5.4.1.4 Design characteristics and assumptions modified in input data specifications, due to limitations in test methods or other data-generation procedures, shall be identified, and a sensitivity analysis of the consequences of the modification shall be performed.

5.4.1.5* The design shall not include mutually inconsistent characteristics, assumptions, or statements of conditions.

5.4.2 Building Characteristics and Assumptions.

5.4.2.1* Characteristics of the building or its contents, equipment, layout, or operations that are not inherent in the design specifications, but that affect occupant or building behavior or the rate of hazard development, shall be explicitly identified.

5.4.2.2* The performance of building systems and features shall reflect the documented performance and reliability of the components of those systems or features, unless design specifications are incorporated to modify the expected performance.

5.4.3 Occupant Characteristics and Assumptions.

5.4.3.1* General. The selection of occupant characteristics to be used in the design calculations shall be approved by the authority having jurisdiction and shall provide an accurate reflection of the expected population of building users.

5.4.3.2 Occupant Profile. Occupant characteristics shall represent the normal occupant profile, unless design specifications are used to modify the expected occupant features.

5.4.3.3 Response Characteristics. The basic response characteristics of sensibility, reactivity, mobility, and susceptibility shall be considered. Such consideration shall include the expected distribution of characteristics of a population appropriate to the use of the building. The source of data for these characteristics shall be documented.

5.4.3.4 Location. It shall be assumed that, in every normally occupied room or area, at least one occupant shall be located at the most remote point from the exits.

5.4.3.5* Number of Occupants. The design shall be based on the maximum number of occupants that every occupied room or area is expected to contain. Where success or failure of the design is contingent on a specified maximum number of occupants, operational controls shall be used to ensure that a greater number of occupants could not be expected to be present.

5.4.3.6* Staff Assistance. In those occupancies where staff assistance is required to ensure the safety of other occupants, such trained assistance shall be provided. The ability of trained employees to be included as part of the building safety system shall be identified and documented.

5.4.4 Emergency Response Personnel Characteristics and Assumptions.

5.4.4.1 Nongovernmental emergency response personnel shall not be relied upon in the performance design, unless they are under the continuous and direct control of the building owner or occupant. Emergency response personnel of the governmental agency legally responsible for providing emergency responders to the local jurisdiction shall be permitted to be relied upon in the performance design when approved by the governmental agency.

5.4.4.2 Design characteristics and assumptions related to the availability, speed of response, effectiveness, roles, and other characteristics of emergency response personnel shall be specified, estimated, or characterized sufficiently for evaluation of the design.

5.5* Design Scenarios.

5.5.1 General.

5.5.1.1 The proposed design shall be considered to meet the goals and objectives if it achieves the performance criteria for each required design scenario. The authority having jurisdiction shall approve the parameters involved with design scenarios.

5.5.1.2 Design scenarios shall be evaluated for each required scenario using a method acceptable to the authority having jurisdiction and appropriate for the conditions. Each scenario shall be as challenging and realistic as any that could realistically occur in the building.

5.6 Evaluation of Proposed Designs.

5.6.1 General. A proposed design's performance shall be assessed relative to each performance objective in Section 4.1 and each applicable scenario in Section 5.5, with the assessment conducted through the use of appropriate calculation methods. The authority having jurisdiction shall approve the choice of assessment methods.

5.6.2 Use. The design professional shall use the assessment methods to demonstrate that the proposed design will achieve the goals and objectives for each scenario, as measured by the performance criteria in light of the safety margins and uncertainty analysis, given the assumptions.

5.6.3 Input Data.

5.6.3.1 Data. Input data for computer fire models shall be obtained in accordance with ASTM E1591, *Standard Guide for Obtaining Data for Deterministic Fire Models*. Data for use in analytical models that are not computer-based fire models shall be obtained using appropriate measurement, recording, and storage techniques to ensure the applicability of the data to the analytical method being used.

5.6.3.2 Data Requirements. A complete listing of input data requirements for all models, engineering methods, and other calculation or verification methods required or proposed as part of the performance-based design shall be provided.

5.6.3.3 Uncertainty and Conservatism of Data. Uncertainty in input data shall be analyzed and, as determined appropriate by the authority having jurisdiction, addressed through the use of conservative values.

5.6.4 Output Data. The assessment methods used shall accurately and appropriately produce the required output data from input data based on the design specifications, assumptions, and scenarios.

5.6.5 Validity. Evidence shall be provided confirming that the assessment methods are valid and appropriate for the proposed building, use, and conditions.

5.7 Safety Factors. Approved safety factors shall be included in the design methods and calculations to reflect uncertainty in the assumptions, data, and other factors associated with the performance-based design.

5.8 Documentation Requirements.

5.8.1* General. All aspects of the design, including those described in 5.8.2 through 5.8.14, shall be documented. The format and content of the documentation shall be acceptable to the authority having jurisdiction.

5.8.2 Technical References and Resources. The authority having jurisdiction shall be provided with sufficient documentation to support the validity, accuracy, relevance, and precision of the proposed methods. The engineering standards, calculation methods, and other forms of scientific information provided shall be appropriate for the particular application and methodologies used.

5.8.3 Building Design Specifications. All details of the proposed building design that affect the ability of the building to meet the stated goals and objectives shall be documented.

5.8.4 Performance Criteria. Performance criteria, with sources, shall be documented.

5.8.5 Occupant Characteristics. Assumptions about occupant characteristics shall be documented.

5.8.6 Design Scenarios. Descriptions of design hazards scenarios shall be documented.

5.8.7 Input Data. Input data to models and assessment methods, including sensitivity analysis, shall be documented.

5.8.8 Output Data. Output data from models and assessment methods, including sensitivity analysis, shall be documented.

5.8.9 Safety Factors. The safety factors utilized shall be documented.

5.8.10 Prescriptive Requirements. Retained prescriptive requirements shall be documented.

5.8.11* Modeling Feature.

5.8.11.1 Assumptions made by the model user and the description of the models and methods used, including known limitations, shall be documented.

5.8.11.2 Documentation shall be provided verifying that the assessment methods have been used validly and appropriately to address the design specifications, assumptions, and scenarios.

5.8.12 Evidence of Modeler Capability. The design team's relevant experience with the models, test methods, databases, and other assessment methods used in the performance-based design proposal shall be documented.

5.8.13 Performance Evaluation. The performance evaluation summary shall be documented.

5.8.14 Use of Performance-Based Design Option. Design proposals shall include documentation that provides anyone involved in ownership or management of the building with notification of the following:

(1) The building was approved as a performance-based design with certain specified design criteria and assumptions.
(2) Any remodeling, modification, renovation, change in use, or change in the established assumptions is to be reevaluated and reapproved.

Chapter 6 Subclassification of Animal Housing Facilities and Categorization of Animals

6.1 General.

6.1.1* Occupancy Classification. The general occupancy classification of a facility housing animals shall be determined in accordance with *NFPA 5000*, Chapter 6, or NFPA *101*, Chapter 6.

6.1.2 Occupancy Separations. The separations required between different occupancies shall be in accordance with *NFPA 5000*, Chapter 6, or NFPA *101*, Chapter 6.

6.2 Animal Housing Facility Subclassifications.

6.2.1 The occupancy of a facility housing animals shall be subclassified in accordance with this section.

6.2.1.1* Class 1 Facility. A Class 1 facility shall be an area of a building housing animals with no general public access.

6.2.1.2* Class 2 Facility. A Class 2 facility shall be an area of a building housing animals with restricted general public access.

6.2.1.3* Class 3 Facility. A Class 3 facility shall be an area of a building housing animals with regular general public access.

6.2.2 Animal housing facility subclassifications shall be subject to the ruling of the AHJ where there is a question of classification.

6.2.3 Types of Subclassifications.

6.2.3.1 Multiple Subclassification. A multiple subclassification facility shall be a facility in which two or more subclasses of animal housing facilities exist.

6.2.3.2 Mixed Subclassification. A mixed subclassification facility shall be a multiple subclassification facility where the subclassifications are intermingled.

6.2.3.3 Separated Subclassification. A separated subclassification facility shall be a multiple subclassification facility where the subclassifications are separated by fire barriers in accordance with NFPA *101* or *NFPA 5000* rated assemblies.

6.2.4 Multiple Subclassification.

6.2.4.1* Multiple subclassifications *(see 6.2.3)* shall comply with the requirements of one of the following:

(1) Mixed subclassification requirements *(see 6.2.5)*
(2) Separated subclassification requirements *(see 6.2.6)*

6.2.4.2* Where minor accessory subclassifications do not occupy more than 25 percent of the area of any story of a facility, the principal use of the facility shall determine the subclassification.

6.2.5 Mixed Subclassification.

6.2.5.1 Each portion of the facility shall be subclassified as to its use in accordance with 6.2.1.

6.2.5.2 The means of egress, type of construction, protection, and other safeguards in the facility shall comply with the most restrictive fire and life safety requirements of the subclassifications involved.

6.2.6 Separated Subclassification.

6.2.6.1 Where separated subclassifications are provided, each part of the structure comprising a distinct subclassification, as described in this chapter, shall be completely separated from other subclassifications by fire-resistive assemblies in accordance with NFPA *101* or *NFPA 5000*, as specified in 6.2.6 and Table 6.2.6.1, unless separation is provided by approved existing separations.

6.2.6.1.1 Subclassification separations shall be classified as 2-hour fire resistance rated or 1-hour fire resistance rated, and shall meet the requirements of *NFPA 5000*, Chapter 8, or NFPA *101*, Chapter 8.

6.2.6.1.2 The fire resistance rating specified in Table 6.2.6.1 shall be permitted to be reduced by 1 hour, but in no case shall it be reduced to less than 1 hour, where the facility is protected throughout by an approved automatic sprinkler system in accordance with Section 9.2.

6.2.6.2 Subclassification separations shall be vertical, horizontal, or both, or, when necessary, of such other form as required to provide complete separation between subclassification divisions in the structure.

6.2.6.3 Where the subclassification separation is horizontal, structural members supporting the separation shall be protected by an equivalent fire-resistive construction.

6.2.7 If there is a change in subclassification, the facility shall meet the requirements for the new subclassification.

6.3 Categorization of Animals.

6.3.1 Animal Type. The type of animal shall be categorized in each area of the animal housing facility in accordance with 6.3.1.1 and 6.3.1.2.

6.3.1.1 Category A. Category A animals shall include any of the following types of animals:

(1)* Animal(s) that pose a potential risk to the health or safety of rescuers or the general public

(2)* Animal(s) that cannot be removed without potential risk to the health and welfare of the animal or other animals

(3)* Animal(s) that are impossible or impractical to move

(4)* Animal(s) that are not mobile or not in a mobile enclosure

Table 6.2.6.1 Required Fire Resistance–Rated Separation for Subclassification in Hours

	Class 1 Facility	Class 2 Facility	Class 3 Facility
Class 1 Facility	—	1	2
Class 2 Facility	1	—	1
Class 3 Facility	2	1	—

Note: See 6.2.6.1.2 for fire-resistance rating reductions.

6.3.1.2 Category B. Category B animals shall include all agricultural animals and any animals not in Category A, as specified in 6.3.1.1.

6.3.2 Question of Categorization. Animal categories shall be subject to the ruling of the AHJ where there is a question of categorization.

6.3.3 Change in Animal Category. If the category of animal in an animal housing facility changes, the facility shall meet the requirements for the new animal category.

Chapter 7 Construction and Separation Requirements

7.1* Types of Construction. The types of construction for animal housing facilities shall be in accordance with NFPA 220 or *NFPA 5000*, Section 7.2.

7.2 Height and Area Requirements.

7.2.1 General. The height and area requirements for the occupancy of the animal housing facility shall be in accordance with *NFPA 5000*, Section 7.4.

7.2.1.1 Exterior areas such as corrals, paddocks, or other fenced holding areas attached to animal housing facilities shall not be included in the calculated allowable area per story.

7.2.1.2 If such exterior areas are partially or totally covered by extended roof structures integral with the building, the line of primary structure supporting such roofed areas shall be considered exterior wall lines when determining location on property.

7.2.2* Additional Requirements. In addition to the requirements of 7.2.1, the allowable number of stories above grade where the animal housing facilities are permitted and the allowable area per story of animal housing facilities shall not exceed the limits set forth in Table 7.2.2. The values in Table 7.2.2 for sprinklered facilities shall apply to facilities protected throughout with an approved, electrically supervised automatic sprinkler system in accordance with Section 9.2.

7.2.3 Maximum Facility Area. The maximum area of the animal housing facilities within a building or structure shall be determined by multiplying the allowable area per story, as determined by Table 7.2.2, by the facility's number of stories up to a maximum of three stories.

7.2.4 Multiple Subclassifications. Where an animal housing facility is occupied by animals of two or more subclassifications, the animal housing facility shall comply with this section.

7.2.4.1 Mixed Subclassifications. Animal housing facilities with mixed subclassifications complying with 6.2.5 shall have their required type of construction determined by applying the most restrictive type of construction to the entire animal housing facility.

7.2.4.2 Separated Subclassifications. Animal housing facilities with separated occupancies complying with 6.2.6 shall have their required type of construction determined in accordance with 7.2.4.2.1 and 7.2.4.2.2.

Table 7.2.2 Allowable Facility Height and Areas

Construction Type		I (442)		I (332)		II (222)		II (111)		II (000)		III (211)		III (200)		IV		V (111)		V (000)	
Sprinklered or Nonsprinklered		**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**	**S**	**N**
Class 1 Facilities																					
Category A Animals	**Stories**	UL	NP	UL	NP	12	NP	6	NP	4	NP	6	NP	4	NP	6	NP	4	NP	3	NP
	Area (1000 ft^2)	UL	NP	UL	NP	UL	NP	75	NP	46	NP	57	NP	38	NP	72	NP	36	NP	18	NP
Category B Animals	**Stories**	UL	UL	UL	UL	12	11	6	5	4	3	6	5	4	3	6	5	4	3	3	2
	Area (1000 ft^2)	UL	90	UL	90	UL	90	75	37.5	46	23	57	28.5	38	19	72	36	36	18	18	9
Class 2 Facilities																					
Category A Animals	**Stories**	UL	NP	UL	NP	12	NP	5	NP	3	NP	5	NP	3	NP	5	NP	4	NP	2	NP
	Area (1000 ft^2)	UL	NP	UL	NP	UL	NP	43	NP	25	NP	37	NP	25	NP	41	NP	28	NP	18	NP
Category B Animals	**Stories**	UL	UL	UL	UL	12	11	5	4	3	2	5	4	3	2	5	4	4	3	2	2
	Area (1000 ft^2)	UL	45	UL	45	UL	45	43	21.5	25	12.5	37	18.5	25	12.5	41	20.5	28	14	18	9
Class 3 Facilities																					
Category A Animals	**Stories**	UL	NP	UL	NP	12	NP	4	NP	3	NP	4	NP	3	NP	4	NP	3	NP	2	NP
	Area (1000 ft^2)	UL	NP	UL	NP	UL	NP	31	NP	19	NP	28	NP	19	NP	30	NP	23	NP	12	NP
Category B Animals	**Stories**	UL	UL	UL	UL	12	11	4	3	3	2	4	3	3	2	4	3	3	2	2	1
	Area (1000 ft^2)	UL	45	UL	45	UL	45	31	15.5	19	9.5	28	14	19	9.5	30	15	23	11.5	12	6

For SI units, 1 ft = 0.3048 m, 1 ft^2 = 0.093 m^2.
S: Sprinklered. Allowable facility height in feet and allowable number of stories above grade in facilities protected with an automatic sprinkler system as specified in 7.2.2.
N: Nonsprinklered. Allowable facility height in feet and allowable number of stories above grade in facilities not protected with an automatic sprinkler system as specified in 7.2.2.
UL: Unlimited.
NP: Not permitted.
Note: Within each subclassification, “Stories” refers to the allowable number of stories above grade where the animal housing facilities are permitted to be located; “Area” refers to the allowable area per story.

7.2.4.2.1 The location of each separated subclassification in the animal housing facility shall comply with the story requirements of 7.2.2.

7.2.4.2.2 For each story in the animal housing facility, the sum of the ratios of the per story area of each separated subclassification divided by the allowable area per story as determined by Table 7.2.2 shall not exceed 1.0.

7.3 Stall, Cage, and Enclosure Requirements.

7.3.1 Stalls, cages, and enclosure requirements shall be based on established standards for the specific animal and facility type.

7.3.2* Animal enclosures shall not interfere with egress or extrication from the enclosure.

7.3.3 Modifications to 7.3.1 and 7.3.2 shall be permitted for temporary (i.e., less than 12 hours) holding areas with the approval of the AHJ.

7.4 Exposure Protection. Adjacent buildings shall be separated in accordance with *NFPA 5000*, Chapter 7.

7.5 Structural Design.

7.5.1 Structural design shall be subject to the requirements of *NFPA 5000*, Chapter 35, and this section.

7.5.2* Structural design criteria for walls and fence assemblies providing animal containment shall be designed to withstand the horizontal forces exerted by the animal occupants.

7.6 Fire-Rated Separations Between Animal Housing Facilities and Hazardous Areas.

7.6.1 Animal housing facilities shall be separated with a 2-hour fire resistance-rated enclosure from hazardous areas, including, but not limited to, feed rooms, tack rooms, vehicle or equipment storage rooms, blacksmith shops, kitchens, mechanical equipment rooms, and similar areas.

7.6.2 In buildings protected throughout with an approved, supervised automatic sprinkler system in accordance with NFPA 13, animal housing facilities shall be permitted to be separated with a 1-hour fire resistance-rated enclosure from the hazardous areas identified in 7.6.1.

7.7 Wildland/Urban Interface or Wildland/Urban Intermix. Animal housing facilities located in a wildland/urban interface or wildland/urban intermix shall comply with this standard and the construction requirements of NFPA 1144.

Chapter 8 Means of Egress Requirements

8.1 General. Means of egress for Category A and Category B animals shall be in accordance with this chapter.

8.1.1* Category A. Category A animals that can be safely egressed to a holding area, without human contact, shall have adequate means of egress provided.

8.1.2 Category B. Category B animals, which will egress with an animal handler, shall have means of egress that comply with NFPA *101* or *NFPA 5000*, and 8.1.2.1 through 8.1.2.4.

8.1.2.1 Number of Means of Egress.

8.1.2.1.1 Two means of egress for human and animal occupants, as a minimum, shall be provided in every facility, section, and area where size, occupancy, and arrangement endanger occupants attempting to use a single means of egress that is blocked by fire or smoke.

8.1.2.1.2 Where two means of egress are required, they shall be arranged to minimize the possibility that both might be rendered impassable by the same emergency condition.

8.1.2.2 Minimum Width of Doors. The minimum width of the door openings in means of egress shall be the greater of the following:

(1) Clear width of 32 in. (815 mm)
(2)* One-and-one-half times the largest average width of the following:
  (a) Largest animal using the door
  (b) Any associated equipment necessary for egress

8.1.2.3 Minimum Height of Doors. The minimum height of the door openings in means of egress shall accommodate the animal, human, and any associated equipment.

8.1.2.4* Exit Travel Distances.

8.1.2.4.1 In animal housing facilities not sprinklered in accordance with Section 9.2, or in animal housing facilities containing agricultural livestock, exit travel distance shall not exceed 75 ft (23 m) from any point in the facility.

8.1.2.4.2 In animal housing facilities sprinklered in accordance with Section 9.2, exit travel distance shall not exceed 100 ft (30 m) from any point in the facility.

8.2* Animal Occupant Load. Animal occupant load shall be determined based upon approved industry standards specific to the size of the animal and the stall, cage, and enclosure configurations.

Chapter 9 Requirements for Protection from Fire and Special Hazards

9.1 General.

9.1.1 Requirements for protection from fire and special hazards shall be in accordance with NFPA 1, NFPA *101*, or *NFPA 5000*, and this chapter.

9.1.2 Where a change in subclassification occurs and the installed fire protection systems are no longer necessary or no longer required, the facility owner shall either maintain the systems in full operation or completely remove them.

9.2 Sprinkler Protection.

9.2.1 Where automatic sprinklers are required by this standard throughout the animal housing facility, the system shall be installed in accordance with the requirements of Section 9.2 and the requirements of NFPA 13.

9.2.2 Occupancy and commodity classifications shall be in accordance with NFPA 13.

9.2.3 Quick-response sprinklers shall be utilized in animal housing facilities.

9.2.4 Automatic sprinkler systems shall be arranged to transmit the alarm automatically via any of the following means acceptable to the authority having jurisdiction and shall be in accordance with *NFPA 72*:

(1) Auxiliary fire alarm system
(2) Central station fire alarm system
(3) Proprietary supervision station fire alarm system
(4) Remote supervising station fire alarm system

9.2.4.1 Where a fire alarm system is not required by another section of this standard, automatic sprinkler system monitoring shall be in accordance with 23.8.5.5 of *NFPA 72*.

9.2.4.2 A single manual pull station shall be provided in accordance with 23.8.5.1 of *NFPA 72* at a location approved by the authority having jurisdiction.

9.3 Fire Alarm Systems.

9.3.1 Where fire alarm systems are required by this standard throughout the animal housing facility, alarm systems shall be in accordance with *NFPA 72* and the requirements of this section.

9.3.2 The alarm system shall sound an audible and visual exterior alarm for purposes of initiating emergency action.

9.3.2.1* Modifications to 9.3.2 shall be permitted to accommodate the needs of the animal occupants, with approval of the AHJ.

9.3.3 Where fire alarm graphic annunciator panels are provided, they shall identify animal areas within the building.

9.3.4 Where the locations of animal facilities are sensitive, the specific locations of animal housing will be provided to the fire department but will not be subject to the graphic annunciator panel requirement in 9.3.3.

9.4 Fire Extinguishers.

9.4.1 Where fire extinguishers are required by this standard throughout the animal housing facility, fire extinguishers shall be provided in accordance with NFPA 10.

9.4.2 Extinguishers in accordance with 9.4.1 shall have a minimum 2-A:10-B:C rating and shall be not more than a 50 ft (15.2 m) travel distance from any point within the animal housing facility.

9.4.3 Livestock areas not typically occupied by humans shall have a minimum 2-A:10:B:C extinguisher located at each exit.

9.4.4 Placement of the fire extinguishers shall be determined by the AHJ so as to prevent injury to or damage by the animal occupants.

9.5 Lightning Protection. Where lightning protection is required by the local building code, lightning protection shall be in accordance with NFPA 780.

9.6 Special Hazards.

9.6.1 Open Burning.

9.6.1.1* No open burning shall be permitted.

9.6.1.2 Open flame heating devices shall not be allowed other than as permitted by the following:

(1) NFPA 31, *Standard for the Installation of Oil-Burning Equipment*
(2) NFPA 54/ANSI Z223.1, *National Fuel Gas Code*
(3) NFPA 58, *Liquefied Petroleum Gas Code*
(4) *NFPA 70, National Electrical Code*
(5) NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*
(6) NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems*
(7) NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*

9.6.1.3 For animal housing facilities with fuel-burning appliances or equipment, carbon monoxide detection shall be installed in accordance with NFPA 720.

9.6.2 Smoking.

9.6.2.1 Smoking shall be prohibited in animal housing facilities.

9.6.2.2 Warning signs shall be posted.

9.6.3 Waste Removal and Housekeeping.

9.6.3.1 A procedure for general housekeeping, cleanliness, animal waste removal, and orderliness shall be maintained.

9.6.3.2 Detached noncombustible trash containers located no less than 20 ft (6 m) from any animal housing structure, for other than animal waste, shall be provided and a frequent removal program shall be established.

9.6.3.3 Aisles, hallways, or other types of corridors of animal housing facilities shall not be used in any form for permanent storage.

9.6.4 Electrical Systems and Appliances.

9.6.4.1* Electrical systems and appliances shall be installed in accordance with the requirements of *NFPA 70.*

9.6.4.2 Use of any portable electrical appliance shall be restricted as follows:

(1) Multiple-outlet adapters shall be prohibited.
(2) Not more than one continuous extension cord shall be used to connect one appliance to the fixed receptacle, and such cord shall be listed for hard service and properly sized for the intended application.
(3) Extension cords shall be used only on a temporary (immediate) basis.

9.6.4.3 Extension cords shall not be supported by any metal objects such as nails, screws, hooks, or pipes.

9.6.4.4 Plug caps and receptacles used in extension cords shall be heavy-duty type equipped with a reliable grounding pole and shall be attached to the cord in a manner to provide strain relief.

9.6.4.5 All electrical appliances used in the animal housing facility shall be listed for commercial use.

9.6.4.6 Outdoor electrical appliances served by the animal housing facility's electrical system shall be installed in accordance with *NFPA 70.*

9.6.4.7 Portable cooking and heating appliances shall be used only in spaces designated for such use and separated from the animal housing facility.

9.6.4.8 Portable electrical heating and cooking appliances shall be of a type that automatically interrupts electrical current to the heating element when the appliance is not in its normal operating position (tip-over disconnect).

9.6.4.9 Use of exposed-element heating appliances, such as immersion heaters and space heaters, shall be prohibited.

9.6.4.10 Receptacles and wiring shall be installed in positions that minimize the possibility of damage by or injury to the animal occupants.

9.6.4.11 Permanently installed lighting shall be provided throughout the animal housing facility.

9.6.5 Flammable Liquids. The storage of flammable and combustible liquids, except those used for medicinal purposes, shall be prohibited.

9.6.6 Control of Vehicular Traffic.

9.6.6.1 All vehicular access shall be subject to local established rules.

9.6.6.2 Aisles, hallways, and other types of corridors shall be maintained clear of obstruction at all times, and access to fire equipment shall not be blocked.

9.7 Vertical Openings. Where required by the AHJ, every vertical opening between the floors of an animal housing facility shall be enclosed or protected, as necessary, to provide the following:

(1) Reasonable safety to animal and human occupants while using the means of egress by preventing spread of fire, smoke, or fumes through vertical openings from floor to floor to allow occupants to complete their use of the means of egress
(2) Limitation of damage to the facility and its contents

9.8 Special Requirements for Category A Animals.

9.8.1 Sprinkler Systems. Animal housing facilities with Category A animals or horses shall be sprinklered throughout in accordance with Section 9.2.

9.8.2 Smoke Control Systems. Animal housing facilities with Category A animals or horses shall have a smoke control system unless modified as approved by the AHJ.

9.8.2.1* Smoke control systems shall be installed, inspected, tested, and maintained in accordance with NFPA 92 or nationally recognized standards, engineering guides, or recommended practices.

9.8.2.2 The engineer of record shall identify clearly the intent of the system, the design method used, the appropriateness of the method used, and the required means of inspecting, testing, and maintaining the system.

9.8.2.3 Acceptance testing shall be performed by a special inspector in accordance with the following:

(1) Special inspections and tests shall be performed to verify the operation of the smoke control system in its final condition for acceptance by the AHJ.
(2) The design documents shall provide the procedures and methods to be used and items subject to special inspections and tests.
(3) The special inspector shall submit an inspection and test report to the AHJ and registered design professional.

9.8.2.4 Smoke Control System Operation.

9.8.2.4.1 Smoke control systems shall be activated automatically by sprinkler waterflow, smoke detection, or other approved detection systems in accordance with *NFPA 72.* Smoke control systems shall remain operational throughout the emergency.

9.8.2.4.2 Means for manual operation of smoke control systems shall be provided at an approved location.

9.8.3* Areas Requiring Human Attendance. With the approval of the AHJ, surgical, procedure, and treatment areas where animals are anesthetized or otherwise require human attendance shall be designed, constructed, and maintained with a defend-in-place strategy to allow continued human attendance to minimize the unnecessary loss of animal life.

9.8.4* Additional Safeguards. For animal housing facilities with Category A animals, the AHJ shall be permitted to require additional safeguards necessary to protect animal occupants that cannot be evacuated safely.

Chapter 10 Interior Finishes, Contents, and Furnishings

10.1 General.

10.1.1 Interior finishes, contents, and furnishings shall be in accordance with Section 10.2 of NFPA *101*, or Sections 10.2 and 10.3 of *NFPA 5000*, and this chapter.

10.1.1.1 Interior wall and ceiling finish materials shall be Class A or Class B in accordance with ASTM E84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, or ANSI/UL 723, *Standard for Test of Surface Burning Characteristics of Building Materials*, in exits and in exit access corridors.

10.1.1.2 Interior wall and ceiling finish materials shall be Class A, Class B, or Class C in accordance with ASTM E84 or ANSI/UL 723 in all other areas.

10.1.1.3 Interior wall and ceiling finish materials tested in accordance with NFPA 286 and complying with the requirements shown in Section 10.2 of NFPA *101*, or Sections 10.2 and 10.3 of *NFPA 5000,* shall be permitted to be used in all areas where a Class A, Class B, or Class C finish material is used in accordance with ASTM E84 or ANSI/UL 723.

10.1.2 The toxicity of finishes, contents, furnishings, and their treatments for the animals housed in the facility shall be minimized.

10.2 Insulation. Exposed insulation shall not be permitted in animal housing facilities.

Chapter 11 Class 1 Animal Housing Facilities

11.1 General.

11.1.1* Application. Class 1 animal housing facilities shall be in accordance with NFPA *101*, Chapter 42; or *NFPA 5000*, Chapter 30, as a minimum, and this chapter.

11.1.2 Minimum Construction Requirements. Class 1 animal housing facilities shall be constructed in accordance with Chapter 7.

11.1.3 Occupant Load.

11.1.3.1* Human Occupants. In Class 1 animal housing facilities, the occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined in accordance with NFPA *101*, Chapter 42; or *NFPA 5000*, Chapter 30, as a minimum.

11.1.3.2 Animal Occupants. In Class 1 animal housing facilities, the occupant load, in number of animals for whom means of egress and other provisions are required, shall be determined in accordance with Chapter 8.

11.2 Means of Egress Requirements.

11.2.1 General. Each required means of egress shall be in accordance with the applicable portions of Chapter 8.

11.2.2 Means of Egress Components.

11.2.2.1 General. Components of means of egress shall be limited to the types described in NFPA *101*, Chapter 7; or *NFPA 5000*, Chapter 11; Chapter 8 of this standard; and as modified in this subsection.

11.2.2.2 Ramps.

11.2.2.2.1 Ramps complying with NFPA *101* and *NFPA 5000* shall be permitted for human occupants.

11.2.2.2.2* Ramps for animal egress shall be designed to safely accommodate the animal occupants.

11.2.3 Number of Means of Egress. See Chapter 8.

11.2.4 Special Means of Egress Features. (Reserved)

11.3 Protection.

11.3.1 Detection, Alarm, and Communications Systems.

11.3.1.1 General. A fire alarm system in accordance with Section 9.3 shall be required in accordance with this subsection.

11.3.1.1.1 In animal housing facilities greater than 3000 ft^2 (280 m^2) but no more than 20,000 ft^2 (1860 m^2), a local fire alarm system shall be provided.

11.3.1.1.2 In animal housing facilities greater than 20,000 ft^2 (1860 m^2), a monitored fire alarm system shall be provided.

11.3.1.2 Existing Systems. Approved existing installations shall be permitted to be continued in use.

11.3.2 Carbon Monoxide Detection Systems. For animal housing facilities with fuel-burning appliances or equipment, carbon monoxide detection shall be installed in accordance with 9.6.1.3.

11.3.3 Fire Extinguishers. Fire extinguishers shall be provided in accordance with Section 9.4.

11.3.4 Lightning Protection. Lightning protection shall be required in accordance with Section 9.5.

11.3.5 Special Hazards. Special hazards shall be addressed in accordance with Section 9.6.

11.3.6 Vertical Openings. Where required by the AHJ, vertical openings shall be in accordance with Section 9.7.

11.3.7 Special Requirements for Category A Animals. Class 1 animal housing facilities with Category A animals or horses shall be in accordance with Section 9.8.

11.3.8 Interior Finishes, Contents, and Furnishings. Interior finishes, contents, and furnishings shall be in accordance with Chapter 10.

11.4 Operating Features.

11.4.1 Disaster/Emergency Management Programs. A disaster/emergency management program shall be required in accordance with 4.3.4.

11.4.2 Disaster/Emergency Drills. In all Class 1 animal housing facilities, animal handlers, employees, and supervisory personnel shall hold disaster/emergency drills once annually in accordance with 4.3.5.

11.4.3 Extinguisher Training. All employees of Class 1 animal housing facilities shall be annually instructed in the use of portable fire extinguishers.

Chapter 12 Class 2 Animal Housing Facilities

12.1 General.

12.1.1* Application. Class 2 animal housing facilities shall be in accordance with NFPA *101*, Chapter 38, or *NFPA 5000*, Chapter 28, as a minimum, and this chapter.

12.1.2 Minimum Construction Requirements. Class 2 animal housing facilities shall be constructed in accordance with Chapter 7.

12.1.3 Occupant Load.

12.1.3.1 Human Occupants. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined in accordance with NFPA *101*, Chapter 38, or *NFPA 5000*, Chapter 28, as a minimum.

12.1.3.2 Animal Occupants. In Class 2 animal housing facilities, the occupant load, in number of animals for whom means of egress and other provisions are required, shall be determined in accordance with Chapter 8.

12.2 Means of Egress Requirements.

12.2.1 General. Each required means of egress shall be in accordance with the applicable portions of Chapter 8.

12.2.2 Means of Egress Components.

12.2.2.1 General. Components of means of egress shall be limited to the types described in NFPA *101*, Chapter 7; or *NFPA 5000*, Chapter 11; Chapter 8 of this standard; and as modified in this subsection.

12.2.2.2 Ramps.

12.2.2.2.1 Ramps complying with NFPA *101* and *NFPA 5000* shall be permitted for human occupants.

12.2.2.2.2* Ramps for animal egress shall be designed to safely accommodate the animal occupants.

12.2.3 Number of Means of Egress. See Chapter 8.

12.2.4 Special Means of Egress Features. (Reserved)

12.3 Protection.

12.3.1 Detection, Alarm, and Communications Systems.

12.3.1.1 General. A fire alarm system in accordance with Section 9.3 shall be required in accordance with this subsection.

12.3.1.1.1 In animal housing facilities greater than 3000 ft^2 (280 m^2) but no more than 10,000 ft^2 (930 m^2), a local fire alarm system shall be provided.

12.3.1.1.2 In animal housing facilities greater than 10,000 ft^2 (930 m^2), a monitored fire alarm system shall be provided.

12.3.1.2 Existing Systems. Approved existing installations shall be permitted to be continued in use.

12.3.2 Carbon Monoxide Detection Systems. For animal housing facilities with fuel-burning appliances or equipment, carbon monoxide detection shall be installed in accordance with 9.6.1.3.

12.3.3 Fire Extinguishers. Fire extinguishers shall be provided in accordance with Section 9.4.

12.3.4 Lightning Protection. Lightning protection shall be required in accordance with Section 9.5.

12.3.5 Special Hazards. Special hazards shall be addressed in accordance with Section 9.6.

12.3.6 Vertical Openings. Where required by the AHJ, vertical openings shall be in accordance with Section 9.7.

12.3.7 Special Requirements for Category A Animals. Class 2 animal housing facilities with Category A animals or horses shall be in accordance with Section 9.8.

12.3.8 Interior Finishes, Contents, and Furnishings. Interior finishes, contents, and furnishings shall be in accordance with Chapter 10.

12.4 Operating Features.

12.4.1 Disaster/Emergency Management Programs. A disaster/emergency management program shall be required in accordance with 4.3.4.

12.4.2 Disaster/Emergency Drills. In all Class 2 animal housing facilities, animal handlers, employees, and supervisory personnel shall hold disaster/emergency drills annually in accordance with 4.3.5.

12.4.3 Extinguisher Training. All employees of Class 2 animal housing facilities shall be annually instructed in the use of portable fire extinguishers.

Chapter 13 Class 3 Animal Housing Facilities

13.1 General.

13.1.1* Application. Class 3 animal housing facilities shall be in accordance with NFPA *101*, Chapter 36, or *NFPA 5000*, Chapter 27, as a minimum, and this chapter.

13.1.2 Minimum Construction Requirements. Class 3 animal housing facilities shall be constructed in accordance with Chapter 7.

13.1.3 Occupant Load.

13.1.3.1 Human Occupants. The occupant load, in number of persons for whom means of egress and other provisions are required, shall be determined in accordance with NFPA *101*, Chapter 36, or *NFPA 5000*, Chapter 27, as a minimum.

13.1.3.2 Animal Occupants. In Class 3 animal housing facilities, the occupant load, in number of animals for whom means of egress and other provisions are required, shall be determined in accordance with Chapter 8.

13.2 Means of Egress Requirements.

13.2.1 General. Each required means of egress shall be in accordance with the applicable portions of Chapter 8.

13.2.2 Means of Egress Components.

13.2.2.1 General. Components of means of egress shall be limited to the types described in NFPA *101*, Chapter 7; or *NFPA 5000*, Chapter 11; Chapter 8 of this standard; and as modified in this subsection.

13.2.2.2 Ramps.

13.2.2.2.1 Ramps complying with NFPA *101* and *NFPA 5000* shall be permitted for human occupants.

13.2.2.2.2* Ramps for animal egress shall be designed to safely accommodate the animal occupants.

13.2.3 Number of Means of Egress. See Chapter 8.

13.2.4 Special Means of Egress Features. (Reserved)

13.3 Protection.

13.3.1 Detection, Alarm, and Communications Systems.

13.3.1.1 General. A monitored fire alarm system in accordance with Section 9.3 shall be required in all Class 3 animal housing facilities.

13.3.1.2 Existing Systems. Approved existing installations shall be permitted to be continued in use.

13.3.2 Carbon Monoxide Detection Systems. For animal housing facilities with fuel-burning appliances or equipment, carbon monoxide detection shall be installed in accordance with 9.6.1.3.

13.3.3 Fire Extinguishers. Fire extinguishers shall be provided in accordance with Section 9.4.

13.3.4 Lightning Protection. Lightning protection shall be required in accordance with Section 9.5.

13.3.5 Special Hazards. Special hazards shall be addressed in accordance with Section 9.6.

13.3.6 Vertical Openings. Where required by the AHJ, vertical openings shall be in accordance with Section 9.7.

13.3.7 Special Requirements for Category A Animals. Class 3 animal housing facilities with Category A animals or horses shall be in accordance with Section 9.8.

13.3.8 Interior Finishes, Contents, and Furnishings. Interior finishes, contents, and furnishings shall be in accordance with Chapter 10.

13.4 Operating Features.

13.4.1 Disaster/Emergency Management Programs. A disaster/emergency management program shall be required in accordance with 4.3.4.

13.4.2 Disaster/Emergency Drills. In all Class 3 animal housing facilities, animal handlers, employees, and supervisory personnel shall hold disaster/emergency drills semiannually in accordance with 4.3.5.

13.4.3 Extinguisher Training. All employees of Class 3 animal housing facilities shall be annually instructed in the use of portable fire extinguishers.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 The requirements of NFPA 150 recognize the following fundamental principles:

(1) Animals are sentient beings with a value greater than that of simple property.
(2) Animals, both domesticated and feral, lack the ability of self-preservation when housed in buildings and other structures.
(3) Current building, fire, and life safety codes do not address the life safety of the animal occupants.

The requirements found in NFPA 150 are written with the intention that animal housing facilities will continue to be designed, constructed, and maintained in accordance with the applicable building, fire, and life safety codes. The requirements herein are not intended to replace or rewrite the basic requirements for the human occupants. Instead, NFPA 150 provides additional minimum requirements for the protection of the animal occupants and the human occupants who interact with those animals in these facilities.

NFPA 150 is divided into three major sections: The first section, Chapters 1 through 3, contains only administrative requirements, while the second section, Chapters 4 through 10, provides general requirements for all facilities housing animals (i.e., facility subclassification, animal category, construction, means of egress, fire protection, and interior finish requirements), and the third section, Chapters 11–13, includes specific requirements focused on the class of the facility.

A.1.3.1 While it would be appropriate for NFPA 150 to clearly establish a minimum number of animals above which the requirements of NFPA 150 apply, the necessary technical information to make these decisions is simply not available at this time. Instead, in 1.3.1, it is stated that, if a facility requires a permit or license from the local, state, or federal authorities to function, it must comply with this standard. With this approach, it is understood that an adopting jurisdiction could further modify the application of the standard to fit its local situation.

A.1.3.3 An extensive modification includes modification of an entire building or an entire occupancy within a building and should be considered a reconstruction. Modification work that is exclusively electrical, mechanical, or structural or that exclusively involves plumbing or equipment used in the care or treatment of animals or the fire protection system should not be considered a reconstruction, regardless of its extent. Where the total area of all the rehabilitation work areas included in a modification exceeds 50 percent of the area of the building, the work should be considered a reconstruction.

A.1.3.4 In this particular situation, the definition of *temporary* is left to the applicable building, life safety, and fire codes enforced in the jurisdiction.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.2.1 Confined Animals. This includes animals in pens near or adjacent to a structure where they would be endangered by smoke, heat, fire spread, or structural failure.

A.3.3.3 Animal Handler. This includes but is not limited to attendants, exhibitors, hands, keepers, groomers, technicians, trainers, veterinarians, wranglers, or their assistants.

A.3.3.4 Animal Housing Facility. This includes but is not limited to barns, kennels, coops, stables, sheds, pens, corrals, runs, vivaria, terraria, laboratories, and zoos. Adjacent exterior spaces include areas near or adjacent to a structure where confined animals would be endangered by smoke, heat, fire spread, or structural failure.

A.3.3.17 Protection. For the purposes of this standard, *protection* takes various distinct forms. The specific provision of the standard will address what the standard intends as an acceptable device, material, or system. With regard to structural fire protection, *protection* or *protected* usually means an assembly of materials that have achieved a specified level of fire resistance as demonstrated by NFPA 251 (withdrawn). For fire suppression systems, *protected* usually means being provided with an approved automatic sprinkler system or similar automatic fire suppression system. The type of *protection* desired must be clearly understood within the context of the item under consideration.

A.4.1 The overall goals of this standard are presented in 4.1.1. These overall goals are treated in greater depth in 4.1.3 and 4.1.4. In each of these subsections, an overall goal for the subsection is defined, specific goals relating to the overall goal are presented, and the objectives that relate to the specific goal follow. This format is intended to enhance the usability of the standard.

A.4.1.1 These highest level goals are intentionally general in nature. Each includes a broad spectrum of topics as shown in 4.1.3 and 4.1.4. Property protection is not included as a highest level goal, as it is contained in most of the other goals.

Safety is intended to indicate a need for protection against immediate or short-duration hazards, such as a fire or similar emergency.

A.4.1.2 The objectives are stated in more specific terms than the goals and tend to be more quantitative.

A.4.1.3.1.1 The phrase "reasonably safe from fire" is defined by subsequent language in this standard, primarily in the objectives.

A.4.1.3.1.2.2 In many cases, the other provisions of the standard that provide safety for occupants will satisfy this goal for protection of emergency responders.

A.4.1.3.2.1 The phrase "reasonably safe during normal use" is defined by subsequent language in this standard, primarily in the objectives. Certain requirements are provided to ensure that the occupants are safe during nonemergency use of the buildings. Failure to address these features could result in injuries to occupants in their normal day-to-day activities in the building.

A.4.1.3.2.2.3 Appropriate consideration should be given to the type of audible device selected, since some animals might respond in a detrimental way given a certain signal (e.g., a bell would be inappropriate as a fire alarm in a racetrack stable).

A.4.1.4.1.1 The long-term function of a building, in total, is not within the scope of this goal. This goal relates, however, to the long-term, continued operation and effectiveness of the building to satisfy the goals of safety and usability.

A.4.1.4.1.2 This objective is intended to apply to systems, features, and construction that are provided in the building for the purpose of meeting the other objectives and is not intended to apply to nonrequired systems, features, and construction.

A.4.2.4 Fire alarms alert occupants to initiate emergency procedures, facilitate orderly conduct of fire drills, and initiate response by emergency services.

A.4.3.1.3 This standard is not intended to address every conceivable arrangement of construction or use of animal housing facilities. These structures are unique in that the life safety of two important, but dramatically different, forms of life are addressed — humans and animals. These structures often involve the interaction of animals and people that are unfamiliar with one another's reaction to fire or other emergency conditions. For instance, for mobility impaired or other disabled individuals, the ability of the humans to egress can be impaired, hindered, or jeopardized by the movement of the animals. These facilities can also be located within or close to a process or other occupancy that elevates the risk to animals, but perhaps not to humans, beyond that contemplated by the standard. These facilities can be housed in a historic building.

If these or other special circumstances clearly exist, the AHJ can require alternative or additional fire protection features. These can include, but are not limited to, a performance-based analysis of the special condition, building fire evacuation plans, management policies on staff response to emergencies, a higher staff-to-client ratio, increased fire resistance ratings, or modification of fire suppression or fire alarm requirements.

A.4.3.4.2.1 Disaster/emergency management programs should include the following items based on the type of occupancy and hazards involved:

(1) Procedures for reporting of emergencies requiring relocation and/or evacuation of occupants
(2) Occupants or staff member duties during emergencies
(3) Floor plans identifying the locations of portable fire extinguishers, other manual fire-extinguishing equipment, other automatic or manual fire suppression systems, first aid equipment, hazardous material spill equipment, and equipment designated as necessary for the evacuation of animals
(4) Manual fire alarm pull stations and fire alarm control panels
(5) Floor plans identifying the primary and secondary routes of evacuation for each room or portion of the occupancy
(6) Floor plans indicating the locations of interior areas of refuge and animal occupied areas
(7) Site maps identifying the designated exterior assembly area for each evacuation route
(8) Assessments of both building systems and management features
(9) Use of alarms
(10) Transmission of alarm to fire department
(11) Response to alarms
(12) Procedures for isolation and/or extinguishment of fire
(13) Properties and location of hazardous storage or operations
(14) Special procedures for staff members who perform or shut down critical plant operations and/or attend to Category A animals
(15) A system to account for animal and human occupants and staff members after evacuation
(16) Designation of an emergency response coordinator and a back-up coordinator
(17) An alternate means of communications other than the fire alarm
(18) Emergency contact information
(19) Special procedures for animal handlers to address such items as animal bites and animal escapes

A.4.3.5 The purpose of disaster/emergency drills is to educate the participants in the fire safety features of the building, the egress facilities available, safe handling of the animal occupants, and the procedures to be followed. Speed in emptying buildings or relocating occupants, while desirable, is not the only objective. Prior to an evaluation of the performance of a disaster/emergency drill, an opportunity for instruction and practice should be provided. This educational opportunity should be presented in a nonthreatening manner, with consideration to the prior knowledge, age, and ability of the audience.

A.4.3.5.2.2 If a disaster/emergency drill is considered merely as a routine exercise from which some persons are allowed to be excused, there is a grave danger that, in an actual emergency, the evacuation and relocation will not be successful. However, there could be circumstances under which all occupants do not participate in a disaster/emergency drill.

A.5.1 The performance-based option of this standard establishes acceptable levels of risk for buildings and structures as addressed in Section 1.2. While the performance-based option of this standard does contain goals, objectives, and performance criteria necessary to provide for an acceptable level of risk, it does not describe how these goals, objectives, and performance criteria are to be met. Design and engineering are needed to meet the provisions of Chapter 5.

A.5.1.3 A third-party reviewer is a person or group of persons chosen by the authority having jurisdiction to review proposed performance-based designs. Qualifications of the third-party reviewer should include experience, education, and credentials that demonstrate knowledgeable and responsible use of applicable models and methods.

A.5.1.5 For guidance on reviewing performance-based designs, see the SFPE *Enforcer's Guide to Performance-Based Design Review*. Additional guidance on reviewing designs in which fire risk analysis is used can be found in NFPA 551.

A.5.1.6 Continued compliance with the goals and objectives of the standard involves many factors. The building construction — including openings, interior finish, and fire- and smoke-resistive construction — and the building and fire protection systems need to retain at least the same level of performance as is provided for the original design parameters. The use and occupancy should not change to the degree that assumptions made about the occupant characteristics, combustibility of furnishings, and existence of trained personnel are no longer valid. In addition, actions provided by other personnel, such as emergency responders, should not be diminished below the documented assumed levels. Also, actions necessary to maintain reliability of systems at the anticipated level need to meet the initial design criteria.

A.5.2.2.2 In many cases, the other provisions of the standard that provide safety for occupants will satisfy this goal for protection of emergency responders.

A.5.2.3.1 The phrase “reasonably safe during normal use” is defined by subsequent language in this standard, primarily in the objectives. Certain requirements are provided to ensure that the occupants are safe during nonemergency use of the buildings. Failure to address these features could result in injuries to occupants in their normal day-to-day activities in the building.

A.5.2.3.2.3 Appropriate consideration should be given to the type of audible device selected, since some animals might respond in a detrimental way given a certain signal (e.g., a bell would be inappropriate as a fire alarm in a racetrack stable).

A.5.4 In the context of this standard, design characteristics are those attributes of the building and its location, systems, contents, and occupants that need to be specified or quantified, or both, to allow evaluation of a design with respect to the goals, objectives, and performance criteria, using appropriate design scenarios and verification methods. Some design characteristics are specified in this standard. Others might be specified by the authority having jurisdiction to accommodate local conditions, and still others might be specified by the designer of the building.

A.5.4.1.5 This requirement includes assumptions about the interrelations between the performance of building elements and systems, occupant behavior, or emergency response actions that conflict with each other. For each design scenario, care needs to be taken to ensure that conflicts in actions do not occur. Typical conflicts could include the following:

(1) Assuming a fire door will remain closed during the fire to contain smoke, while this same door is used by occupants during egress from the area
(2) Assuming fire apparatus will arrive immediately from a distant location to provide water to fire department connections.

For example, an assumption that compartmentation blocking the passage of fire and smoke will be maintained at the door to a stairwell cannot be paired with an assumption that evacuation through that door will extend over many minutes.

A.5.4.2.1 Building contents and furnishings are not normally included in design specifications; however, in some cases, they might have an impact on building or occupant behavior. Where contents and furnishings could affect building or occupant behavior, the designer must present the authority having jurisdiction with detailed information about such contents and furnishings and their locations in the building to enable an assessment of their impact in various design scenarios to be determined. A designer must also clearly express the overall layout of the building, especially those items that might not appear on building plans but that could affect the performance of the building or the occupants. Examples include the layout of office cubicles that could affect emergency egress and temporary storage areas that could exceed permissible loading for a portion of a floor assembly.

A.5.4.2.2 Systems addressed by this requirement include but are not limited to automatic fire suppression systems and fire alarm systems. Performance issues that need to be documented might include response time indexes, discharge densities, and waterflow distribution patterns. Calculations should not include an unlimited supply of extinguishing agent if only a limited supply will be provided in the actual structure or building.

A.5.4.3.1 Guidance on human characteristics for use in design can be found in the SFPE *Engineering Guide to Predicting Human Behavior in Fire*. Guidance on animal characteristics for use in design can be formulated based on discussions with facility staff, animal handlers, researchers, and other subject matter experts including but not limited to industry associations and regulatory agencies.

A.5.4.3.5 The guidelines cited in A.7.3 for the minimum areas for stalls, cages, and enclosure areas can be used to develop appropriate occupant loads for the animal occupants. For animals not covered in A.7.3, other recognized industry guidelines should be consulted. The number of people expected to be contained in a room or area should be based on the occupant load factor specified in other approved sources.

A.5.4.3.6 For example, in research facilities, staff characteristics such as number, location, quality, and frequency of training should be considered.

A.5.5 Many events can occur during the life of a building; some have a higher probability of occurrence than others. Some events, though not typical, could have a devastating effect on a building. A reasonable design should be able to achieve the goals, objectives, and performance criteria of this standard for any typical or common design scenario and for some of the nontypical, potentially devastating scenarios, up to a level commensurate with society's expectations as reflected in this standard.

The challenge in selecting design scenarios is finding a manageable number that are sufficiently diverse and representative so that, if the design is reasonably safe for those scenarios, it should then be reasonably safe for all scenarios, except for those specifically excluded as being unrealistically severe or sufficiently infrequent to be fair tests of the design.

A.5.8.1 The SFPE *Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings* describes the documentation that should be provided for a performance-based design.

Proper documentation of a performance design is critical to the design acceptance and construction. Proper documentation will also ensure that all parties involved understand what is necessary for the implementation, maintenance, and continuity of the fire protection design. If attention to detail is maintained in the documentation, then there should be little dispute during approval, construction, start-up, and use. Poor documentation could result in rejection of an otherwise good design, poor implementation of the design, inadequate system maintenance and reliability, and an incomplete record for future changes or for testing the design forensically.

A.5.8.11 Documentation for modeling should conform to ASTM E1472, *Standard Guide for Documenting Computer Software for Fire Models*, although most, if not all, models were originally developed before this standard was promulgated.

A.6.1.1 The user should reference *NFPA 5000* or NFPA *101* to obtain the general occupancy classification of an animal housing facility whether it's storage, business, mercantile, assembly, or other occupancy. If there are multiple occupancies within the facility, they will be in accordance with the mixed or separated occupancy requirements in *NFPA 5000*, Chapter 6, or NFPA *101*, Chapter 6. NFPA 150 and its subclassification, defined in Section 6.2, are intended to apply only to those portions of the facility housing animals.

A.6.2.1.1 Class 1 facilities include but are not limited to rest, feed, work, exercise, viewing, and production areas at facilities where there is no general public access or physical interaction with the animal occupants. These types of facilities include but are not limited to livestock and poultry processing plants, dairy barns, private breeding facilities, treatment and holding areas in veterinary clinics or hospitals, educational facilities, quarantine areas, respite facilities, and private kennel areas. It is assumed that these facilities will have no access by the general public, as defined in Chapter 3.

A.6.2.1.2 Class 2 facilities include but are not limited to rest, feed, work, exercise, viewing, and production areas at facilities where there is restricted general public access and interaction with the animal occupants. Restricted general public access permits limited access for people on an infrequent basis who do not have an intimate knowledge of the layout of the building or structure or the general behavior of the animals.

A.6.2.1.3 Class 3 facilities include but are not limited to rest, feed, work, exercise, production, or viewing areas at facilities where there is general public access and interaction with the animal occupants. These types of facilities include but are not limited to zoo display areas, petting zoos, show grounds/barns, and pet stores. General public access includes regular access for people who do not have an intimate knowledge of the layout of the building or structure or the general behavior of the animals.

A.6.2.4.1 See Figure A.6.2.4.1(a) and Figure A.6.2.4.1(b) for illustrations of the multiple subclassifications.

A.6.2.4.2 An example of a minor accessory subclassification could be a small public viewing area at a dairy production facility. The barn might meet the subclassification for a Class 1 facility. If the other subclassification is less than 25 percent of the gross floor area of the animal housing facility, then the provisions of a multiple subclassification would not apply, and the facility could be classified as the predominant subclassification (in this example, Class 1).

A.6.3.1.1(1) This includes wild or feral animals, zoonotic disease carriers, or poisonous animals.

A.6.3.1.1(2) This includes animals that are under anesthesia, injured or ill, immune-deficient, or infectious disease carriers.

A.6.3.1.1(3) This includes animals that are wild or feral, too large or too numerous, or in situations where there is inadequate staff-to-animal ratio for evacuation purposes or inadequate safeguards to deal with evacuated animals.

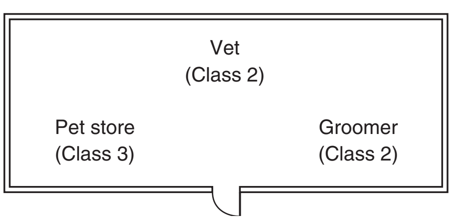

FIGURE A.6.2.4.1(a) Multiple Mixed Subclass.

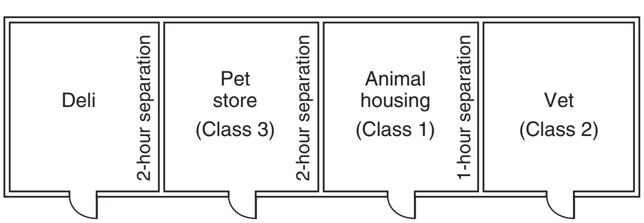

FIGURE A.6.2.4.1(b) Multiple Separated Subclass.

A.6.3.1.1(4) This includes animals that cannot be led by collars, halters, or other devices and equipment and animals that are not in mobile or rolling cages.

A.7.1 Table A.7.1 is a reprint of Table 7.2.1.1 from *NFPA 5000*.

A.7.2.2 Descriptions of the construction types found in Table 7.2.2 can be found in NFPA 220 and *NFPA 5000*.

A.7.3.2 Animals shall be able to lie down with their limbs extended in a normal manner without obstruction from enclosure sides or having to extend their feet through feed doors or bars.

A.7.5.2 Table A.7.5.2 lists the recommended animal enclosure horizontal design forces for a sampling of animals.

A.8.1.1 A holding area can be a temporary or permanent, internal or external area that provides a safe environment for an animal during an emergency. It could include, but is not limited to, a movable enclosure, pen, yard, paddock, or corral.

A.8.1.2.2(2) The width of the animal should be the widest part of the animal, including horns, antlers, and other appendages.

A.8.1.2.4 Exit distances are more stringent than those specified in NFPA *101* because of the difficulty of evacuating panicked animals from the facility in an emergency situation.

A.8.2 The guidelines cited in A.7.3 for the minimum areas for stalls, cages, and enclosure areas can be used to develop appropriate occupant loads for the animal occupants.

A.9.3.2.1 Consideration should be given to animal reactions and undue stress caused by audible sounds or flashing strobes. For example, in zoos, an acknowledge station where the keeper can disengage the notification appliances only in the animal areas could be incorporated into the design where acceptable to the AHJ. After the notification appliances are deactivated, another means, such as a red beacon, could be used as an alternative notification method. Other means acceptable to the AHJ might be more suitable for other animal housing occupancies.

A.9.6.1.1 This restriction is intended primarily to prohibit open flame heaters in the barn and stable-type areas. It is not intended to limit properly installed and equipped devices such as gas water heaters and blacksmith forges as long as they are approved by the AHJ.

A.9.6.4.1 Animal housing facilities containing agricultural livestock should be in accordance with *NFPA 70*, Article 547, Agricultural Buildings.

A.9.8.2.1 Because most animals require shelter in place, a smoke control system of some type is required. Tenable conditions such as the maximum and minimum exposure temperatures, sensitivity to sudden changes in temperature, maximum carbon monoxide concentrations, and the acceptable smoke layer height above the finished floor during a fire condition are not available for many animals. Data for design of an effective smoke control system can be obtained from facility staff, animal handlers, researchers, and other subject matter experts, including industry associations and regulatory agencies.

A.9.8.3 It is anticipated that if staff is to remain with anesthetized animals or animals that cannot be left unattended, addi-

Table A.7.1 Fire Resistance Ratings for Type I Through Type V Construction (hr)

	Type I		Type II			Type III		Type IV	Type V	
Construction Element	**442**	**332**	**222**	**111**	**000**	**211**	**200**	**2HH**	**111**	**000**
Exterior Bearing Walls[a]										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting one floor only	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting a roof only	4	3	1	1	0[b]	2	2	2	1	0[b]
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses, and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor-Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof-Ceiling Assemblies	2	1½	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls[c]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]

H: heavy timber members *(see text for requirements).*
[a]See *NFPA 5000*, 7.3.2.1.
[b]See *NFPA 5000*, Section 7.3.
[c]See *NFPA 5000*, 7.2.3.2.12, 7.2.4.2.3, and 7.2.5.6.8.
[**5000:** Table 7.2.1.1]

Table A.7.5.2 Animal Enclosure Design Forces

	Horizontal Force		Height Above Grade of Load Application	
Animal	**lb**	**N**	**ft**	**m**
Bull elephant	10,000	44,480	7	2.13
Female elephant	8,000	35,584	7	2.13
Hippopotamus	4,000	17,792	4	1.22
Rhinoceros	4,000	17,792	4	1.22
Lion	500	2,224	5	1.53
Cheetah	100	445	4	1.22
Giraffe	1,600	7,117	8	2.46
All other animals	500	2,224	4	1.22

Source: EPCOT Building Code, 1998.

tional safeguards would be necessary to ensure the safety of both human and animal occupants.

A.9.8.4 Additional safeguards can include such items as two-way communication, secondary animal containment, smoke compartments, and emergency response training and equipment in accordance with 4.3.4 (i.e., tranquilizers and other animal control equipment, and first-aid items).

A.11.1.1 Class 1 facilities are those facilities that are most closely related to storage occupancies. That is to say, they are characterized by relatively low human occupant loads in relation to the large size of the floor areas. The requirements found in Chapter 11 compare most closely to those requirements found in Chapter 42 of NFPA *101.* By no means should a Class 1 animal housing facility be automatically classified as a storage occupancy. The occupancy of an animal housing facility should be determined in accordance with NFPA *101* or *NFPA 5000,* based on the intended use of that facility. NFPA 150 makes additional requirements to safeguard the animal life within that facility.

A.11.1.3.1 In NFPA *101*, Chapter 42, there is no occupant load factor specified for storage occupancies. Rather, the actual probable maximum number of persons present needs to be considered in determining the occupant load.

A.11.2.2.2.2 Ramp design should be able to accommodate not only the size, weight, and capability of the animal, but also any animal handlers and equipment necessary for the animal's movement. It should also anticipate the animal's possible behavior during emergency situations.

A.12.1.1 Class 2 facilities are those facilities that are most closely related to business occupancies. These facilities typically include vet offices, grooming facilities, research labs, and so forth. The requirements found in Chapter 12 compare most closely to those requirements found in Chapter 38 of NFPA *101*. By no means should a Class 2 animal housing facility be automatically classified as a business occupancy. The occupancy of an animal housing facility should be determined in accordance with NFPA *101* or *NFPA 5000*, based on the intended use of that facility. NFPA 150 makes additional requirements to safeguard the animal life within that facility.

A.12.2.2.2.2 Ramp design should be able to accommodate not only the size, weight, and capability of the animal, but also any animal handlers and equipment necessary for the animal's movement. It should also anticipate the animal's possible behavior during emergency situations.

A.13.1.1 Class 3 facilities are those facilities that are most closely related to mercantile occupancies. In such facilities, the public might be in close proximity to the animals, in occupant loads typically associated with a mercantile occupancy. The requirements found in Chapter 13 compare most closely to those requirements found in Chapter 36 of NFPA *101*. By no means should a Class 3 animal housing facility be automatically classified as a mercantile occupancy. For instance, arenas with fixed seating for exhibition purposes of animals should probably be treated as assembly occupancies, since the public in the stands has little or no interaction with the animals and probably has separated means of egress from the animals. The occupancy of an animal housing facility should be determined in accordance with NFPA *101* or *NFPA 5000*, based on the intended use of that facility. NFPA 150 makes additional requirements to safeguard the animal life within that facility.

A.13.2.2.2.2 Ramp design should be able to accommodate not only the size, weight, and capability of the animal, but also any animal handlers and equipment necessary for the animal's movement. It should also anticipate the animal's possible behavior during emergency situations.

Annex B Sample Ordinance Adopting NFPA 150

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 The following sample ordinance is provided to assist a jurisdiction in the adoption of this standard and is not part of this standard.

ORDINANCE NO. ___________

An ordinance of the [*jurisdiction*] adopting the [*year*] edition of NFPA [*document number*], [*complete document title*], and documents listed in Chapter 2 of that [*code, standard*]; prescribing regulations governing conditions hazardous to life and property from fire or explosion; providing for the issuance of permits and collection of fees; repealing Ordinance No. _______ of the [*jurisdiction*] and all other ordinances and parts of ordinances in conflict therewith; providing a penalty; providing a severability clause; and providing for publication; and providing an effective date.

BE IT ORDAINED BY THE [*governing body*] OF THE [*jurisdiction*]:

SECTION 1 That the [*complete document title*] and documents adopted by Chapter 2, three (3) copies of which are on file and are open to inspection by the public in the office of the [*jurisdiction's keeper of records*] of the [*jurisdiction*], are hereby adopted and incorporated into this ordinance as fully as if set out at length herein, and from the date on which this ordinance shall take effect, the provisions thereof shall be controlling within the limits of the [*jurisdiction*]. The same are hereby adopted as the [*code, standard*] of the [*jurisdiction*] for the purpose of prescribing regulations governing conditions hazardous to life and property from fire or explosion and providing for issuance of permits and collection of fees.

SECTION 2 Any person who shall violate any provision of this code or standard hereby adopted or fail to comply therewith; or who shall violate or fail to comply with any order made thereunder; or who shall build in violation of any detailed statement of specifications or plans submitted and approved thereunder; or fail to operate in accordance with any certificate or permit issued thereunder; and from which no appeal has been taken; or who shall fail to comply with such an order as affirmed or modified by a court of competent jurisdiction, within the time fixed herein, shall severally for each and every such violation and noncompliance, respectively, be guilty of a misdemeanor, punishable by a fine of not less than $ _____ nor more than $_____ or by imprisonment for not less than ______ days nor more than ______ days or by both such fine and imprisonment. The imposition of one penalty for any violation shall not excuse the violation or permit it to continue; and all such persons shall be required to correct or remedy such violations or defects within a reasonable time; and when not otherwise specified the application of the above penalty shall not be held to prevent the enforced removal of prohibited conditions. Each day that prohibited conditions are maintained shall constitute a separate offense.

SECTION 3 Additions, insertions, and changes — that the [*year*] edition of NFPA [*document number*], [*complete document title*] is amended and changed in the following respects:

List Amendments

SECTION 4 That ordinance No. _________ of [*jurisdiction*] entitled [*fill in the title of the ordinance or ordinances in effect at the present time*] and all other ordinances or parts of ordinances in conflict herewith are hereby repealed.

SECTION 5 That if any section, subsection, sentence, clause, or phrase of this ordinance is, for any reason, held to be invalid or unconstitutional, such decision shall not affect the validity or constitutionality of the remaining portions of this ordinance. The [*governing body*] hereby declares that it would have passed this ordinance, and each section, subsection, clause, or phrase hereof, irrespective of the fact that any one or more sections, subsections, sentences, clauses, and phrases be declared unconstitutional.

SECTION 6 That the [*jurisdiction's keeper of records*] is hereby ordered and directed to cause this ordinance to be published.

[NOTE: An additional provision may be required to direct the number of times the ordinance is to be published and to specify that it is to be in a newspaper in general circulation. Posting may also be required.]

SECTION 7 That this ordinance and the rules, regulations, provisions, requirements, orders, and matters established and adopted hereby shall take effect and be in full force and effect [*time period*] from and after the date of its final passage and adoption.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 150, *Standard on Fire Safety in Racetrack Stables,* 2000 edition.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA 551, *Guide for the Evaluation of Fire Risk Assessments*, 2013 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2015 edition.

C.1.2 Other Publications.

C.1.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E1472, *Standard Guide for Documenting Computer Software for Fire Models*, 2007.

C.1.2.2 RCID Publications. Reedy Creek Improvement District, 1900 Hotel Plaza Blvd., Orlando, FL 32830-8438.

EPCOT Building Code, 1998 edition.

C.1.2.3 SFPE Publications. Society of Fire Protection Engineers, 7315 Wisconsin Avenue, Suite 1225 W, Bethesda, MD 20814.

Enforcer's Guide to Performance-Based Design Review, 2004.

Engineering Guide to Performance-Based Fire Protection Analysis and Design of Buildings, 2000.

Engineering Guide to Predicting Human Behavior in Fire, 2003.

C.2 Informational References. (Reserved)

C.3 References for Extracts in Informational Sections.

NFPA 5000®, *Building Construction and Safety Code*®, 2015 edition.

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NFPA®160

Standard for the

Use of Flame Effects Before an Audience

2016 Edition

This edition of NFPA 160, *Standard for the Use of Flame Effects Before an Audience,* was prepared by the Technical Committee on Special Effects. It was issued by the Standards Council on May 26, 2015, with an effective date of June 15, 2015, and supersedes all previous editions.

This edition of NFPA 160 was approved as an American National Standard on June 15, 2015.

Origin and Development of NFPA 160

NFPA 160, *Standard for Flame Effects Before an Audience,* was developed by the Technical Committee on Special Effects, which was established in 1994, in response to a recognized need for a document to provide guidance to public safety officials, designers, and operators of flame effects. The purpose of this standard is to provide requirements for reasonable protection for viewing audiences and performers of flame effects. The first edition of the standard was 1998.

For the 2001 edition, the Committee completed a partial revision of the standard. Revisions included amendments to standardized definitions, harmonization with the pyrotechnics special effects document, and editorial changes according to the *Manual of Style for NFPA Technical Committee Documents.*

The 2006 edition included a complete revision of the standard by the Committee. Key changes found in the 2006 edition included revisions to Chapter 3, Definitions; clarification of the document applicability by modifying the document title; definitions for temporary and permanent installations to correlate with the effect classifications based upon those terms; a new requirement for inspection intervals; and a new Annex C on inspection guidelines.

The 2006 edition of the standard also incorporated editorial changes according to the *Manual of Style for NFPA Technical Committee Documents.*

The 2011 edition of the standard incorporated amendments to the application section to clarify that NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations,* applies to flame effect use when no audience is present. The Committee added definitions for the terms *performer* and *support personnel* extracted from NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience,* for consistency between the special effects documents. Requirements for development and approval of the flame effects plan were included. The Committee revised the separation distance requirements to eliminate the thermal flux provision and retain the skin surface temperature requirements. The skin surface temperature is based on a test method that can be more easily performed in the field.

The 2016 edition of NFPA 160 defines a hybrid flame effect and adds requirements for their use. The new edition of NFPA 160 indicates which portions of hybrid flame effects are covered by NFPA 160 and which are covered by NFPA 1126, since both documents apply, and adds explanatory annex material to provide further guidance on the simultaneous application of NFPA 160 and NFPA 1126. The 2016 edition also clarifies that the use of ground-based effects utilizing explosives, liquid fuels, or other combustibles in air show environments is not covered by NFPA 160 and provides a reference for the use of such effects.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the controlled use of flame, pyrotechnics, or other means of special effects for entertainment, exhibition, demonstration, or simulation before a proximate audience; and the design, fabrication, installation, testing, control, operation, and maintenance of user equipment, fuel storage, and sources for special effects before a proximate audience. This Committee does not have responsibility for documents on hazards other than those involving a proximate audience and the life safety considerations of the audience.

NFPA 160

Standard for the

Use of Flame Effects Before an Audience

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex D. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1* Scope. This standard shall provide requirements for the protection of the audience, support personnel, performers, the operator, assistants, and property where flame effects are used.

1.2 Purpose. The purpose of this standard shall be to provide minimum requirements for the design, manufacture, and operation of flame effects.

1.3 Application.

1.3.1* This standard shall apply to flame effects for entertainment, exhibition, demonstration, or simulation before an audience, including their design, fabrication, installation, testing, control, operation, and maintenance.

1.3.2 This standard shall apply to the following:

(1) Use of flame effects before an audience *(see 3.3.12, Flame Effect)*
(2) Design, fabrication, installation, testing, control, operation, and maintenance of equipment, materials, procedures, and systems used to produce flame effects
(3) Rehearsal, videotaping, audiotaping, or filming of any television, radio, or movie production if such production is before an audience and includes the use of flame effects
(4) Rehearsal of any production incorporating flame effects intended to be presented before an audience
(5) Storage and holding at a venue where flammable and combustible materials are to be used to create flame effects
(6) That portion or component of any hybrid flame effect that utilizes fuels, materials, devices, and methodologies governed by this standard.

1.3.3 This standard shall not apply to the following:

(1)* Flame effects produced solely by pyrotechnic special effects devices or pyrotechnic material
(2)* Use of pyrotechnic special effects
(3)* Storage of flammable solids, liquids, and gases not to be used to create flame effects
(4) Nitrocellulose-based flame projectors
(5) Manufacture, off-site storage, and transportation of materials and equipment used to produce flame effects
(6) Use of flame effects in fire training, except where there is an audience that is not part of the training
(7)* Manufacture, transportation, storage, sale, or use of model or high-power rocket motors
(8) Traditional nontheatrical public display of flames such as the following:
    (a) Use of lighted candles in restaurants or religious services
    (b) Fireplaces in areas open to the public
    (c) Restaurant cooking visible to the patrons
    (d) Listed Group II flame effects
    (e) Flame effects used in a fireworks display *(see NFPA 1123)*
(9) Use of consumer fireworks by the public
(10) Use of motor vehicles in races or sanctioned competitive sporting events
(11)* Use of ground-based effects utilizing explosives, liquid fuels, or other combustibles in air show environments

1.3.4* This standard shall not be used as a product standard.

1.3.5 When there is no audience present, NFPA 140. shall be used to regulate any flame effect use.

1.4 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.5.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.
NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations,* 2013 edition.
NFPA 1123, *Code for Fireworks Display,* 2014 edition.

2.3 Other Publications.

2.3.1 ASME Publications. American Society of Mechanical Engineers, Three Park Avenue, New York, NY 10016-5990.

Boiler Pressure Vessel Code, 2013.

2.3.2 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience,* 2016 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.3 General Definitions.

3.3.1 Accumulator. A container or piping that holds a predetermined volume of fuel that is ready for use in a flame effect.

3.3.2 Area.

3.3.2.1 *Hazard Area.* The area made hazardous by the operation of the flame effect.

3.3.2.1.1 Accessible Hazard Area. That area made hazardous by the flame effect that is normally accessible to a person without the deliberate use of an additional means of access that is not normally in place.

3.3.2.2 *Holding Area.* An area where flame effect material or loaded flame effect devices are held prior to use.

3.3.2.3 *Storage Area.* An area where flame effect material or flame effect devices are stored prior to use or movement to a holding area.

3.3.3* Arm. That sequence of control system functions for the establishing of a source of ignition that must be complete and verified immediately before the firing of the flame effect.

3.3.4 Assistant. A person who works under the supervision of the flame effect operator.

3.3.5 Cast Members. Performers involved in a production involving the use of flame effects that may or may not be employees. (Many amusement employees are also referred to as "cast members.")

3.3.6 Direct Ignition. An automatic or manual ignition system that ignites fuel without a pilot.

3.3.7 Emergency Stop [Emergency Shutdown (ESD) System]. A circuit or other mechanism that, when actuated, results in the complete shutdown and extinguishment of all flame effects that are controlled by it.

3.3.8* Enable. The final set of control system functions that must be verified to be in a specific control mode immediately before the arming and firing of a flame effect may be implemented.

3.3.9 Enable Button. The control operator that is manually actuated by the operator prior to and during the arming and firing of the effect.

3.3.10 Fail-Safe. A state or an attribute of a system such that every single point failure in the system results in all controlling parts of the system with the ability to do harm to humans, animals, or equipment being disconnected from all sources of power and stored energy at the primary disconnect point.

3.3.11* Fire. The sequence of control system functions that result in the deliberate release of fuel for ignition.

3.3.12 Flame Effect. The combustion of solids, liquids, or gases utilizing atmospheric oxygen to produce thermal, physical, visual, or audible phenomena before an audience.

3.3.12.1 ***Automatic Flame Effect.*** A flame effect that is supervised and fired by an automatic control system.

3.3.12.2* ***Hybrid Flame Effect.*** A flame effect that is used in combination with a pyrotechnic material or device.

3.3.12.3 ***Manual Flame Effect.*** A flame effect that is operated manually without the use of an automatic control system.

3.3.12.4 ***Portable Flame Effects.*** Flame effects that are designed and installed, either in a permanent or temporary installation, and that are designed to move or be moved in the course of operation or installation.

3.3.13 Flame Effect Appliance. The complete assembly of components and devices that controls and generates a flame effect.

3.3.14 Flame Effect Burner. A burner designed to produce specific sizes and configurations of flames for flame effects.

3.3.15 Flame Effect Material. Any solid, liquid or gas fuel, or combination thereof, that requires the addition of oxygen in order to initiate and maintain combustion.

3.3.16 Flame Effect Operator. The single person with overall responsibility for flame effect operations and safety.

3.3.17 Flame Effect Safety Controller. A control system that is part of a flame effect appliance that is used to prove that the source of ignition is present (“flame safeguard control”).

3.3.18* Flame Effect System. The complete assembly of interconnected components, devices, and/or appliances that provides all of the functions necessary to fuel, monitor, supervise, generate, and control flame effects, including the emergency shutdown of the flame effects and, where necessary, the monitoring of external conditions that affect operation.

3.3.19* Flame Effect Systems, Classifications.

3.3.19.1 ***Group I Flame Effect.*** An attended, manually controlled flame effect.

3.3.19.2 ***Group II Flame Effect.*** An individual or group flame effect designed for unattended operation that is temporarily or permanently installed outside any structure.

3.3.19.3 ***Group III Flame Effect.*** An attended, temporarily installed flame effect for a specific production with limited operation and fixed time for removal.

3.3.19.4 ***Group IV Flame Effect.*** A large individual or group flame effect that is permanently installed inside or outside any structure designed for unattended operation without a main show supervisory control system.

3.3.19.5 ***Group V Flame Effect.*** A large individual or group flame effect that is temporarily or permanently installed inside or outside any structure and is designed for intermittent or continuous operation under the supervision of a main show control system but without full-time supervision by a technician.

3.3.19.6 ***Group VI Flame Effect.*** A large individual or group flame effect that is temporarily or permanently installed inside or outside any structure and is designed for intermittent operation under the supervision of a main show control system and a technical director, with cast members in close proximity to the effect at the time of operation.

3.3.19.7 ***Group VII Flame Effect.*** An individual flame effect that can be temporarily or permanently installed inside or outside any structure that, due to its unique operating requirements, does not fit into any other classification.

3.3.20 Hybrid Flame Effect. See 3.3.12.2.

3.3.21 Installation, Term of.

3.3.21.1 ***Permanent Installation.*** An installation of flame effects for which the governing use permit has a duration longer than 180 days.

3.3.21.2 ***Temporary Installation.*** An installation of flame effects for which the governing use permit has a duration of 180 days or less within a twelve-month period in a single venue.

3.3.22* Performer. Any person active in a performance during which pyrotechnics are used and who is not part of the audience or support personnel. [**1126,** 2016]

3.3.23 Permit. A document issued by the AHJ for the purpose of authorizing performance of a specified activity. Unless otherwise specified, the word *permit,* when used in this document, refers to a use permit.

3.3.23.1 ***Use Permit.*** A document issued by the AHJ for the purpose of authorizing the use of specific flame effects in a specific venue on a specified date and time or within a specified period.

3.3.24 Plan.

3.3.24.1 ***Design Plan.*** The plan for a flame effect appliance or design that presents the design criteria and/or assumptions used in the design, along with complete design information.

3.3.24.2 ***Flame Effect Plan.*** The document that is used to convey to the AHJ the information needed to evaluate the flame effect for the purpose of applying for a permit.

3.3.25* Primary Safety Control. A control with a sensor that is directly responsive to the ignition device attributes necessary for the safe operation of the effect.

3.3.26 Rated. A description of performance derived from testing or evaluation that guides appropriate selection, installation, and use of equipment that is not listed.

3.3.27* Safety Shutdown (Lockout). The safe shutdown of the flame effect in the event of the actuation of any flame effect primary safety control or limit switch.

3.3.28 Safety-Critical. The failure of a device, component, system, or mechanism, which results in a situation that is immediately dangerous to life, health, or property.

3.3.29* Supervisory Control System. A manual or automatic control system that supervises the operation of the flame effect.

3.3.30* Support Personnel. Any individual who is not a performer or member of the audience. [**1126,** 2016]

3.3.31 Valve.

3.3.31.1 ***Accumulator Charge Valve.*** A valve used to control the flow of fuel into an accumulator.

3.3.31.2 ***Effect Valve.*** The last fuel shutoff valve before the flame effect burner.

3.3.31.3 ***Safety Shutoff Valve.*** A fast-closing valve that automatically and completely shuts off the fuel supply in response to a normal or safety shutdown.

3.3.31.4 ***Vent Valve.*** A normally open, power-closed valve, normally located between the two safety shutoff valves.

3.3.32* Venue. The property, facility, building, or room within a building where flame effects are used, intended to be used, or are prohibited.

Chapter 4 Holding Areas for Flame Effect Materials and Devices

4.1* General. All flame effect materials and devices not connected for use shall be stored in accordance with applicable codes and standards and any state and local regulations.

4.2 Holding Areas. All flammable flame effect materials and loaded devices that have been removed from storage areas in anticipation of use shall be stored in a holding area acceptable to the authority having jurisdiction.

4.2.1 Quantity Limitations.

4.2.1.1 The maximum quantity of flammable flame effect materials and loaded devices stored in a holding area shall be that quantity used in one day.

4.2.1.2 Quantities of flammable flame effect materials and devices in excess of those used in one day shall be permitted to be stored in holding areas with the approval of the authority having jurisdiction.

4.2.2 Flammable flame effect materials and loaded devices in holding areas shall be secured or supervised continuously by an attendant trained in emergency response procedures.

Chapter 5 Permit and Approval Requirements and Terms of Installation

5.1 Permit Requirements.

5.1.1* Permit Required. Except when otherwise required by the jurisdiction, a use permit shall be required for the use of flame effects before an audience.

5.1.2* Terms of Installation.

5.1.2.1 Permanent Installation. An installation of flame effects for which the governing use permit has a duration longer than 180 days shall be considered a permanent installation.

5.1.2.2 Temporary Installation. An installation of flame effects for which the governing use permit has a duration of 180 days or less within a 12-month period in a single venue shall be considered a temporary installation.

5.1.3 Use Permits.

5.1.3.1 A use permit shall authorize the use of only the number and types of flame effects in the venue as specified in the flame effect plan, as described in Section 5.3.

5.1.3.2 Use permits shall have a specified expiration date.

5.1.3.2.1 Use permits for temporarily installed flame effects shall specify the date(s) and time(s) of use and the expiration date of the permit.

5.1.3.2.2 Use permits for permanently installed flame effects shall specify the duration and expiration date of the permit.

5.1.3.3 Any activity authorized by the use permit shall be conducted by the permittee or the permittee's agents or employees in compliance with all requirements of this standard applicable thereto and in accordance with the approved plans and conditions.

5.2 Approval Requirements.

5.2.1 Prior Approval Required. Other than during the flame effect demonstration, as described in Section 5.4, the use of all flame effects shall be first approved by the authority having jurisdiction (AHJ).

5.2.1.1* Hybrid flame effects shall meet the requirements of 5.2.1.1.1 and 5.2.1.1.2.

5.2.1.1.1 That portion of the hybrid flame effect that is governed by NFPA 160 shall meet all of the requirements of NFPA 160.

5.2.1.1.2 That portion of the hybrid flame effect that is governed by NFPA 1126 shall meet all of the requirements of NFPA 1126.

5.2.2 Approval of Flame Effect Plan. A plan for the use of flame effects shall be submitted to the AHJ for approval.

5.2.2.1 After a flame effect plan has been approved, the plan shall be maintained to be readily accessible at the venue and shall be subject to inspection as specified by the AHJ.

5.2.2.2* If any addition or modification of flame effects to that described in the approved plan is made, that addition or modification shall be approved by the AHJ prior to use of the modified flame effects.

5.2.2.3 In the case of a hybrid flame effect, the plan shall identify those portions of the flame effect that require compliance with NFPA 160 and those portions that require compliance with NFPA 1126.

5.3* Content of Flame Effect Plans.

5.3.1 Flame Effect Plan Requirements.

5.3.1.1 The plan for the use of flame effects shall be submitted in writing or other form acceptable to the authority having jurisdiction.

5.3.1.2* The plan shall include the following:

(1) The name of the person, group, or organization responsible for the production

(2) The dates and times of the production
(3) The location of the production
(4) The flame effect classification
(5) A site plan showing the following:
    (a) A narrative description of the flame effect
    (b) The location of flame effect devices to be fired and their controls and control sequence
    (c) The area affected by the flame effect device
    (d) The location of the audience
    (e) The fuels used and their estimated consumption
    (f) Air for combustion and ventilation for indoor effects
    (g) Flammable materials piping
    (h) Storage and holding areas and their capacities
    (i) Supplemental fire protection features
    (j) Emergency response procedures
    (k) Means of egress
(6) A current material safety data sheet (MSDS) for the materials (fuels) consumed in the flame effect
(7) Documentation that the combustible materials used for construction of the flame effects have been rendered flame retardant
(8) The name of the effect operator

5.3.2 The operator shall make operating instructions for flame effects available to the authority having jurisdiction.

5.3.3 The plan shall be reviewed with the authority having jurisdiction, flame effects operator, and building owner/representative prior to the production, to ensure coordinated response in the event of an emergency.

5.4 Flame Effect Demonstration.

5.4.1* When required, a walk-through and a representative demonstration of the flame effects shall be provided to the authority having jurisdiction before flame effects are approved.

5.4.2 The demonstration shall be scheduled with sufficient time to allow resetting of the flame effects prior to the arrival of the audience.

5.5 Interruption of Fire Protection and Life Safety Systems During Flame Effect Demonstrations and Operations. Fire protection and life safety systems shall not be permitted to be interrupted during the operation of flame effects.

5.5.1 Portions of fire protection and life safety systems shall be permitted to be interrupted during the operation of temporary indoor flame effects when the following conditions are met:

(1) Approval of the authority having jurisdiction is received.
(2) Approval of the owner or owner's agent is received.
(3)* An approved fire watch capable of directing the operation of all fire protection and life safety systems installed in the building is present.

5.5.2 Fire protection and life safety systems shall be permitted to be interrupted during the operation of permanently installed indoor flame effects only for initial acceptance of the system.

Chapter 6 Documentation of Flame Effects

6.1 General.

6.1.1 All flame effect devices and materials shall have drawings, manuals, or written descriptions to describe the type of item and performance specifications of the flame effect created.

6.1.2 This documentation shall be on site and available to the authority having jurisdiction.

6.2 Operating Procedures.

6.2.1 All flame effects shall have written operating instructions, including start-up, show operations, normal shutdown procedures, and emergency shutdown procedures.

6.2.2 Operating instructions shall be available to the operator.

Chapter 7 Use of Flame Effects

7.1 Testing and Evaluation.

7.1.1 Flame effects shall be tested to verify that they operate in accordance with their designs.

7.1.2* Flame effects shall be evaluated to verify that spectators, performers, support personnel, and the operator are not exposed to a hazardous situation when the flame effects are activated as designed or anticipated.

7.1.3 On an interval acceptable to the authority having jurisdiction, flame effects shall be inspected for normal and safe operating condition and retested for operation as designed and anticipated.

7.1.4 Documentation of the testing and evaluation shall be permitted to be prepared by a third party acceptable to the authority having jurisdiction.

7.1.5 The documentation shall be made available to the authority having jurisdiction as a part of the application for approval of the effect.

7.2 Housekeeping. The premises where flame effect devices are installed or fired shall be maintained in a neat and orderly condition.

7.3 Site Inspection. The flame effect operator shall inspect all areas of the site where flame effect materials and devices are ignited before start-up and after shutdown.

7.4 Smoking.

7.4.1 Smoking shall be prohibited in the area where fuels used in flame effects are present.

7.4.2 Smoking by performers as part of the performance shall be permitted where approved by the authority having jurisdiction.

7.5 Rehearsal and Pre-Show Operations.

7.5.1 The flame effect operator shall advise all performers and support personnel that they are exposed to a potentially hazardous situation when performing or otherwise carrying out their responsibilities in the vicinity of a flame effect.

7.5.2 Performers and support personnel familiar and experienced with the flame effects being used shall be permitted to be in the area of a flame effect, but only voluntarily and in the performance of their duties.

7.6 Show Operations. Show operations shall be in accordance with the plan approved by the authority having jurisdiction.

7.7 Post-Show Operations. Post-show operations shall be in accordance with the plan approved by the authority having jurisdiction.

7.7.1 Fire and life safety systems that have been interrupted shall be restored immediately after completion of the flame effect.

7.7.2 When restoration of fire and life safety systems is necessary, it shall be conducted by a person trained in the operation of all aspects of the systems.

7.8 Maintenance. Flame effect systems shall be maintained to design specifications.

7.9 Emergency Operations. Emergency operations shall be in accordance with the plan approved by the authority having jurisdiction.

7.10 Protective Clothing.

7.10.1 The flame effect performers, operators, and assistants shall be protected by clothing or other means suitable for their exposure to flame effects.

7.10.2 Protective clothing requiring fire resistance shall be tested and demonstrated to be flame retardant, and documentation shall be furnished to the authority having jurisdiction upon request.

7.10.3 Bare skin (naked) shall be permitted when the illusion of danger is implicit in the visual effect desired by the performer.

7.11 Security.

7.11.1 A means shall be provided to render installed flame effect systems inoperative when not in use.

7.11.2 Portable flame effects shall be stored and secured when not in use.

Chapter 8 Flame Effect Operator

8.1* Operator Qualifications.

8.1.1 The operator of any flame effect shall understand and be familiar with the operating manual or instructions.

8.1.2 The operator shall demonstrate competency by experience and training or by holding a license acceptable to the authority having jurisdiction.

8.2 Operator Responsibilities. The flame effect operator shall be responsible for storage, setup, operations, and teardown of all flame effect materials, devices, equipment, systems, and supervision of assistants.

8.3 Substance Abuse and Safety. No person shall use or handle flame effect materials or devices while under the influence of the following:

(1) Intoxicating beverages
(2) Narcotics or controlled substances
(3) Prescription drugs and/or nonprescription drugs that impair judgment

8.4* Minimum Age. All flame effect operators shall be at least 21 years of age.

Chapter 9 System Components, Flame Effect Control Systems, and Design

9.1 General Requirements for Flame Effect Control System Design.

9.1.1 All flame effect control systems shall be designed and installed to prevent accidental firing and unintentional release of fuel.

9.1.2 All Group II through Group VII control systems shall be designed to ensure against accidental firing by providing at least a removable activator, keyswitch, or coded arming system in which no control power can be applied to any control system unless the operator intentionally does both of the following:

(1) Deliberately applies control power
(2) Enables or arms the control system

9.1.3 Control System Attendance Requirements.

9.1.3.1 Any Group III, Group VI, or Group VII flame effects control systems shall not be left unattended while connected to a fuel source.

9.1.3.2 Control systems that are disconnected from their power source or de-energized by means of a removable activator, keyswitch, or coded arming system shall be permitted to be left unattended while connected to a fuel source.

9.1.4 Control System Operation.

9.1.4.1 All flame effect control systems shall be designed to implement the following functions:

(1) Emergency stop capability
(2) Fuel management
(3) Controlled enabling of flame effect
(4) Controlled arming of flame effect
(5) Controlled and repeatable firing of flame effect

9.1.4.2 The flame effect plan submitted for approval to the authority having jurisdiction shall indicate the means of providing for these requirements.

9.1.5 Flame effect control system components shall be listed.

9.1.5.1 Where listed devices are not available, approved devices shall be permitted.

9.1.6 Control system components and protective devices, including sensors, valves, and switches, shall be located so that they are protected against physical damage and tampering, and so that they can be serviced and maintained.

9.2* Specific Requirements for Flame Effect Control System Design and Operation, by Group. Control systems for each flame effect group shall be in accordance with Table 9.2.

9.3 Implementation of the Required Control Functions.

9.3.1* Emergency Stop.

9.3.1.1 One of the following conditions shall be met prior to the use of flame effects:

Table 9.2 Group Control Functions Required

Flame Effect Group	Control Type	Minimum Control Requirements
I	Manual controls	1. No automatic controls shall be required.
II	Automatic controls	1. Ignition supervision shall be provided. 2. Automatic shutoff shall follow failure.
III	Automatic controls	1. Manual operation of the effect valve shall be permitted. 2. If the operator cannot confirm the pilot or direct ignition source for the flame special effect, a primary safety control shall be installed. 3. Two fuel shutoff valves, one of which will be a safety shutoff valve, shall be provided and installed in series.
IV	Automatic controls	1. Primary limit device(s) shall be installed as required. 2. A fuel supervisory station shall be installed with fuel pressure limit switches to control the supervisory station valves. 3. Each flame effect burner shall be equipped with a primary safety control and an effect valve. 4. A flame effect safety control system that is capable of safely operating the entire flame effect consistently for repeated cycles shall be used.
V	Automatic controls	1. The requirements for Group IV shall apply. 2. A flame effect safety control system that is capable of safely operating the entire flame effect consistently that is sequenced by the main control system shall be used. The flame effect safety control system shall maintain all of its internal safety features, with the interface between the flame effect control system and the main show control system limited to those commands and status indicators that cannot alter or override the flame supervisory system control logic.
VI	Automatic controls	1. The requirements for Group V shall apply. 2. Where cast members are in close proximity to the flame effect, the flame effect shall be under the active control of a main show control system and a fail-safe positive manual enable (PME).
VII	Manual or automatic controls	1. Controls shall be as recommended by the designer and acceptable to the authority having jurisdiction.

(1) Approval of a plan to extinguish the flame effect as required in 9.3.1.4
(2) Approval of a supervisory control system for the emergency stop and complete shutdown of the flame effect and any interrelated safety-critical system as required in 9.3.1.5

9.3.1.2 Interrelated safety-critical system and flame effect control system safety considerations shall extend to safety-critical effects, allied equipment, and other proximate equipment to avoid additional or contributory hazards.

9.3.1.3 Where the hazards described in 9.3.1.2 exist, the effects safety controller shall have a direct validated means of confirming the status or other information from the other systems before the safety-critical effect is enabled or triggered.

9.3.1.4 Manually controlled flame effects (Group I and manually controlled Group VII) shall have a plan for the emergency stop and complete shutdown of the operation of the effects through one or more of the following:

(1) Manual fuel shutoff valve(s)
(2) Manual turn-off of control power
(3) Fire containment devices
(4) Other devices acceptable to the authority having jurisdiction

9.3.1.5 Automatically controlled flame effects (Group II through Group VI and automatically controlled Group VII) shall have provisions for the emergency stop and complete shutdown of the operation of the effects installed according to the following criteria:

(1) The flame effect control system shall not be capable of operation unless the emergency stop is reset.
(2) The actuation of the emergency stop shall bring the flame effect control system to a safe state.
(3) The emergency stop shall require manual reset.
(4) The emergency stop shall actuate both manually and automatically upon the detection of an unsafe condition, including power failure.
(5) The emergency stop shall be fail-safe.
(6)* The emergency stop shall be automatically actuated when a monitored condition exceeds a preset limit of operation.

9.3.1.6 Manual Emergency Stop Control Stations.

9.3.1.6.1 Manually operated emergency stop control stations shall be clearly identified and placed in accessible locations and shall maintain the actuated state until manually reset.

9.3.1.6.2 Operation of a manual emergency stop station shall actuate the emergency stop.

9.3.2 Fuel Management.

9.3.2.1 The fuel supply for the operation of the flame effect shall be available only during operation.

9.3.2.2 Fuels not provided through a central distribution system and that are supplied to the flame effect shall be limited to that amount necessary for operation.

9.3.2.3 Minimum tank size for liquefied flammable gas flame effects shall be determined by the surface area required to prevent reduced fuel delivery to the burner during the effect.

9.3.2.4 Fuel Delivery.

9.3.2.4.1 Fuels delivered through a central distribution system shall be in accordance with the following:

(1) A manual fuel shutoff valve shall be installed as follows:
  (a) It shall be installed in an accessible location at the point of delivery and upstream of any other flame effect control system components that, when closed, will shut off all fuel supplied to the flame effect control system.
  (b) Where the point of delivery is outside a building containing the flame effect control system, the valve shall be located outside of the building.
(2) The following shall apply to fuel pressure:
  (a) Where low fuel pressure could cause the flame effect control system to malfunction, devices to provide low-fuel-pressure supervision shall be installed.
  (b) Where high fuel pressure could cause the flame system to malfunction, devices to provide high-fuel-pressure supervision shall be installed.
(3)* A supervisor station shall be installed and shall meet the following criteria:
  (a) It shall be installed downstream of the manual fuel shutoff valve.
  (b) It shall shut off all fuel supplied to the flame effect control system when closed.
  (c) When opened during the enable process, it shall be held open by a maintained signal from the flame effect control system.

9.3.2.4.2 The supervisor station shall be provided with a means to test the seat-tightness of the shutoff valve at the operating pressure.

9.3.2.5 Effect Valve.

9.3.2.5.1 Each flame effect shall be provided with an automatic fuel shutoff valve (the effect valve), installed upstream of the burner.

9.3.2.5.2 The effect valve shall shut off all fuel to the burner when closed.

9.3.2.5.3 The effect valve shall be opened only at the time of firing the flame effect and shall be held open by a maintained signal from the flame effect control system.

9.3.2.5.4 The effect valve shall close on loss of the hold-open signal.

9.3.2.6* Systems Using Fuel Accumulators. Fuel accumulators used in flame effect control systems shall meet the following requirements:

(1) Accumulator tanks shall be designed, manufactured, and certified as unfired pressure vessels.
  (a)* Accumulators for use with flammable or liquefied gas shall be designed, manufactured, and tested in accordance with the ASME *Boiler Pressure Vessel Code* or the Department of Transportation for the pressure of the gas in use.
(2)* The volume of fuel stored in an accumulator tank shall be no more than what is required to produce the desired flame effect.
(3) Each accumulator shall have a manual fuel shutoff valve at the connection to the inlet of the tank, and when closed, this valve shall shut off all fuel supplied to the accumulator tank.
(4) An accumulator charge valve that charges the accumulator when opened shall be installed at the connection to the inlet of the tank.
(5) The accumulator shall be charged as close to the time of the actual arming and firing of the effect as is practical.
(6) Each accumulator shall be designed and installed so that the fuel can be safely removed, as follows:
  (a) Accumulators fixed in location shall be provided with a permanently installed means of conveying the fuel to a safe point of discharge.
  (b) Portable accumulators shall be allowed to be moved to a safe location for discharge.
(7) The mixing of air or any other oxidizing media with fuel that creates a flammable mixture within an accumulator tank shall be prohibited.

9.3.3* Controlled Enabling of Flame Effect Control System. All flame effect control systems shall be manually or automatically enabled according to a prescribed sequence of operations outlined in the plan, which prepares the flame effect for subsequent arming and firing.

9.3.3.1 Flame Effect Safety Controller Function.

9.3.3.1.1 A flame effect safety controller shall be used to automatically sequence the enable process, monitor areas of restricted access, and allow, trigger, and request safety-critical action.

9.3.3.1.2 Flame effect control system safety considerations shall extend to other safety-critical effects, allied equipment, and other proximate equipment to avoid additional or contributory hazards.

9.3.3.1.3 In circumstances described in 9.3.3.1.2, the flame effect safety controller shall have a direct validated means of confirming the status or other information from the other systems before the flame effect is enabled.

9.3.3.2* The enable process shall begin with the activation of the control power to the flame effect control system.

9.3.3.3 Fuel Supply and Auxiliary Services.

9.3.3.3.1 Following the activation of the control power, the fuel supply and auxiliary services necessary to the operation of the flame effect control system (compressed air supply, oxidizers, additives, etc.) shall be permitted to be turned on.

9.3.3.3.2 Positive confirmation through the use of an interlock or other device of the fuel supply and each auxiliary service shall be made prior to the continuation of the enable process.

9.3.3.4* Interlocks.

9.3.3.4.1 Interlocks shall be provided in the control system to monitor changes of condition and to automatically implement control system responses to the change of condition.

9.3.3.4.2 Safety interlocks shall be fail-safe.

9.3.4 Controlled Arming of Effect.

9.3.4.1 All flame effects shall be manually or automatically armed prior to any attempt to fire.

9.3.4.2 The arming of the effect shall be manually or automatically monitored and confirmed until the effect is fired.

9.3.4.3 Manual Confirmation of Arming (Group I and Manually Controlled Group VII).

9.3.4.3.1 The flame effect shall be confirmed as armed when the means of ignition can be clearly and directly seen by the operator or assistant(s) firing the flame effect for the entire time that the effect is enabled.

9.3.4.3.2 When the means of ignition cannot be clearly and directly seen by the operator or assistant(s) firing the flame effect for the entire time that the effect is enabled, the confirmation of the arming of that effect shall be done automatically.

9.3.4.4* Automatic Confirmation of Arming (Group II through Group VI and Automatically Controlled Group VII). The flame effect shall be confirmed as armed when a sensor(s) has detected the presence of the means of ignition necessary for the correct operation of the effect through the monitoring of a characteristic unique to the means of ignition.

9.3.4.5 Control sensors and devices used to automatically confirm arming shall operate in the environment where installed.

9.3.4.6 Where cast members or moving set pieces are present in the hazard area immediately before or after the arming and firing of the flame effect, a positive manual enable (PME) shall be required during arming and firing.

9.3.4.7 Ignition Detection Device Function.

9.3.4.7.1 It shall not be possible for an ignition detection device to report the presence of an ignition device or pilot, due to false sensing of ignition devices, pilots, or flame effects other than that ignition device or pilot intended to be sensed by the ignition detection device.

9.3.4.7.2 It also shall not be possible for an ignition detection device to report the presence of an ignition device or pilot due to false sensing of other non-fire-related devices normally present in the local environment including, but not limited to, spark effects, ultraviolet light sources, or effects that generate heat without flame.

9.3.5* Firing of Flame Effects.

9.3.5.1 Flame effects shall only be fired after they have been confirmed as armed following the completion of the enable and arming process and confirmation that the hazard area is clear.

9.3.5.2 If the arming confirmation is lost during the firing process or the hazard area becomes unsafe, the firing of the effect shall be immediately terminated and the effect secured until the problem has been corrected.

9.3.5.3* Monitoring of the Hazard Area Surrounding the Flame Effect.

9.3.5.3.1 That area surrounding each flame effect that is made hazardous by the operation of the effect shall be monitored and confirmed clear and ready for firing, or access to the area shall be supervised by automatic means, or the area shall be made inaccessible, prior to any attempt to fire the effect.

9.3.5.3.2 Other parameters critical to the safety of the flame effect shall also be monitored or supervised.

9.3.5.4* Supervision of the Hazard Area Surrounding the Flame Effect.

9.3.5.4.1 The accessible hazard area shall be under the direct observation of the operator or assistant(s) firing the flame effect for the entire time that the effect is enabled and fired.

9.3.5.4.2 Where the hazard area cannot be seen by the operator or assistant(s) firing the flame effect for the entire time that the effect is enabled, an alternative means of monitoring the area shall be permitted to be used, with the approval of the authority having jurisdiction.

9.3.5.4.3 Use of Enable Buttons.

9.3.5.4.3.1 If all areas of safety concern cannot be seen by a single human operator, as many enable buttons shall be used as are necessary to ensure safety.

9.3.5.4.3.2 Such buttons shall be monitored separately and verified for proper operation by the flame effect control system.

9.3.5.5 Firing. The design of the flame effect control system shall prevent the firing of any flame effect except on the deliberate positive action of an operator or on the verification by the automatic control system of correct enabling and arming of the effect.

9.3.5.5.1 Manual Firing of Flame Effects. It shall be the responsibility of the operator to verify the correct enabling and arming and the safety of the hazard area prior to the manual firing of the effect.

9.3.5.5.2 Automatic Firing of Flame Effects.

9.3.5.5.2.1 The operating power for firing any flame effect shall originate from the flame effect control system and only be supplied under the supervision of all limits, interlocks, and ignition-monitoring devices present for the safe and reliable operation of the flame effect.

9.3.5.5.2.2 All effect valves shall be permitted to be opened only by a maintained firing signal from the flame effect control system and shall automatically close on loss of signal.

9.3.6 Post-Operation Securing. Immediately following the firing of any flame effect, the enable and arming signals shall be removed, all fuel and auxiliary services shall be secured without going through the sequence of operation specified in 9.3.5.5, and a visual inspection of all effect hazard areas shall be completed prior to confirmation that the flame effect control system is secure.

Chapter 10 System Installation and Testing

10.1 General.

10.1.1 Flame effects shall be tested to verify that they operate in accordance with the flame effect control system design.

10.1.2 Documentation of the testing shall be provided by the manufacturer or fabricator.

10.2 Pressure Testing and Inspection of Piping. Where flame effect systems use piping, such piping shall be pressure tested in accordance with the requirements of the authority having jurisdiction.

10.2.1 The complete piping system with all accessories in place shall be pressure tested at no less than the system operating pressure.

10.2.2 Pressure Test Procedures.

10.2.2.1 System pressures shall be recorded together with the temperature and the atmospheric pressure.

10.2.2.2 Pressure testing of reassembled flame effect piping systems designed to be separated into subassemblies shall be permitted to be tested at system operating pressure, with leak detection using a noncorrosive leak-detecting solution, or other means acceptable to the authority having jurisdiction, at the reconnected joints.

10.3 Temperatures of Components.

10.3.1 Temperatures of components that are used in the fabrication of a flame effect control system shall not exceed the rated temperature limits of the component during sustained operation of the flame effect.

10.3.2 Temperatures of components subject to the heat of the flame effect shall be determined while the flame effect is being operated at its maximum design cycle rate during the acceptance test required by Section 10.1.

10.3.2.1 The temperatures shall be observed until a maximum or stable reading has been attained.

10.3.2.2 The temperatures attained shall not exceed the rated temperatures for the components.

10.3.3 Temperatures of Surroundings.

10.3.3.1 Temperatures of combustible materials subject to the heat of the flame effect shall not exceed 117°F (47.2°C) above the ambient temperature after equilibrium temperatures are attained.

10.3.3.2 The temperatures shall be observed until a maximum or stable reading has been attained.

Chapter 11 Fire Protection Provisions

11.1 General. The wide range in size, arrangement, and location of flame effects covered by this standard shall preclude the inclusion of detailed fire protection provisions that are applicable to all flame effects.

11.2 Evaluation for Permanently Installed Flame Effects.

11.2.1* Where required by the authority having jurisdiction, a fire hazards evaluation shall be conducted for permanently installed flame effects to be used at a venue for a performance.

11.2.2 The evaluation in 11.2.1 shall be coordinated with the building owner, the flame effect operator, and the authority having jurisdiction.

11.3* Additional Fire Safety Provisions for Temporary Installations.

11.3.1 Where determined by the authority having jurisdiction that a need for fixed or additional fire protection equipment or standby fire safety personnel exists, such equipment or personnel shall be provided.

11.3.2 Four or more fire extinguishers of the proper classification and size as approved by the authority having jurisdiction shall be readily accessible while the flame effects performance is being conducted.

11.3.2.1 In all cases, at least two pressurized water, Class 2-A extinguishers and two Class 10-BC extinguishers shall be provided, in addition to those required by NFPA 10, for the building.

11.3.2.2 The extinguishers shall be placed so that at least one each is located on opposing sides of the performance where flame effects are used.

11.4 Standby Fire Safety Personnel Requirements.

11.4.1 Where required by the fire hazards evaluation or the authority having jurisdiction, standby fire safety personnel shall be present along with operational supplemental equipment.

11.4.2 Standby fire safety personnel shall have a working knowledge of the supplemental fixed or portable fire-fighting equipment used in the area of the flame effects.

11.4.3 Standby fire safety personnel shall have a means of communication or of transmitting an alarm during the operation of flame effects.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 This document details how to control the use of flame effects. The issue of permitting or prohibiting the use of open flames before an audience is in the scope of a code such as NFPA *101*, The *Life Safety Code* has traditionally prohibited open flames within assembly occupancies.

A.1.3.1 The circumstances of each show or attraction can be unique and can require individual evaluation when determining the need for protective systems. Factors such as the experience and qualifications of the operations and maintenance personnel, clearance distance between show elements and nonparticipants, visual conditions, and magnitude of the potential hazards are to be weighed in the development and presentation of the production.

A.1.3.3(1) As covered in NFPA 1126.

A.1.3.3(2) For information on the use of pyrotechnic special effects before an audience, see NFPA 1126.

A.1.3.3(3) For information on the storage of flammable and combustible liquids, see NFPA 30. For information on the storage of flammable gases, see NFPA 55, and NFPA 58.

A.1.3.3(7) For information on the manufacture, transportation, or storage of model or high power rocket motors, see NFPA 1125. For information on the sale or use of model or high power rocket motors, see NFPA 1122 and NFPA 1127.

A.1.3.3(11) For information and guidance on ground-based effects in air shows, refer to International Council on Air Shows (ICAS) *Guidelines for the Use of Pyrotechnics and Special Effects at Air Shows* and NFPA 495.

A.1.3.4 This standard contains user requirements for the performance, use, or installation of flame effects. User requirements are those that apply to users of the product and specify when, where, and how a product is used.

Unlike this standard, a product standard contains performance, testing, and third-party certification requirements, and can contain design requirements, for a specific product, such as a flame effect appliance. Third-party certification includes the requirements for the testing, labeling, listing, follow-up, and quality assurance programs by which a product is certified as being compliant with a specific standard from a certification organization. Product standards should be written, to the extent possible, such that the product is evaluated and tested for compliance with minimal or no judgmental decisions and with specific pass/fail requirements and a designated test method to evaluate the performance. NFPA 160 does not meet these requirements, nor is it intended for use as a product standard.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.3 Arm. In a manually operated system, the enabling, arming, and firing functions are provided directly through the actions of the flame effect operator or assistant. *Arm* means supplying a source of ignition and verifying its presence, such as with manual ignition of a pilot, flammable liquid, or flammable solid.

A.3.3.8 Enable. In a manually operated system, the enabling, arming, and firing functions are provided directly through the actions of the flame effects operator or assistant. *Enable* means bringing to the site all the equipment, setting it up, and readying it for arming, such as bringing a campfire effect to the stage, verifying that no hazards are present in the area, and connecting all components.

A.3.3.11 Fire. In a manually operated system, the enabling, arming, and firing functions are provided directly through the actions of the flame effect operator or assistant. *Fire* means supplying fuel to the source of ignition, such as by manually opening a valve and verifying that the fuel ignites.

A.3.3.12.2 Hybrid Flame Effect Flame effects that use any of the fuels allowed by this standard but are initiated or directly ignited by means of a pyrotechnic device are common examples of a hybrid flame effect. One example of a hybrid flame effect is one that uses a pyrotechnic device or igniter to provide the initial flame to light a supervised pilot burner, which, when ignited, can be then proven by a conventional flame safeguard or other means. Often this hybrid configuration is used where the pilot burner is in and/or around water or spray, and conventional ignition means have been determined to be unreliable or to utilize voltages or currents that provide a risk of hazard to persons in and around the water. In other instances, this configuration might be used for added reliability, operational integration, or simply for convenience. In any of these instances, the pyrotechnic igniter is used under the requirements of NFPA 1126 and is installed, maintained, and operated to meet the requirements of both NFPA 1126 and the AHJ. The flame effect itself, regardless of the fuel it uses, is designed, installed, maintained, and operated to meet the requirements of both NFPA 160 and the AHJ.

A second example of a hybrid flame effect is one that utilizes a combustible dust, initially aerosolized and propelled out the end of the burner nozzle by a charge of compressed air and ignited as it passes through a field of burning metal sparks generated by yet another pyrotechnic device. Dust or powder fuel is an acceptable flame effect material under this standard. What causes this effect to be classified as a hybrid flame effect is that the pyrotechnic ignition device(s) falls under the purview of NFPA 1126. (Note that if a gas pilot burner or even a burning brand were used to ignite an aerosolized powder, this flame effect would not be considered hybrid and would fall entirely under the scope of NFPA 160.)

A third example is an often-used flame effect that is typically limited to outdoor use and utilizes flammable or combustible liquid as a fuel. This would be an acceptable flame effect material under this standard. The fuel is contained in a nonporous bag and placed inside a suitable open-topped container that serves as a "mortar" or burner nozzle. Upon firing, the liquid is freed from the bag, lifted from the barrel, and aerosolized by means of a substantial black powder lifting charge. A second pyrotechnic device might or might not be used to ensure ignition of the fuel at the mouth of the container. What causes this effect to be classified as a hybrid flame effect is that the aerosolizing and igniting charges fall under the purview of NFPA 1126, or, depending upon the particular composition and quantity of the charge in use, possibly NFPA 1123 or NFPA 495. Additionally, the storage and/or handling of the liquid fuel would be governed by the requirements of NFPA 30. (Note that if a compressed air charge was used to aerosolize the liquid and a gas fired pilot burner or even a burning brand was used to ignite the aerosol, this flame effect would not be considered hybrid and would fall entirely under the scope of NFPA 160.)

A.3.3.18 Flame Effect System. Manually controlled systems might not have interconnected components, devices, and/or appliances that provide all of the functions necessary to fuel, monitor, supervise, generate, and control flame effects, including the emergency shutdown of the flame effects and, where necessary, the monitoring of external conditions that affect operation. The flame effects operator or assistant carries out all the functions described in the definition.

A.3.3.19 Flame Effect Systems, Classifications. Examples of flame effects are as follows:

(1) *Group I.* Where used to give the illusion of danger to a performer, the use of hand-held burning torches, cigarette lighters, candles, matches, lighting paper in an ashtray, jugglers burning batons, fire rings that are jumped through, and other flame effects that are not included in another flame effect group.
(2) *Group II.* Unattended torches, burning urns, and small fires.
(3) *Group III.* An attended, temporarily installed flame effect used by traveling shows and concerts and effects used for limited-duration special events, such as the Olympics. This group also includes a traveling entertainment event that plays various venues, such as (but not limited to) circuses, operas, musicals, stage plays, trade shows, or corporate events. This group effect also includes a non-traveling entertainment event that plays a single venue.
(4) *Group IV.* A burning cabin or bonfire and large single or multiple flaming brazier entrance features used to create a "theme" atmosphere. A standalone-type flame effect control system without any significant control supervision by a main show control system is used.
(5) *Group V.* A simulated building or vehicle explosion that is part of a larger theme-type attraction. The flame effect control system is totally dedicated to the operation of the flame effect elements. The flame effect control system maintains all its internal safety features, with the interface between the flame effect control system and the main show control system limited to those commands and status indicators that cannot alter or override the flame supervisory system control logic.
(6) *Group VI.* A live-action stunt show that is part of a larger theme-type attraction. The flame effect control system is totally dedicated to the operation of the flame effect elements. The flame effect control system maintains all its internal safety features, with the interface between the flame effect control system and the main show control system limited to those commands and status indicators that cannot alter or override the flame supervisory system control logic.
(7) *Group VII.* A fire created as part of an illusion used to make an item or individual disappear.

See Table A.3.3.19 for a list of features included in each flame effect group.

Table A.3.3.19 Features Included in Flame Effect Groups

	Flame Effect Groups						
Features	**I**	**II**	**III**	**IV**	**V**	**VI**	**VII**
Outside	X	X	X	X	X	X	X
Inside	X		X	X	X	X	X
Temporary installation	X	X	X		X	X	X
Permanent installation		X		X	X	X	X
Attended	X		X			X	X
Unattended		X		X	X		X
Visual flame verification	X		X				X
Automatic flame supervision		X		X	X	X	X
Manual fuel controls	X						X
Automatic fuel controls		X	X	X	X	X	X
Main show control					X	X	
Proximate cast			X			X	X

Note: A blank space means that the feature cannot be in the group. An X means that it is a feature of the group.

A.3.3.22 Performer. Performers can include, but are not limited to, actors, singers, musicians, and acrobats. [**1126,** 2016]

A.3.3.25 Primary Safety Control. In the event of ignition failure or loss of flame, the control causes a safety shutdown.

A.3.3.27 Safety Shutdown (Lockout). The flame effect can be restarted only after a manual reset following correction of the abnormal condition.

A.3.3.29 Supervisory Control System. In the case of a manual system, this function might be performed by the flame effect operator or assistant.

A.3.3.30 Support Personnel. Among others, support personnel include the road crew of any production, stage hands, property masters, security guards, fire watch officers, janitors, or any other employee. [**1126,** 2016]

A.3.3.32 Venue. The term *venue* is one that is widely used in the entertainment industry. For the purposes of this standard, the term is to be used to specify the exact area of the property, building, or the room within a building where the use of flame effects is to be allowed. For example, the use of flame effects can be allowable in one specific meeting room of a hotel, but not in another; or in the case of reconfigurable (flexible plan) buildings or rooms, some configurations can be safe for the use of flame effects, but not others.

A.4.1 The following NFPA standards cover storage of flame effect materials:

NFPA 30, *Flammable and Combustible Liquids Code*

NFPA 54, *National Fuel Gas Code*

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*

NFPA 58, *Liquefied Petroleum Gas Code*

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*

NFPA *101*, *Life Safety Code*

NFPA 400, *Hazardous Materials Code*

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*

A.5.1.1 Because permit and approval requirements vary with each jurisdiction, this standard is intended to provide requirements that can be used by the authority having jurisdiction in making sound judgment regarding the safety of the proposed use of flame effects and the qualifications of the flame effect operator.

A.5.1.2 The use of flame effects is governed by a permit, which specifies the date(s) and time(s) or the expiration date of the permit, which, in turn, define the period during which the effects can be used. The length of this period determines the term of installation — that is, whether the flame effect installation is to be considered permanent or temporary. The term of installation is used in this standard as a criterion to classify the flame effects into one of seven groups.

A.5.2.1.1 Where the standards impose different requirements, the most stringent requirement should be the one used, unless otherwise approved by the AHJ.

A.5.2.2.2 There is an inherent danger in the modification of flame effects once the initial commissioning activities are complete. A protective control system could provide protection against events and safety concerns that are not recognized or fully understood by other than the original designers of the system. For others to attempt modifications to a protective system invites the inadvertent elimination of subtle but important safety features of a system.

A.5.3 Measures for control of inadvertent liquefied or gaseous fuel releases, additive system releases, portable component releases, or fire should be coordinated with local emergency-handling agencies, such as fire and police departments.

Information on those hazards not commonly covered in the training programs of emergency-handling agencies should be provided upon request to emergency responders.

The safety of emergency personnel should be considered in the plan.

A.5.3.1.2 See Annex B for guidelines on design of flame effects.

A.5.4.1 The AHJ should invite the local responding fire companies to witness the demonstration to familiarize them with the potential hazards involved.

A.5.5.1(3) A fire watch is a qualified person or persons in attendance during all times when fixed fire protection systems are intentionally taken out of operation and should be acceptable to the authority having jurisdiction. The fire watch should be familiar with the operation of all fire and life safety systems in the building and be able to notify emergency responders.

A.7.1.2 As a guide, the incident radiation from the flame effect should not cause the surface temperature of the exposed skin of a member of the audience to exceed 111°F (44°C), as measured using an infrared surface thermometer or other equivalent means. The operator should have, on site, the instrumentation necessary to verify skin temperature, if requested by the authority having jurisdiction.

A.8.1 There is no substitute for a diligent, capable, well-trained operations and maintenance staff; therefore, operators of equipment involved in safety-critical processes or effects are the primary safety and control element and should have a full understanding of the system, including the possible dangers and the required responses.

A.8.4 The flame effect operator is defined as the person who has overall responsibility for the flame effect. Attendants and assistants can be less than 21 years of age.

A.9.2 In Table 9.2, Group VI, positive manual enable (PME) is sometimes known as “Man in the Loop.”

A.9.3.1 Enabling the safety-critical effect could require coordination of the emergency stop systems of independent subsystems developed by separate vendors or contractors. This requirement applies only when an emergency stop button is pressed. Generally, conditions internal or local to a single subsystem (other than pressing an emergency stop button) that cause an automatic safety shutdown of one subsystem need not cause a shutdown of other subsystems. After a safety shutdown resulting from a pressed emergency stop button, and after the offending button has been reset, individual subsystems can be brought out of the shutdown condition, as long as no emergency stop button remains pressed.

A.9.3.1.5(6) Examples of monitored conditions are as follows:

(1) Loss of purge airflow to electrical enclosures in classified areas
(2) Loss or impairment of required ventilation systems
(3) Detection of flammable gas
(4) Loss of “proof of vacancy” in areas that present a serious hazard to personnel
(5) Loss of proof of the safe state of any valve or other protective device that is required to maintain the protective nature of the system
(6) Detection of a person in an unsafe area
(7) Detection of unsafe environmental conditions
(8) Detection of equipment in an unsafe state, condition, or position
(9) Wind or other weather conditions that create unsafe conditions
(10) System errors that should be addressed or acknowledged prior to a restart of the system

A.9.3.2.4.1(3) As shown in Figure A.9.3.2.4.1(3), an example of a supervisor station can include the following:

(1) Two safety valves in series, each with proof of closure, should be provided in the gas line to the main burners. An automatic vent valve should be provided between the two valves.
(2) Where the automatic vent valve is prohibited by the authority having jurisdiction, two safety shutoff valves in series, each with an interlock switch, supervised by a listed automatic valve proving system, should be provided in the

gas line to the burners. Valve proving should be performed either after every burner shutdown or prior to every burner light-off.

(3) Where flame effect fuel piping systems are subdivided into zones, each zone should be separated from other zones by a zone station. A zone station should consist of a manual fuel shutoff valve at the point of connection to the fuel supply piping and upstream of any other station components, and an automatic zone valve. The zone station shuts off all fuel to or from the flame effect zone when closed. When opened during the enable process, this station should be held open by a maintained signal from the flame effect control system.

The zone valve should automatically close in the event of the loss of the hold-open signal. The zone valve should only be opened as close to the time of the actual arming and firing of the flame effects as is practical. The zone valve should be provided with a means to test the seat-tightness of the valve at operating pressure.

A.9.3.2.6 The operating characteristics of some flame effects require that fuel be released at a rate greater than can be delivered by the fuel supply. To do so requires that quantities of fuel be temporarily accumulated at the location of the effect.

A.9.3.2.6(1)(a) For applications outside of the United States, equivalent national standards can be used.

A.9.3.2.6(2) The standard requires that the amount of fuel in an accumulator tank never be more than what is required to produce the effect. However, that amount deserves some consideration, as producing the desired effect can sometimes require that more fuel be stored in the accumulator than is actually discharged during the effect. Three examples of situations where it is necessary to store more fuel in the accumulator than is actually consumed are as follows:

(1) The creation of perfectly round fireballs — those without a tail — often requires that the effect valve be shut while the gas is still exiting the burner nozzle at relatively high velocity. This means that significant residual pressure is

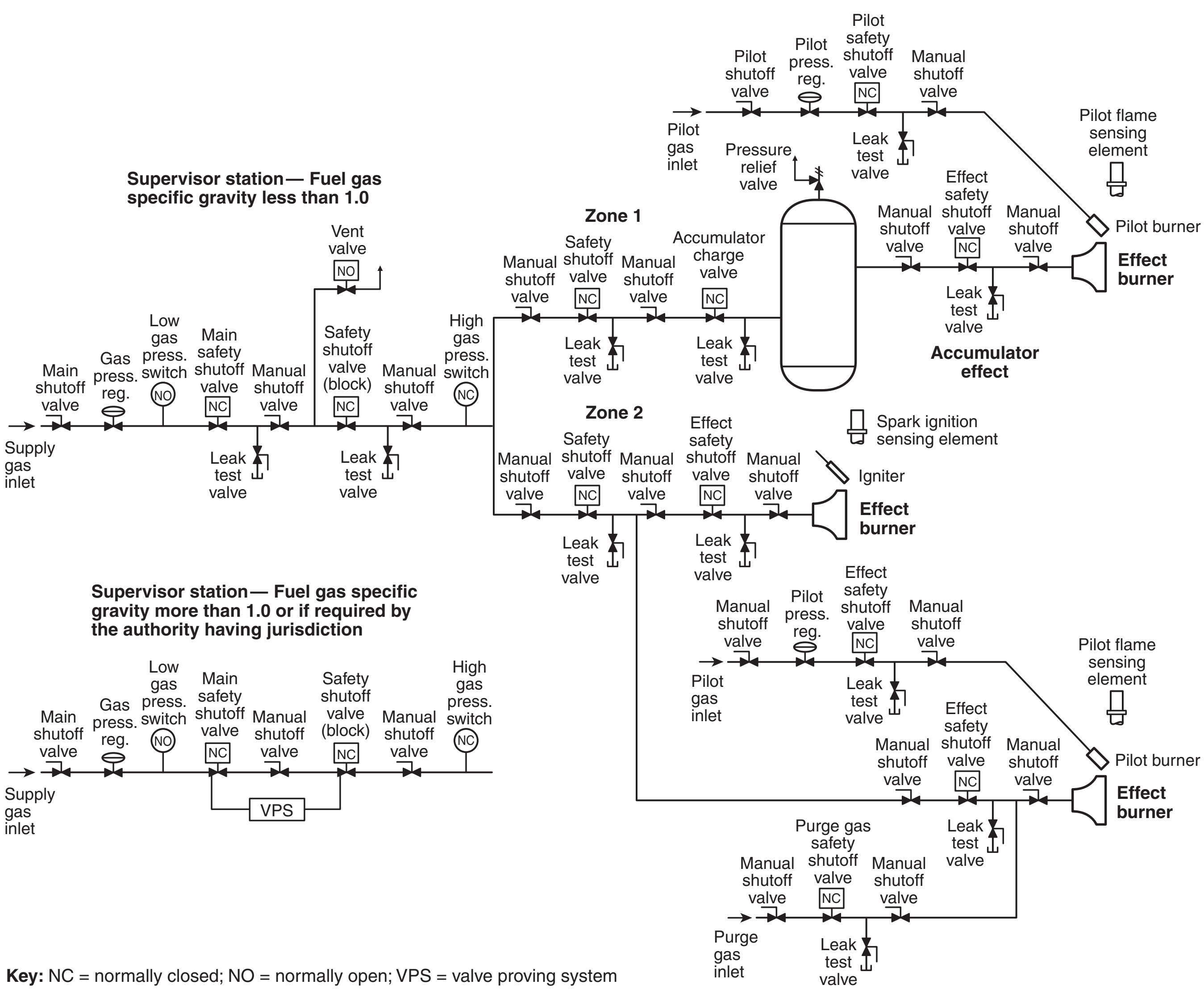

FIGURE A.9.3.2.4.1(3) Example of Various Flame Effect Control and Piping Components.

left in the accumulator after the effect is complete; in other words, to produce round fireballs it is required to have an amount of fuel in the accumulator in excess of that consumed.

(2) Bursts of multiple fireballs or jet flames are often required to be produced rapidly, sometimes without sufficient interval between each discharge to allow the accumulator to recharge. This situation occurs often in temporarily installed or portable flame effect appliances, particularly when the fuel supply is not capable of supporting high flow rates during the charge cycle. In this case, the accumulator must store more fuel than is consumed in a single discharge, although it is expected that the bulk of the fuel will be consumed over the course of a full burst.

(3) It is considered good practice to maintain a fuel-rich atmosphere inside the accumulator at all times, one that is well above the upper flammable limit. In order to do so it is necessary to shut the effect valve before all of the pressure in the accumulator is exhausted, trapping some fuel in the accumulator in excess of the amount consumed.

It is important to realize that even when an accumulator is sized exactly to the amount of fuel to be consumed, there are some situations where the accumulator will be left with an excess of fuel. Take, for example, an accumulator that has been charged, but for any number of reasons — performer off the mark, detected failure of the igniter, and so forth — the flame effect is not discharged. The result is a fully charged accumulator that can or cannot be consumed during the subsequent course of the performance. This scenario points out the necessity of providing each accumulator with a means of venting the fuel to a safe point of discharge, as required in 9.3.2.6(6).

A.9.3.3 Some of the operating parameters that can be enabled or monitored during the enabling of the flame effect control system include the following:

(1) Control power
(2) Main fuel supply
(3) Safety interlocks
(4) Ventilation airflow interlock (where used)
(5) Support services (compressed air, hydraulic pressure, etc.)
(6) Other parameters as required by the authority having jurisdiction

A.9.3.3.2 Where required for operation and maintenance, control systems can have separate sources of control power to allow operation in distinct modes; for example, they can have one source for automatic (normal) operation and a second for limited operation of the flame effects for the purpose of maintenance and testing. Where multiple sources of control power are available, the design of the flame effect control system should meet the following minimum criteria:

(1) One mode of operation should be "off," which should remove all control power from the flame effect control system.

(2) System operation should be such that the selection of one mode of operation disables all other modes of operation. It should not be possible to change from one mode of operation to another without turning all control power off. The flame effect control system should operate safely during the transition from one mode to any other mode of operation.

(3) All control power, regardless of source and mode of operation, should be interrupted by actuation of the emergency stop system. Loss of control power should bring the flame effect system to a safe state.

(4) When a main show control system is used, the status of the control power (mode of operation) should be automatically sent to the show control system at all times. Where a main show control system is used, and the mode of operation is in any mode other than that of normal automatic operation, or "off," the sending of any command from the show control system to the flame effect control system should automatically actuate the emergency stop system and bring the flame effect system to a safe state.

Circumstances for consideration include the following:

(1) Particular position, mode, or state for the proper operation of a safety-critical system.
Example: A fire-breathing dragon that needs to be in a particular position before fire is initiated. Similarly, other set pieces might have to be out of the area of the fire before fire is initiated.
Example: A fire on a set that is on a lift and that is not to be initiated until the lift is confirmed to be in the fully raised position.

(2) Effects on vision or hearing that could prevent the safe operation of systems or the related procedures or operations.
Example: A fog or other atmospheric effects system that could obscure egress routes or interfere with monitoring an effect fire or with taking corrective action in case of an incident.

(3) Conditions that can be confused with conditions or events of the safety-critical system.
Example: Other effect systems that create the appearance of fire, smoke, or heat.

Personal computers, single-board controllers, and other systems that have control capability but that are not routinely used in protective applications should not be used as life safety controllers. Only effect safety controllers should be used to prevent any safety-critical action. Non-effect safety controllers should not be used to allow, trigger, or request safety-critical action unless the signals of these non-effect safety controllers are intercepted and qualified by an effect safety controller that has responsibility for allowing safety-critical actions. Personal computers and single-board controllers can be used in related applications such as the display, logging, and trending of process variables, environmental conditions, status, faults, and other information.

Show controllers, including stage, lighting, pyrotechnics, animation, automation, and audio controllers that are used to control overall show timing relationships or that provide synchronization with audio, lighting, and unrelated effects, should be permitted to provide timing information to a flame effect safety controller but should not directly control safety-critical processes. The flame effect safety protective controller then should use this information, and other safety-related information, to control safety-critical effects.

The flame effect control system that is responsible for control of safety-critical effects should not provide control of general show timing or of non-safety-critical effects, except as follows:

(1) Timing internal to a single effect, such as to create phases or sub-effects, should be permitted to be programmed into the flame effect control system.
(2) The protective flame effect control system should be permitted to provide control of a limited number of small non-safety-critical effects with limited and simple timing needs. In such cases, there should be a division of the safety-critical and non-safety-critical functions of the system.

The purpose of the requirement in 9.3.3.2 is to prevent equipment that is being used for protective control purposes from being utilized for general show control purposes when doing so would partially obscure the protective control purpose of the system, distracting the designers and operators from devoting attention to the safety-critical aspects of the system, which are of primary concern.

A.9.3.3.4 Examples of interlocks that can be included in the flame effect control systems are as follows:

(1) Wind speed and direction
(2) Critical temperatures
(3) Opacity instrumentation
(4) Purge airflow and/or damper positions
(5) Combustion airflow
(6) Position indicator switches for animated figures and sets
(7) Cast position confirmation switches
(8) Audience position/ride vehicle position indicators
(9) Others as required by the operation of the show

A.9.3.4.4 Some of the sensors that are currently in use for monitoring these characteristics are as follows:

(1) Ultraviolet flame detector in combination with a listed primary safety control
(2) Infrared flame detector in combination with a listed primary safety control
(3) Flame rod in combination with a listed primary safety control
(4) Thermocouple temperature sensor in combination with a listed primary safety control or as part of a listed automatic valve assembly
(5) Other devices directly sensitive to the characteristics of the means of ignition and acceptable to the authority having jurisdiction

A.9.3.5 The firing of the flame effect is normally achieved through the release of the fuel into ambient air where the mixture is ignited by an ignition device. Normally, this is achieved by the opening of a manual or electrically actuated fuel release valve. Other methods of fuel release are acceptable on the approval of the local authority. Examples of firing methods for flame effects are as follows:

(1) Manual firing by cast member or technician
(2) Firing by a timer and/or programmable logic controller (PLC)
(3) Firing by a PLC with PME

A.9.3.5.3 Certain venues can have areas, both visible to and out of sight of the technical director, in which a person who is present in the area during the firing of the effects might be exposed to the possibility of injury. These areas should be supervised by an intrusion monitor and alarm system during all times when the effects are enabled.

A.9.3.5.4 Certain venues can have areas, both visible to and out of sight of the technical director, where during the enable process one of the following can occur:

(1) Cast members can be present immediately before or after the firing of the effect.
(2) Members of the audience might enter the area during the firing of the effect.
(3) Moving set pieces can affect the safe operation of the effect.

A PME of the flame effect control system should be maintained by a qualified operator with a clear view of the operating area of the effect during the entire process of the enabling, arming, and firing of the effect.

Where the technical director does not have a clear view of the hazard area, additional PME devices should be installed and operated by qualified operators who are in such a position that they have a clear view of the area. Cast members who can be present immediately before the arming and firing of the effect should have additional PME devices that have to be actuated before the flame effect can be fired.

These PME devices should have the following characteristics:

(1) The PME device should consist of a momentary contact push button switch that will close a normally open isolated contact when depressed, thereby sending a confirming signal to show control.
(2) These enable operators should be located in positions such that the technician or cast member can view the effects area and/or confirm that they are safely out of harm's way.
(3) Manual enable operators should be clearly identified as to function. Indicator lights can be provided in the push button or adjacent to the push button to confirm to the operator that the enable signal has been sent to show control.
(4) In the event that any PME signal is not sent or is removed during the arming and firing sequence of an effect, a non-recycling shutdown of that effect or group of effects should occur. The effects can be returned to service only following the removal of the effect enable input and restarting the process. Other flame effects and show elements can continue to operate normally for the remainder of the show.

Repetitive protective operations by human operators are of limited value due to the acclimatization of the operator. When repetitive enabling of an effect is required, appropriate steps should be taken to assure that the operator remains alert for every action.

Although each situation is different and multiple remedies could be required in some situations, steps that can be used to address this concern include the following:

(1) Use two individually monitored buttons, each serving the same enabling function, separated by a distance such that the operator has to be facing the area of safety concern when the buttons are pressed.
(2) Activate the buttons upon an indication in the vicinity of the area of safety concern. For example, rather than illuminating the enable buttons, illuminate an indicator near the flame so that the operator will be encouraged to look in the direction of the flame to determine when to press the enable button.

(3) Vary the timing of the effect to the extent possible within the creative constraints of the show.

A.11.2.1 The following steps are recommended as part of the fire hazards evaluation procedure:

(1) List and describe the following:
    (a) Sources of ignition
    (b) Spread of fire
    (c) Potential duration of fire
    (d) Smoke generation
    (e) Potential collection or drift of flammable vapors and gases
    (f) Exposure of personnel to decomposition products
    (g) The time required for emergency evacuation of the audience
    (h) Extinguishment potential of supplemental standby fire equipment
    (i) The additional fire load from the flame effect
    (j) Existing building fire protection systems
    (k) Other factors specific to the flame effect
(2) Prepare a general description of the fire prevention and fire protection systems that exist and that will be provided. Define the fire hazards that can exist and state the loss-limiting criteria to be used in the design of the flame effect.
(3) Conduct an exposure analysis to determine safe distances of the flame effect from adjacent facilities. Consider the use and effect of noncombustible fire-retardant and heat-resistant materials.
(4) Review and describe the control and operating room areas, if applicable, and the detection and extinguishing systems that will be provided for these areas.

A.11.3 Supplemental fire protection equipment can consist of charged handlines, hand portable extinguishers, wheeled extinguishers, pre-engineered or engineered systems capable of properly extinguishing the flame effect, and any combustible materials within the immediate area. The manufacturer of the equipment should be consulted for assistance on fire extinguishing equipment and agents.

Annex B Design of Flame Effects

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Design Plan. The design plan for flame effects should be based on the criteria outlined in B.1.1 through B.1.2.

B.1.1 Location.

B.1.1.1 The design plan for outdoor flame effects should include the following:

(1) Weather (e.g., wind), with safety provisions provided to halt the effect where safe operation of a flame effect can be influenced by hazardous weather conditions
(2) Intrusion (security)
(3) Egress
(4) Clearance to combustibles
(5) Fire protection

B.1.1.2 The design plan for indoor flame effects should include the following:

(1) Ventilation (where used to exhaust the products of combustion of a flame effect), with means provided to prevent fuel flow in the event that the source of ventilation air is interrupted
(2) Clearance to combustibles
(3) Egress
(4) Environment
(5) Fire protection
(6) Life safety provisions
(7) Intrusion (security)

B.1.2 Flame Effect Operator Participation.

B.1.2.1 The design plan for attended effects should include the following:

(1) Control by the operator or performer during start-up, operation, and shutdown
(2) Operator in attendance during effect
(3) Training of operators

B.1.2.2 The design plan for unattended effects should include the following:

(1) Design for unattended operation
(2) Supervision by automatic systems
(3) Audience proximity/audience intrusion prevention
(4) Control type — automatic
    (a) Show events cued by a control system (mechanical or electrical)
    (b) Different levels of automatic operation
    (c) Requirements to be developed for flame effect control systems
(5) Manual control type — supervision of the performance of the device by the operator or technician with the flame effect in open view
(6) Control location
    (a) Local control — a flame effect controlled by an operator who has a clear view of the flame effect area
    (b) Remote control
(7) Fuel supply and fuel additives
    (a) Portable
    (b) Fixed

Annex C Inspection Guidelines

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 General. The following guidelines are provided as a possible inspection routine that can be used as a model.

C.2 Inspection and Re-Verification of Flame Effects Function. Following issuance of the use permit by the local authority having jurisdiction *(see 5.3.1)* and completing the Approval Requirements *(see Section 5.2)*, the flame effect(s) show action equipment should be subjected to a periodic functional verification and calibration of critical components according to the requirements of a written test plan/procedure as created by the designer of the effects or other responsible individual. A written report and/or completed checklist in a format acceptable to the local jurisdiction should be made a permanent part of the effects documentation.

C.2.1 Temporary Flame Effects Installations. Temporary flame effects installations should be evaluated on a periodic basis by a qualified technician/operator according to the guidelines outlined in C.2.1.1 and C.2.1.2.

C.2.1.1 Daily Inspection and Testing. Any critical deficiencies and/or malfunctions are to be corrected and noted in the show documentation prior to the operation of the effects in the show. Inspection should include the following:

(1) Visual inspection of fuel storage area, which includes verifying that the fuel supply is properly secured, that general housekeeping is according to proper standards, whether there is accumulation of flammable materials, convenient access to critical areas, and the absence of any items not directly related to the storage or management of the fuel supply.
(2) Visual inspection of performance area(s), which includes general housekeeping, accumulation of incidental flammable materials, condition of sets and props, convenience of access, and any other condition relating to the proper operation of the effects.
(3) Visual inspection of fire effects equipment to verify that the components are functional. Significant degradation or damage should be noted and repaired or replaced as necessary.
(4) As part of the daily preset for the show, the effect(s) should be operated according to the procedure established by the designer of the effect to verify the proper operation of the enable and arming as designed. Any discrepancies in the normal operation of the effect should be noted and corrected prior to the operation of the effect during the show.
(5) Verification that all provisions for the emergency shutdown of the effect, including fuel management and fire suppression measures, are present and/or operating normally.
(6) Observation of the operation of the effect during the show to verify that it is functioning according to the expected operating profile.

C.2.1.2 Weekly and Monthly Inspection and Testing. Weekly and monthly inspection and testing should be conducted and noted as dictated by the design and operation of the effects and the duration of the temporary installation.

C.2.2 Permanent Flame Effects Installations. Permanent flame effects installations should be evaluated on a periodic basis by a qualified operator according to the guidelines outlined in C.2.2.1 through C.2.2.4.

C.2.2.1 Daily Inspection and Testing. Any critical deficiencies and/or malfunctions are to be corrected and noted in the show documentation prior to the operation of the effects during the show. Inspection should include the following:

(1) Visual inspection of fuel storage area, which includes verifying that the fuel supply is properly secured, that general housekeeping is according to proper standards, whether there is accumulation of flammable materials, convenient access to critical areas, and the absence of any items not directly related to the storage or management of the fuel supply.
(2) Visual inspection of performance area(s), which includes general housekeeping, accumulation of incidental flammable materials, condition of sets and props, convenience of access, and any other condition relating to the proper operation of the effects.
(3) Visual inspection of fire effects equipment to verify that the components are functional. Significant degradation or damage should be noted and repaired or replaced as necessary.
(4) Verification that all primary limits [lower explosive limit (LEL) sensors, airflow switches, fuel pressure switches, etc.] are conditioned in the proper control profile and that they indicate a proper operating level of the parameter being monitored.
(5) As part of the daily preset for the show, the effect(s) should be operated according to the procedure established by the designer of the effect to verify the proper operation of the enable and arming as designed. Any discrepancies in the normal operation of the effect should be noted and corrected prior to the operation of the effect during the show.
(6) Verification that all provisions for the emergency shutdown of the effect, including fuel management and fire suppression measures, are present and/or operating normally.
(7) Observation of the operation of the effect during the show to verify that it is functioning according to the expected operating profile.

C.2.2.2 Monthly Inspection and Testing. In addition to the recommended tests as stated in C.2.2.1, the following tests and inspections should be performed as required:

(1) Test and calibrate any limit or interlock control device that could be subject to a change in the measured value as a normal part of the operation of the device over a period of time according to the recommendations of the manufacturer.
(2) Perform a leak test of any primary fuel supply shutoff valves according to the recommendations of the manufacturer.
(3) Verify that any intrusion and/or position interlocks are operating properly and the actuation of any such device results in the desired control system response.
(4) Other test sequences as recommended by the effects designer or other cognizant individual.

C.2.2.3 Quarterly Inspection and Testing. In addition to the recommended tests as stated in C.2.2.1 and C.2.2.2, the following tests and inspections should be performed as required:

(1) Calibrate all primary limit or interlock control devices, which could be subject to a change in the measured value as a normal part of the operation of the device over a period of time.
(2) Actuate all primary limit or interlock control devices to confirm proper function, control response, and confirmation of actuation.
(3) Actuate any central fire alarm system to verify that the actuation will result in the emergency stop of the effects control system.
(4) Actuate all show emergency stop operators to confirm their proper function and confirmation of actuation. Furthermore, selected emergency stop operators should be actuated during the operation of the effects to verify the proper emergency shutdown of the effects.
(5) Operate the fuel supply enable control circuit to verify the proper function of the fuel limits and valves.
(6) Enable and arm randomly selected effects to verify the proper operation of the ignition management control circuit, including safe start check, trial for ignition, flame failure response time, and non-recycling operation as necessary. The number of effects to be tested should be a minimum of 3 or 20 percent of the total number of flame effects in the control system. Where the design of the

controls includes multiple zones, at least one effect in each zone should be tested.

(7) Test the PME operator during the operation of the effects to verify that the effects will not enable, arm, and fire without the presence of the PME and that the removal of the PME during the enabling, arming, and firing sequence of the effects will shut down the effects operation as designed.

(8) Operate the effects in the normal show mode to verify that they are enabling, arming, and firing in the expected sequence according to the normal show profile.

(9) Other test sequences as recommended by the effects designer or other cognizant individual.

C.2.2.4 Annual Inspection. The annual inspection of the flame effects will verify the proper function of all effects control components and serve as a certification of the condition and operation of the effects control system for the renewal of the operating permit as issued by the local jurisdiction. The test sequence should include those sequences as stated in C.2.2.1, C.2.2.2, and C.2.2.3, to such an extent that all control systems and components are tested, verified, and functioning properly, and that any other tests as recommended by the effects designer or other cognizant individual are performed.

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

D.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 30, *Flammable and Combustible Liquids Code*, 2015 edition.

NFPA 54, *National Fuel Gas Code*, 2015 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2016 edition.

NFPA 58, *Liquefied Petroleum Gas Code*, 2014 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2013 edition.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 400, *Hazardous Materials Code*, 2016 edition.

NFPA 495, *Explosive Materials Code*, 2013 edition.

NFPA 1122, *Code for Model Rocketry*, 2013 edition.

NFPA 1123, *Code for Fireworks Display*, 2014 edition.

NFPA 1125, *Code for the Manufacture of Model Rocket and High Power Rocket Motors*, 2012 edition.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2016 edition.

NFPA 1127, *Code for High Power Rocketry*, 2013 edition.

D.1.2 Other Publications.

D.1.2.1 ICAS Publications. The International Council of Air Shows (ICAS), 751 Miller Drive, SE., Suite F-4, Leesburg, Virginia 20175.

Guidelines for the Use of Pyrotechnics and Special Effects at Air Shows.

D.2 Informational References. (Reserved)

D.3 References for Extracts in Informational Sections.

NFPA 1126, *Standard for the Use of Pyrotechnics Before a Proximate Audience*, 2016 edition.

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NFPA® 170

Standard for

Fire Safety and Emergency Symbols

2015 Edition

This edition of NFPA 170, *Standard for Fire Safety and Emergency Symbols*, was prepared by the Technical Committee on Fire Safety and Emergency Symbols. It was issued by the Standards Council on November 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 170 was approved as an American National Standard on December 1, 2014.

Origin and Development of NFPA 170

The 1994 edition of NFPA 170 represented the completion of an effort to combine four previously separate documents that covered fire safety symbols for different purposes. These documents were the following:

NFPA 171, *Public Firesafety Symbols*

NFPA 172, *Fire Protection Symbols for Architectural and Engineering Drawings*

NFPA 174, *Fire Protection Symbols for Risk Analysis Diagrams*

NFPA 178, *Symbols for Fire Fighting Operations*

The Technical Committee on Fire Safety Symbols believed that placing all fire safety symbols in one document made it easier for users of symbols to find the one(s) most appropriate for their application. It also eliminated duplication between these and eventually other NFPA documents.

The first edition of NFPA 170, in 1991, placed these four documents in one document but did not combine them, except for definitions that were in each document.

For the second edition of NFPA 170, in 1994, the Technical Committee on Fire Safety Symbols completely restructured the text into a logical and cohesive arrangement. The duplication of symbols that occurred during the aforementioned consolidation of documents was eliminated. New symbols added included those for *campfire prohibitions*, *smoke barriers*, *illuminated exit signs*, and *belowground tanks*.

For the third (1996) edition of NFPA 170, changes included the following:

(1) Upgrading recommendations on *pre-incident planning* to requirements
(2) Adding new symbols for *pull station*, *area of refuge*, and *cooking prohibition*
(3) Clarifying the symbols for *smoke detectors*, *battery-powered emergency lights*, and *fire service/emergency telephone station*
(4) Recognizing the phaseout of Halon now taking place and the introduction of *clean agents*

The 1999 edition further recognized the introduction of clean agents by adding new symbols for *clean agent* and *water mist systems*. A new appendix (Appendix C) was added to include symbols that can be used for life safety planning.

The 2002 edition was reformatted to conform to the *Manual of Style for NFPA Technical Committee Documents*. Symbols for fire alarm system components were added for consistency with *NFPA 72®*, *National Fire Alarm Code®*.

In 2004, the scope of the committee was expanded to include emergency symbols to allow emergency mapping symbols in a new Chapter 8.

The 2006 edition of NFPA 170 included the refinement of exit symbology for better recognition of exit, arrow, and flame symbols that are consistent with international standards.

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A new Chapter 8, Symbology for Emergency Management Mapping, was added to assist the user in the preparation for, prevention of, protection against, response to, and recovery from threats to the nation's population centers and critical infrastructure from terrorist, criminal, accidental, or natural origin.

The symbols in Chapter 8 were the result of efforts by the Federal Geographic Data Committee — Homeland Security Working Group (http://www.fgdc.gov/fgdc/homeland/index.html). The symbols were included in the 2006 edition so that they can be processed through an accredited standards-writing organization and made available to the public.

The 2009 edition of NFPA 170 included a new chapter (Chapter 9) that provided guidance on the development of emergency evacuation diagrams and plans.

The 2012 edition of NFPA 170 included a new Chapter 7 and a new Chapter 8, previously all encompassed within the old Chapter 6. This affected symbol detail for various device symbols such as fire alarm devices, fire sprinkler devices, electronic fire and smoke detection, and so forth. This action better organized existing symbols within the standard for the user.

The 2015 edition has revised several symbols for consistency and clarity. The "wisp of smoke" has been replaced by an "S" to simplify the symbol when viewed on plans. Many tables have been reorganized for clarity and ease of use as well.

Technical Committee on Fire Safety and Emergency Symbols

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on fire safety and emergency symbols including those for building design plans, investigation diagrams, maps, and for public fire safety and emergency. It shall coordinate its work with NFPA technical committees and other groups dealing with subjects to which fire safety symbols apply.

NFPA 170

Standard for

Fire Safety and Emergency Symbols

2015 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex D. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex D.

Chapter 1 Administration

1.1 Scope. This standard presents symbols used for fire safety, emergency, and associated hazards.

1.2 Purpose. The purpose of this standard is to standardize the symbols used in representing fire safety, emergency, and associated hazards.

1.3 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.3.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.3.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.3.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.4 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.4.1 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency.

1.4.2 The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.5 Units. Metric units of measurement used in this standard shall be in accordance with the International System of Units (SI). One unit (liter), outside of but recognized by SI, is commonly used in international fire protection. For conversion factors, see Table 1.5.

Table 1.5 Metric Conversion Factors

Name of Unit	Unit Symbol	Conversion Factor
Liter	L	1 gal = 3.785 L
Cubic decimeter	dm^3	1 gal = 3.785 dm^3
Pascal	Pa	1 psi = 6894.757 Pa
Meter	m	1 ft = 0.3048 m
Millimeter	mm	1 in. = 25.4 mm

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

NFPA 704, *Standard System for the Identification of the Hazards of Materials for Emergency Response,* 2012 edition.

2.3 Other Publications.

2.3.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI A117.1, *Accessible and Usable Buildings and Facilities,* 2009.

ANSI Z535.1, *Safety Color Code,* 2011.

2.3.2 NECA Publications. National Electrical Contractors Association, 3 Bethesda Metro Center, Suite 1100, Bethesda, MD 20814.

NECA 100, *Symbols for Electrical Construction Drawings*, 2006.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 10, *Standard for Portable Fire Extinguishers,* 2013 edition.

NFPA *101*®, *Life Safety Code*®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1 Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.2.7 Standard. An NFPA Standard, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and that is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the NFPA Manuals of Style. When used in a generic sense, such as in the phrase "standards development process" or "standards development activities," the term "standards" includes all NFPA Standards, including Codes, Standards, Recommended Practices, and Guides.

3.3 General Definitions.

3.3.1 Photoluminescent. Having the ability to store incident electromagnetic radiation typically from ambient light sources, and release it in the form of visible light. [***101***, 2015]

3.3.2 Pre-Incident Planning. A written document resulting from the gathering of general and detailed information/data to be used by public emergency response agencies and private industry for determining the response to reasonable anticipated emergency incidents at a specific facility.

3.3.3* Referent. An object or concept (message) represented by a symbol.

3.3.4 Self-luminous (Emergency Symbols). A type of sign that is self-energized used for an emergency symbol with respect to luminosity and requires no external power source, or photoluminescent materials having the ability to store incident electromagnetic radiation typically from ambient light sources, and release it in the form of visible light.

3.3.5* Supplementary Indicators. Figures, numbers, subscripts, or letter abbreviations used to enhance the effectiveness of symbols.

3.3.6* Symbol. A graphic representation of a referent.

Chapter 4 Symbols for General Use

4.1 Introduction.

4.1.1 This chapter presents general referents and symbols for fire prevention and visual alerting that shall be used for fire and related life safety emergencies.

4.1.2 Purpose.

4.1.2.1 This chapter shall provide uniform fire safety symbols to improve communication wherever signs and symbols are employed to provide fire safety information.

4.1.2.2 This chapter provides uniformity in the selection of symbols that shall be designed to assist in locating exits, fire safety alerting equipment, and safe areas.

4.1.2.3* The fundamental imagery for symbols, as well as their background color and shape, shall be designated in this chapter.

4.1.3* Symbol Presentation.

4.1.3.1 The orientation for prohibition symbols shall not be altered from that shown in this chapter.

4.1.3.2 The symbol background shape shall be as specified in Table 4.2.

4.1.3.2.1* For prohibition symbols, a circle and diagonal slash (at 45 degrees from upper left to lower right) shall be used.

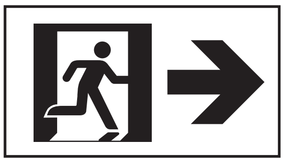
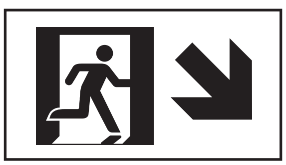
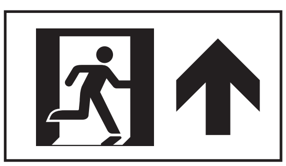
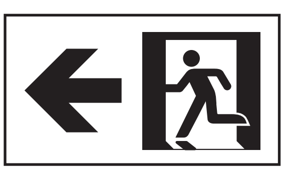
4.1.3.3 Symbol Color. The symbol color shall meet the requirements of ANSI Z535.1, *Safety Color Code.*

4.1.3.4* Symbols shall be permitted to be used in combination with other symbols, either vertically or horizontally, on the same sign or on separate signs adjacent to each other.

4.2* Symbols for General Use. The symbols for general use shall be as given in Table 4.2.

4.3 Class of Fire Symbols. The symbols for class of fire shall be as given in Figure 4.3(a) and Figure 4.3(b).

Table 4.2 Symbols for General Use

Symbol	Characteristics	Application	Example
Emergency Exit 	Square field Background green Door opening white Image in green	The identification and location of an emergency exit	The location of exit for use in a fire emergency
Emergency Exit Use of Arrows — Rectangular Field 	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress to the right
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress up and to the right
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress down and to the right
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress forward
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress down
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress to the left

(continues)

Table 4.2 *Continued*

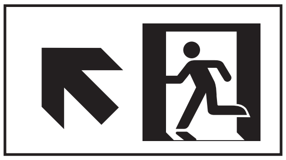
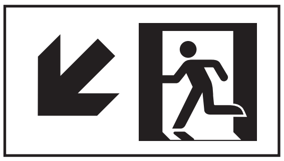
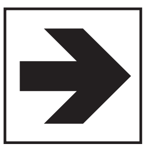
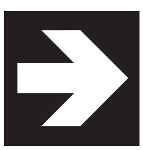
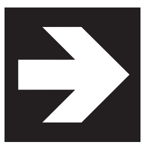
Symbol	Characteristics	Application	Example
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress up and to the left
	Painted version: Background color white Arrows red or black Backlit version: Doorway, arrows, and lettering in green or red	The identification and location of a route to an emergency exit	Progress down and to the left
Emergency Exit Route (Combination of Two Symbols)    	Square field Background green Door opening white Image in green For arrows: Square field Green arrow on white background or white arrow on green background	The identification and location of a route to be used in an emergency	The direction to a fire exit
Accessible Emergency Exit (Combination of Two Symbols)  	Square field Background green Door opening white Image in green International symbol of accessibility per ANSI A117.1, *Accessible and Usable Buildings and Facilities*	The identification of a route that leads to an emergency exit that is accessible to disabled users, as specified by ANSI A117.1, *Accessible and Usable Buildings and Facilities*	The location of a route toward a fire exit that is accessible to disabled users

Table 4.2 *Continued*

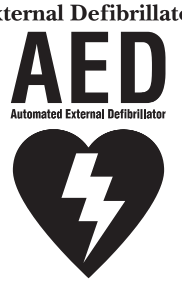
Symbol	Characteristics	Application	Example
Accessible Emergency Exit Route (Combination of Three Symbols) 	Square field Background green Door opening white Image in green	The identification of a route that leads to an emergency exit that is accessible to disabled users	The location of the route toward a fire exit that is accessible to disabled users
	International symbol of accessibility per ANSI A117.1, *Accessible and Usable Buildings and Facilities*		
	For arrows: Square field Green arrow on white background or white arrow on green background		
Not an Exit 	Circular field Red prohibition symbol Background white Door frame green Door opening white Image in black	The identification of doors that do NOT lead to an exit	The location of an interior door such as one leading to a closet, an interior courtyard, or a basement
Use Stairs in Case of Fire 	Square field Red flame Black figure White background	An instruction to the user to use stairs (downward egress) in case of fire	The identification that stairs are to be used in case of fire
Use Stairs in Case of Fire 	Square field Red flame Black figure White background	An instruction to the user to use stairs (upward egress) in case of fire	The identification that stairs are to be used in case of fire

(continues)

Table 4.2 ***Continued***

Symbol	Characteristics	Application	Example
Do Not Use Elevator in Case of Fire 	Rectangular field Red flame Black figures White background Red circle and slash	An instruction not to use elevators in case of fire	Posted near elevator call button
No Open Flame — Flame 	Circular field Red circle and slash Black image White background	The identification of areas in which open flame is prohibited	The identification of areas, such as combustible storage areas, gas stations, and hazardous areas
No Open Flame — Lighted Match 	Circular field Red circle and slash Black image White background	An instruction not to use lighted matches	Where posted, the use of matches is prohibited
No Smoking 	Circular field Red circle and slash Black image White background	The identification of areas in which smoking is prohibited	The identification of areas, such as those for flammable liquid storage, where smoking could lead to fire or explosion
No Campfires 	Circular field Red circle and slash Black image White background	The identification of areas where campfires are not permitted	The identification of areas, such as municipal parks, where campfires are not permitted

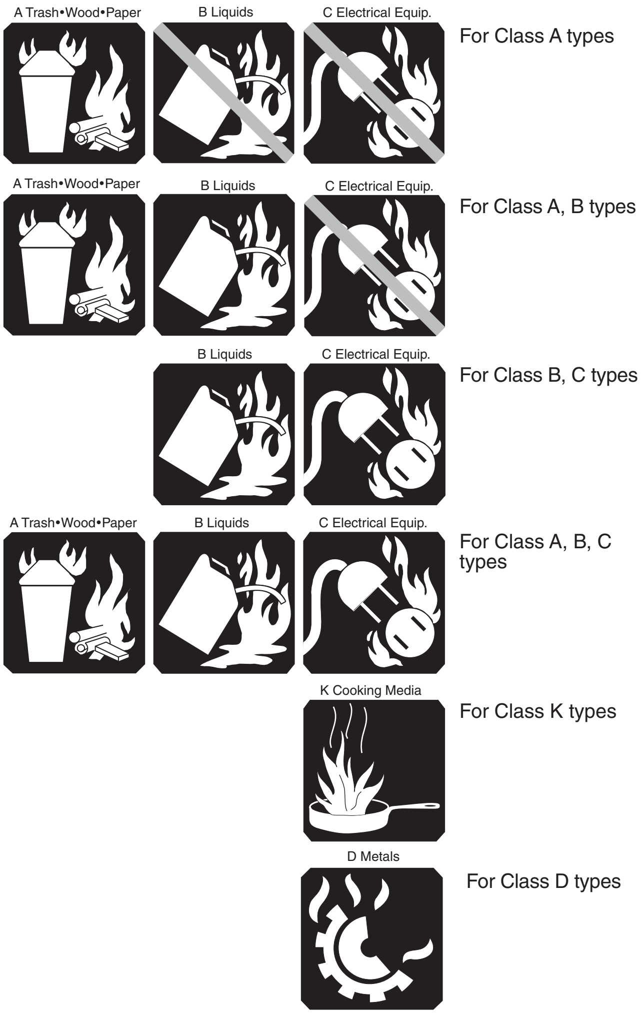
Table 4.2 *Continued*

Symbol	Characteristics	Application	Example
Manual Station — Pull Station/Fire Alarm Box 	Rectangular field Red background White flame White hand White box White horn	An instruction to actuate an alarm-initiating device in a fire emergency	Posted above a manually activated initiating device
No Cooking 	Square field White background Red flame Black pot and steam Red circle and slash	An instruction not to cook food in an area	Posted inside a guest room in a hotel or a student room in a college dormitory
Area of Refuge 	Square field White background Red flame	The identification of an area of refuge	A designated area of refuge to be used in a fire emergency
No Hanger 	Red circle and slash Black image	To prohibit hanging clothes or other items from sprinklers	Where posted
Automated External Defibrillator (AED) 	Square field White background Red heart White bolt through the heart Black lettering	To identify the location of AEDs	Posted in airports and other places of assembly

(continues)

Table 4.2 *Continued*

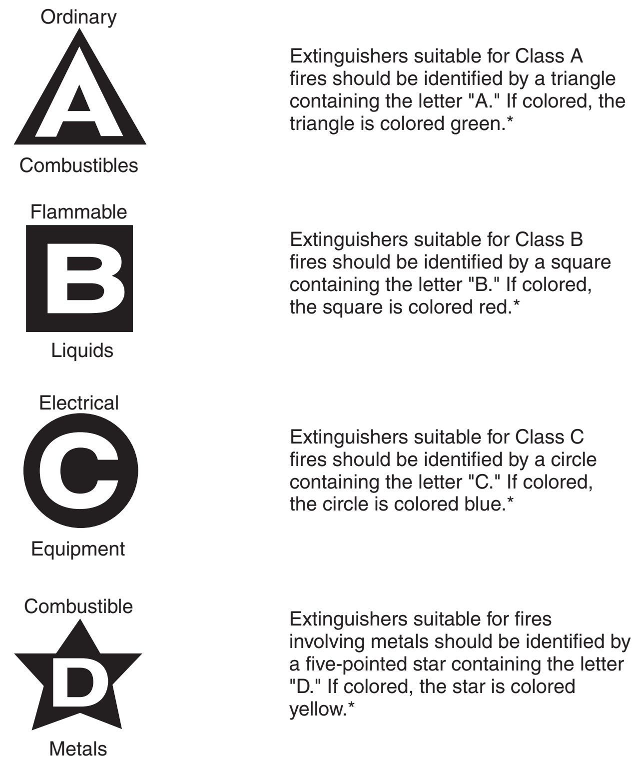
Symbol	Characteristics	Application	Example
Fire Extinguisher 	Square field Red background White symbol	For everyday use in workplaces and public areas; supplementary text sign can be used to increase comprehension	Fire safety signage, manuals, and notices
Fire Hose or Standpipe 	Square field Red background White symbol	For everyday use in workplaces and public areas; supplementary text sign can be used to increase comprehension	Fire safety signage, manuals, and notices



Note: Recommended colors, per PMS (Pantone Matching System) include the following:

BLUE — 299
RED — Warm Red

FIGURE 4.3(a) Recommended Marking System. [10:Figure B.1.1]



* Recommended colors, per PMS (Pantone Matching System) include the following:

GREEN — Basic Green
RED — 192 Red
BLUE — Process Blue
YELLOW — Basic Yellow

FIGURE 4.3(b) Letter-Shaped Symbol Markings. [10:Figure B.2.2]

Chapter 5 Symbols for Use by the Fire Service

5.1 Introduction.

5.1.1* This chapter presents standard referents and symbols that shall be used for visually alerting fire fighters and other emergency responders during fire and related emergencies.

5.1.2* Fundamental shapes of symbols, as well as the background color and shape, shall be as designated in this chapter.

5.1.3* Symbol Presentation.

5.1.3.1* Symbol Shapes. The shape of symbols shall be as illustrated in Section 5.2.

5.1.3.2 Symbol Background.

5.1.3.2.1 The symbol background shall be as specified in Table 5.2.

5.1.3.2.2 The symbol background color shall be red, white, or blue as designated and shall meet the requirements of ANSI Z535.1, *Safety Color Code,* for safety red, white, or blue.

5.1.3.3 Symbol Color. The symbol color shall be safety white or blue and shall meet the requirements of ANSI Z535.1, *Safety Color Code,* for safety white or blue.

5.1.3.4 Symbol Orientation. Symbol orientation shall not be altered from that shown in this chapter.

5.2* Symbols for Use by the Fire Service. The symbols for use by the fire service shall be as given in Table 5.2.

Table 5.2 Symbols for Use by the Fire Service

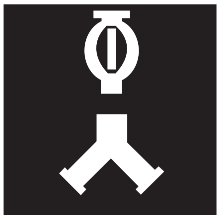
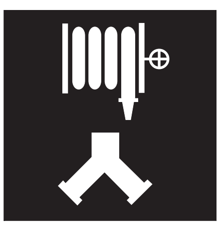
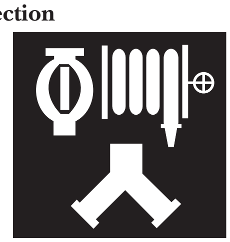
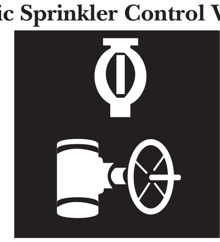
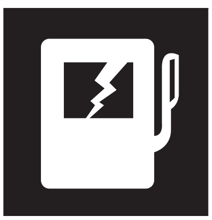
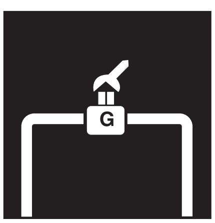
Symbol	Characteristics	Application	Examples
Fire Department Automatic Sprinkler Connection — Siamese 	Square field Red background White symbol	The identification and location of a fire department automatic sprinkler connection	The location of a siamese automatic sprinkler connections on buildings The location of siamese freestanding automatic sprinkler connections
Fire Department Automatic Sprinkler Connection — Single 	Square field Red background White symbol	The identification and location of a fire department automatic sprinkler connection	The location of a single automatic sprinkler connection on buildings The location of a single freestanding automatic sprinkler connection
Fire Department Standpipe Connection 	Square field Red background White symbol	The identification and location of a fire department standpipe connection	The location of standpipe connections on buildings and structures The location of freestanding standpipe connections
Fire Department Combined Automatic Sprinkler/Standpipe Connection 	Square field Red background White symbol	The identification and location of a fire department combined automatic sprinkler/standpipe connection	The location of combined sprinkler/standpipe connections on buildings The location of freestanding combined sprinkler/standpipe connections

Table 5.2 *Continued*

Symbol	Characteristics	Application	Examples
Fire Hydrant (All Types) 	Square field Red background White symbol	The identification and location of a fire hydrant	The location of fire hydrants, wall hydrants, underground hydrants, or other fire-fighting water supplies
Automatic Sprinkler Control Valve 	Square field Red background White symbol	The identification and location of an automatic sprinkler control valve	The location of control valves for automatic sprinkler systems On doors of rooms containing control valves
Electric Panel or Electric Shutoff 	Square field Blue background White symbol	The identification and location of an electrical panel or other electric shutoff device	The location of electric panels or other electric control devices that can be located in basements or mechanical rooms
Gas Shutoff Valve 	Square field Red background White symbol Red letter G	The location of a gas shutoff valve	The location of gas shutoff valves On doors of rooms containing gas shutoff valves
Fire-Fighting Hose or Standpipe Outlet 	Square field Red background White symbol	The location of a fire-fighting hose or a standpipe outlet	The location of interior fire-fighting hose stations and standpipe outlets in buildings and structures The location on bridges or elevated highways

(continues)

Table 5.2 *Continued*

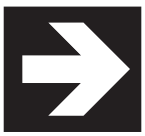
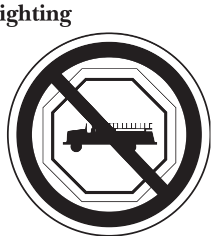
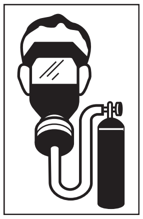
Symbol	Characteristics	Application	Examples
Fire Extinguisher 	Square field Red background White symbol	The location of a fire extinguisher	The location of fire extinguishers in buildings and exterior locations
Directional Arrow 	Square field Background green to correspond to accompanying sign White symbol	Direction to the location of fire-fighting equipment or utility; always used in conjunction with, and adjacent to, another symbol indicating the particular equipment or utility	
Diagonal Directional Arrow 	Square field Background green to correspond to accompanying sign White symbol	Direction to the location of fire-fighting equipment or utility; always used in conjunction with, and adjacent to, another symbol indicating the particular equipment or utility	
Child Care Center 	Square field Blue infant and hands White background	The identification and location of child care centers	On the door opening into child care centers At a fire department command or access point indicating presence and location of child care centers
Emergency Telephone 	Square field Red background White phone	The identification and location of fire service or emergency telephone system	
No Fire Fighting 	Red prohibition symbol Circular field White background Black truck within black octagonal outline	To be posted on, near, or on the approach to buildings where fire fighting is not to occur	Explosives bunkers, frangible buildings, or contaminated buildings

Table 5.2 *Continued*

Symbol	Characteristics	Application	Examples
Self-Contained Breathing Apparatus (SCBA) 	Rectangular field White symbol Green background	To indicate the location of SCBA, breathing air connections, or refill location	For SCBA fill locations in high-rise buildings

Chapter 6 Symbols for Use in Architectural and Engineering Drawings and Insurance Diagrams

6.1* Introduction.

6.1.1 This chapter presents symbols that shall be used in drawings and diagrams.

6.1.2* Symbol Presentation.

6.1.2.1* Symbol Shapes. The shape of symbols shall be as illustrated in Sections 6.2 through 7.9.

6.1.2.2 Screened Lines. Screened lines in the chapter shall not be considered part of the symbol but shall be used to represent the piping, wiring, or mounting surface associated with the symbol.

6.1.2.3 Symbol Scale. All scales for symbols on any one drawing shall be the same relative size.

6.1.2.4* Symbol Orientation. Symbols shall be oriented to the walls, piping, electrical lines, and so forth, to which they are attached.

6.2 Symbols for Site Features.

6.2.1 Buildings.

6.2.1.1 The exterior walls of buildings shall be outlined in single thickness lines if other than fire rated and double thickness lines if fire rated.

6.2.1.2* The perimeter of canopies, loading docks, and other open-walled structures shall be shown by broken lines.

6.2.2 Railroad Tracks. Railroad tracks shall be shown by a single line with cross dashes, as shown in Figure 6.2.2.

FIGURE 6.2.2 Symbol for Railroad Tracks.

6.2.3* Streets. Streets shall be shown.

6.2.4* Bodies of Water. Rivers, lakes, and so forth, shall be outlined.

6.2.5 Fences.

6.2.5.1 Fences shall be shown by lines with x's evenly spaced.

6.2.5.2* Gates shall be shown.

6.2.6 Property Lines. The notation given in Figure 6.2.6 shall indicate property lines.

FIGURE 6.2.6 Notation Indicating Property Lines.

6.2.7 Fire Department Access. The symbol for fire department access shall be as shown in Figure 6.2.7.

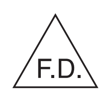


FIGURE 6.2.7 Symbol for Fire Department Access.

6.2.8 Other Site Features. For other fire protection site features, Section 7.2 shall be viewed.

6.3 Symbols for Building Construction.

6.3.1* Types of Building Construction. Types of construction shall be shown narratively.

6.3.2* Height. Height shall be shown to indicate number of stories above ground, number of stories below ground, and height from grade to eaves.

6.3.3* Symbols for Walls and Parapets. Symbols for walls and parapets shall be as given in Table 6.3.3.

Table 6.3.3 Symbols for Walls and Parapets

Symbol	Description
	Wall — basic shape
	Smoke barrier wall
	½-hour fire barrier wall
	½-hour fire/smoke barrier wall
	¾-hour fire barrier wall
	¾-hour fire/smoke barrier wall
	1-hour fire barrier wall
	1-hour fire/smoke barrier wall
	2-hour fire barrier wall
	2-hour fire wall
	2-hour fire/smoke barrier wall
	3-hour fire barrier wall
	3-hour fire wall
	3-hour fire/smoke barrier wall
	4-hour fire barrier wall

Table 6.3.3 *Continued*

Symbol	Description
	4-hour fire wall
	4-hour fire/smoke barrier wall
	Parapet — One cross for each 150 mm (6 in.) parapet that extends above roof (shown is plan view of symbol).

6.3.4 Symbols for Floor Openings, Wall Openings, Roof Openings, and Their Protection. Symbols for floor openings, wall openings, roof openings, and their protection shall be as given in Table 6.3.4.

Table 6.3.4 Symbols for Floor Openings, Wall Openings, Roof Openings, and Their Protection and Life Safety Plans

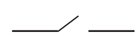
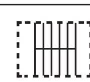
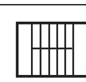
Symbol	Description	Comments
	Opening in wall	
	Rated fire door in wall (less than 3 hours)	
	Fire door in wall (3-hour rated)	
	Elevator in combustible shaft	
	Elevator in noncombustible shaft	
	Open hoistway	
	Escalator	
	Stairs in combustible shaft	
	Stairs in fire-rated shaft	

Table 6.3.4 *Continued*

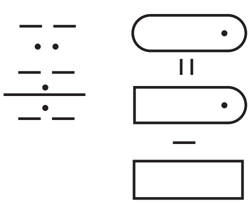
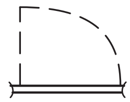
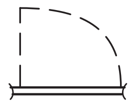
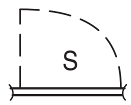
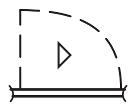
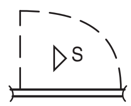
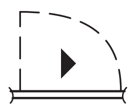
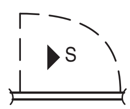
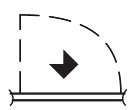
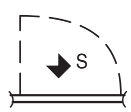
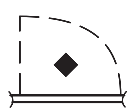
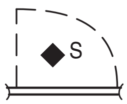
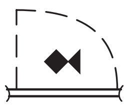
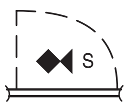
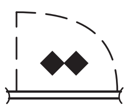
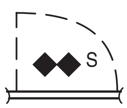
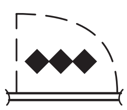
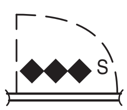
Symbol	Description	Comments
	Stairs in open shaft	
	Skylight	
E: _ _	Egress component identifier	Specify egress component: EX# = Exit number HE = Horizontal exit EP = Exit passageway CP = Common path of travel PD = Public discharge RD = Room door ES = Escape
< _ _ >	Egress component capacity	Specify allowable number of persons through egress component (e.g., < 25 >)
<< _ _ >>	Governing component capacity	Specify maximum capacity of the egress path
_ _ > _ _	Travel distance	Left side: Distance to egress component Right side: Egress component identifier
	Occupancy capacity	Top: Specify capacity Middle: Specify area [square feet (square meters)] Bottom: Specify occupant load factor

Table 6.3.4 *Continued*

Symbol	Description	Comments
	Fire door	
	Non-rated fire door	
	Non-rated smoke-resistant fire door	
	20-minute fire-rated fire door	
	20-minute fire-rated, smoke-resistant fire door	
	½-hour fire-rated fire door	
	½-hour fire-rated, smoke-resistant fire door	
	¾-hour fire-rated fire door	
	¾-hour fire-rated, smoke-resistant fire door	
	1-hour fire-rated fire door	

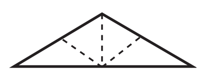
(continues)

Table 6.3.4 *Continued*

Symbol	Description	Comments
	1-hour fire-rated, smoke-resistant fire door	
	1½-hour fire-rated fire door	
	1½-hour fire-rated, smoke-resistant fire door	
	2-hour fire-rated fire door	
	2-hour fire-rated, smoke-resistant fire door	
	3-hour fire-rated fire door	
	3-hour fire-rated, smoke-resistant fire door	
	Exit	Wide, black, solid line
	Exit access	Wide, black, dashed line
	Exit discharge	Wide, black, short, dashed line

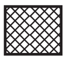
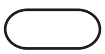
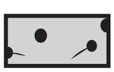
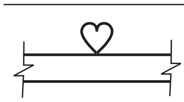
6.3.5* Special Symbols for Cross-Sections. The symbols shown in Table 6.3.5 shall be used to indicate features of cross-sections. It is recognized that descriptive notes often are required.

Table 6.3.5 Special Symbols for Cross-Sections

Symbol	Description	Comments
	Fire-resistive floor or roof	
	Wood-joisted floor or roof	
(Steel deck on steel joists)	Other floors or roofs	Note construction
	Floor/ceiling or roof/ceiling assembly	Details indicated, as necessary
	Floor on ground	
	Truss roof	Note construction

6.3.6 Miscellaneous Features. A number of features related to fire protection that do not fall under 6.3.1 through 6.3.5 shall be as given in Table 6.3.6.

Table 6.3.6 Miscellaneous Features

Symbol	Description	Comments
	Boiler	
	Chimney	Describe height and construction
	Fire escape	
	Horizontal aboveground tank	Indicate type, dimensions, construction, capacity, pressurization, and content
	Vertical aboveground tank	Indicate type, dimensions, construction, capacity, pressurization, and content
	Belowground tank	Indicate type, dimensions, construction, capacity, pressurization, and content
	Class I, Division 1 or 0	Hatch patterns for electrically classified locations
	Class I, Division 1 or Zone 1	Hatch patterns for electrically classified locations
	Class I, Division 2 or Zone 2	Hatch patterns for electrically classified locations
	Designates the location of automated external defibrillators (AEDs) on plans	

Chapter 7 Symbols for Use in Water Supply, Extinguishing, and Sprinkler System Drawings and Insurance Diagrams

7.1* Introduction.

7.1.1 This chapter presents symbols that shall be used in drawings and diagrams.

7.1.2* Symbol Presentation.

7.1.2.1* Symbol Shapes. The shape of symbols shall be as illustrated in Sections 7.2 through 7.7.

7.1.2.2 Screened Lines. Screened lines in the chapter shall not be considered part of the symbol but shall be used to represent the piping, wiring, or mounting surface associated with the symbol.

7.1.2.3 Symbol Scale. All scales for symbols on any one drawing shall be the same relative size.

7.1.2.4* Symbol Orientation. Symbols shall be oriented to the walls, piping, electrical lines, and so forth, to which they are attached.

7.2* Water Supply and Distribution Symbols. Water supply and distribution symbols shall be as given in Table 7.2.

Table 7.2 Water Supply and Distribution Symbols

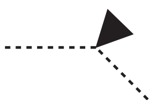
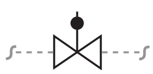
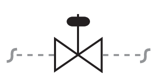
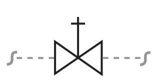
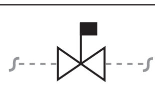
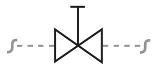
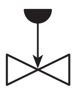
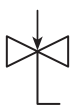
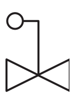
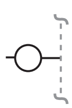
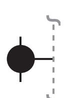
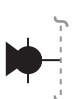
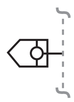
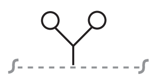
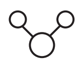
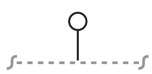
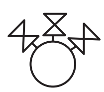
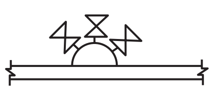
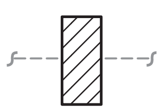
Symbol	Description	Comments
	Public water main	Indicate pipe size and material
	Private water main	Indicate pipe size and material
	Water main under building	Indicate pipe size and material
	Suction pipe	Indicate pipe size and material
	Thrust block	
	Riser	
	Pipe elbow up or down	Height on either side indicated by pipe height tags
	Pipe tee up or down	Height of crossed pipes indicated by pipe height tags
	Valves (general)	Basic shape; indicate valve size
	Valve in pit	Indicate valve size
	Post-indicator valve	Indicate valve size
	Key-operated valve	Indicate valve size
	OS&Y valve (outside screw and yoke, rising stem)	Indicate valve size
	Indicating butterfly valve	Indicate valve size

Table 7.2 ***Continued***

Symbol	Description	Comments
	Nonindicating valve (nonrising-stem valve)	Indicate valve size
	Check valve	Basic shape; indicate valve size, direction of flow
	Backflow preventer — double check type	Also referred to as a double check valve assembly
	Backflow preventer — reduced pressure zone (RPZ) type	
	Pressure-regulating valve	
	Pressure relief valve	
	Float valve	
	Meter	Indicate type
	Private hydrant, one hose outlet	Indicate size, type of thread, or connection
	Public hydrant, two hose outlets	Indicate size, type of thread, or connection
	Public hydrant, two hose outlets and pumper connection	Indicate size, type of thread, or connection

(continues)

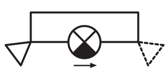
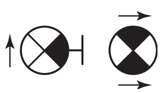
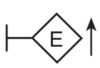
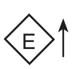
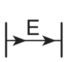
Table 7.2 ***Continued***

Symbol	Description	Comments
	Wall hydrant, two hose outlets	Indicate size, type of thread, or connection
	Private housed hydrant, two hose outlets	Indicate size, type of thread, or connection
	Siamese fire department connection	Specify type, size, and angle
	Freestanding siamese fire department connection	Sidewalk or pit type; specify size
	Single fire department connection	Specify type, size, thread, and angle
	Fire pump with driver	Specify driver type and rated capacity
	Freestanding test header	Freestanding; specify number and sizes of outlets
	Wall-mounted test header	Wall; specify number and sizes of outlets
	Screen/strainer	

7.3 Reserved.

7.4 Symbols Related to Means of Egress. Symbols related to means of egress shall be as given in Table 7.4.

Table 7.4 Symbols Related to Means of Egress

Symbol	Description	Comments
	Emergency light, battery-powered	Number of lamps on unit to be indicated; indicate whether light head(s) [lamp(s)] is remote from battery
	Illuminated exit sign, single face	Indicate direction of flow for the face
	Illuminated exit sign, double face	Indicate direction of flow for each face
	Combined battery-powered emergency light and illuminated exit sign	Number of lamps on unit to be indicated; indicate whether light head(s) [lamp(s)] is remote from battery; indicate direction of flow for the face
	Exit lighting	Exit lighting fixture, arrows, and exit face as indicated on drawings (mounting heights to be determined by job specifications) — from NECA 100, symbol 2.005
	Luminaire providing emergency illumination (filled in)	From NECA 100, symbol 2.300
	Directional sounder — exit marking audible appliance, wall mounted	Applied from NECA 100, symbol 9.109
	Directional sounder — exit marking audible appliance, ceiling mounted	Applied from NECA 100, symbol 9.110
	Directional exit indicating strip lighting appliance	Applied from NECA 100, symbol 2.002

7.5 Indicating Appliances. Symbols for indicating appliances shall be as given in Table 7.5.

Table 7.5 Symbols for Indicating Appliances

Symbol	Description	Comments
	Water motor alarm (water motor gong)	Shield optional

7.6* Symbols for Fire Extinguishing Systems.

7.6.1 Various Types of Fire Extinguishing Systems.

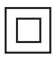
7.6.1.1 Water-Based Systems. Symbols for water-based systems shall be as given in Table 7.6.1.1.

Table 7.6.1.1 Symbols for Water-Based Systems

Symbol	Description
	Wet charged system — automatically actuated
	Wet charged system — manually actuated
	Dry system — automatically actuated
	Dry system — manually actuated
	Foam system — automatically actuated
	Foam system — manually actuated
	Water mist extinguishing system — automatically actuated
	Water mist extinguishing system — manually actuated

7.6.1.2 Dry Chemical Systems. Symbols for dry chemical systems shall be as given in Table 7.6.1.2.

Table 7.6.1.2 Symbols for Dry Chemical Systems

Symbol	Description
	For liquid, gas, and electrical fires — automatically actuated
	For liquid, gas, and electrical fires — manually actuated
	For fires of all types (except metals) — automatically actuated
	For fires of all types (except metals) — manually actuated

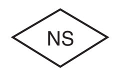
7.6.1.3 Systems Utilizing a Gaseous Medium. Symbols for systems utilizing a gaseous medium shall be as given in Table 7.6.1.3.

Table 7.6.1.3 Symbols for Systems Utilizing a Gaseous Medium

Symbol	Description
	Carbon dioxide system — automatically actuated
	Carbon dioxide system — manually actuated
	Halon system or clean agent extinguishing system — automatically actuated
	Halon system or clean agent extinguishing system — manually actuated

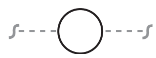
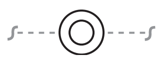
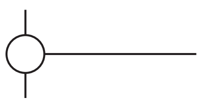
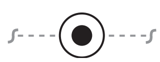
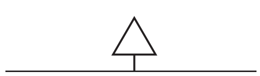
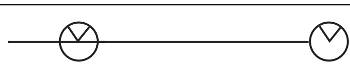
7.6.1.4 Supplementary Symbols. Supplementary symbols shall be as given in Table 7.6.1.4.

Table 7.6.1.4 Supplementary Symbols

Symbol	Description
	Fully sprinklered space
	Partially sprinklered space
	Nonsprinklered space
	Water spray system

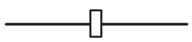
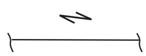
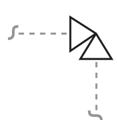
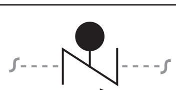
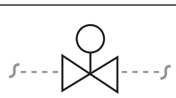
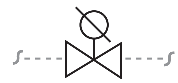
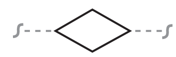
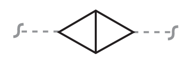
7.6.2* Symbols for Fire Sprinklers. Symbols for fire sprinklers shall be as given in Table 7.6.2.

Table 7.6.2 Symbols for Fire Sprinklers

Symbol	Description	Comments
	Upright sprinkler	
	Pendent sprinkler	Note “DP” on drawing and/or in specifications where dry pendent sprinklers are employed
	Upright sprinkler; on sprig	
	Upright sprinkler on top of riser nipple	
	Upright sprinkler on top of riser nipple with sprig	
	Pendent sprinkler; on drop nipple	Note “DP” on drawing and/or in specifications where dry pendent sprinklers are employed
	Sprinkler, with guard	Upright sprinkler head shown
	Sidewall sprinkler	
	Outside sprinkler	Specify type, orifice size; for example, open sprinkler (window or cornice)
	Open sprinkler on branch line	
	Open sprinkler on branch line with sprig	
	Water spray nozzle	
	Window sprinklers	

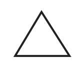
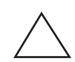
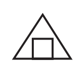
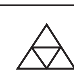
7.6.3* Symbols for Piping, Valves, Control Devices, and Hangers. Symbols for piping, valves, control devices, and hangers shall be as given in Table 7.6.3.

Table 7.6.3 Symbols for Piping, Valves, Control Devices, and Hangers

Symbol	Description	Comments
	Sprinkler piping and branch line	Indicate pipe size
	Pipe trace heater	See NECA 100, symbol 5.106
	Mechanical coupling	
	Pipe hanger	Diagonal stroke imposed on the pipe that the hanger supports
	Lateral brace	
	Longitudinal brace	
	Four-way brace	Only used to brace risers
	Angle valve (angle hose valve)	Indicate size, type, and other required data
	Check valve (general)	
	Alarm check valve	Specify size, direction of flow
	Dry pipe valve	Specify size
	Dry pipe valve with quick opening device (accelerator or exhauster)	Specify size and type
	Deluge valve	Specify size and type
	Preaction valve	Specify size and type

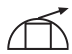
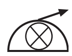
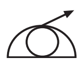
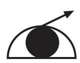
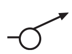
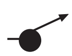
7.7 Symbols for Portable Fire Extinguishers. Symbols for portable fire extinguishers shall be as given in Table 7.7.

Table 7.7 Symbols for Portable Fire Extinguishers

Symbol	Description	Comments
	Portable fire extinguisher	Basic shape
	Water extinguisher	
	Foam extinguisher	
	Dry chemical extinguisher for liquid, gas, or electrical fires	BC type
	Dry chemical extinguisher for fires of all types (except metals)	ABC type
	CO_2 extinguisher	
	Halon or clean agent extinguisher	
	Extinguisher for metal fires	

7.8 Symbols for Fire-Fighting Equipment. Symbols for fire-fighting equipment shall be as given in Table 7.8.

Table 7.8 Symbols for Fire-Fighting Equipment

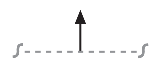
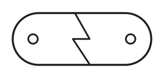
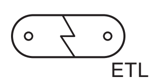
Symbol	Description	Comments
	Fire-fighting equipment	Basic shape
	CO_2 reel station	
	Dry chemical reel station	
	Fire hose valve connection	Specify thread size
	Foam reel station	
	Hose station, dry standpipe	
	Hose station, wet standpipe	
	Monitor nozzle, dry	Specify orifice size
	Monitor nozzle, charged	Specify orifice size

7.9* Miscellaneous Symbols. Miscellaneous symbols shall be as given in Table 7.9.

Table 7.9 Miscellaneous Symbols

Symbol	Description	Comments
	Agent storage container	Specify type of agent and mounting
	Agent storage container — foam	
	Agent storage container — Halon	

Table 7.9 *Continued*

Symbol	Description	Comments
	Agent storage container — carbon dioxide	
	Agent storage container — clean agent	
	Agent storage container — dry chemical	
	Agent storage container — water mist	
	Agent storage container — wet chemical	
	Special spray nozzle	Specify type, orifice, size, other required data (shown here on pipe)
	Fusible link	Specify degrees
	Fusible link with electrothermal feature	Specify degrees

Chapter 8 Symbols for Use in Electronic Fire and Smoke Detection and Notification System Drawings and Insurance Diagrams

8.1* Introduction.

8.1.1 This chapter presents symbols that shall be used in drawings and diagrams.

8.1.2* Symbol Presentation.

8.1.2.1* Symbol Shapes. The shape of symbols shall be as illustrated in Sections 8.2 through 8.6.

8.1.2.2 Screened Lines. Screened lines in the chapter shall not be considered part of the symbol but shall be used to represent the piping, wiring, or mounting surface associated with the symbol.

8.1.2.3 Symbol Scale. All scales for symbols on any one drawing shall be the same relative size.

8.1.2.4* Symbol Orientation. Symbols shall be oriented to the walls, piping, electrical lines, and so forth, to which they are attached.

8.2 Symbols for Control Panels. Symbols for control panels shall be as given in Table 8.2.

Table 8.2 Symbols for Control Units (Panels)

Symbol	Description
	Basic shape
AMP	Amplifier rack
ARCM	Area of refuge emergency communication system — master unit
ARCR	Area of refuge emergency communication system — remote unit
ACU	Autonomous control unit
BATT	Battery cabinet
CRT	Cathode ray tube
HVAC	Control panel for heating (H), ventilation (V), air conditioning (AC), exhaust (E), stairwell pressurization (P)
DACR	Digital alarm communicator receiver
DACT	Digital alarm communicator transmitter
ESR	Elevator status/recall
ECCU	Emergency communications control unit
FAA	Fire alarm annunciator
FAC	Fire alarm communicator

Table 8.2 *Continued*

Symbol	Description
FACP	Fire alarm control panel
FACU_D	Fire alarm control unit (dedicated)
FATC	Fire alarm terminal cabinet
TPR *n*	Fire alarm transponder n = transponder number
FFI	Fire fighter interface
FSCP xx	Fire suppression control panel xx denotes suppression type
FSCU xx	Fire suppression control unit xx denotes suppression type
GAP	Graphic annunciator panel
LCD	LCD annunciator/display
MFACU	Master fire alarm control unit
NAC_n	Notification circuit power booster, extender panel n = unit number
	Power panel
PRE	Pre-action system/control unit
PRN	Printer
PPCU	Protected premises control unit (local)

Table 8.2 ***Continued***

Symbol	Description
PP	Purge panel
RP	Relay panel
RSFACU	Releasing service fire alarm control unit
MIC	Remote voice evacuation microphone
EVAC_n	Remotely located evacuation amplifier cabiner
SAP	Sprinkler alarm panel
UPS	Uninterruptible power supply
EVAC	Voice evacuation control unit
WCU	Wireless control unit
Fire Suppression/Releasing Service Control Unit Types:	
RSFACU_{A}	Aerosol
RSFACU_{CO_2}	Carbon dioxide
RSFACU_{CA}	Clean agent
RSFACU_{DL}	Deluge fire sprinkler
RSFACU_{DC}	Dry chemical

Table 8.2 ***Continued***

Symbol	Description
FACI	Fire alarm control interface
FPC	Fire pump controller
RSFACU_{FO}	Foam
RSFACU_{HL}	Halon
MNS	Mass notification system interface
OCU	Operating control unit
RSFACU_{WM}	Water mist
RSFACU_{WC}	Wet chemical

8.3* Symbols for Fire Alarms, Detection, and Related Equipment — Signal Initiating Devices and Activation Switches. Symbols for signal initiating devices and activation switches shall be as given in Table 8.3.

Table 8.3 Symbols for Signal Initiating Devices and Activation Switches

Symbol	Description
Abort Switch Types:	
	Abort switch — basic shape
	Abort switch

(continues)

Table 8.3 *Continued*

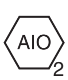
Symbol	Description
	Aerosol release abort station
	Clean agent
	Deluge fire sprinkler
	Dry chemical
	Foam
	Halon
	Manual releasing station
	Preaction
	Water mist
	Wet chemical
Addressable Modules:	
	Addressable input monitor module
	Addressable input/output module; # denotes number of inputs and outputs

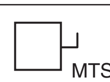
Table 8.3 *Continued*

Symbol	Description
	Addressable output control module
	Isolation module
Automatic Detection Type:	
	Automatic detection and supervisory devices — basic shape
Flame Detection Types:	
	Flame detector basic shape XX = detection type
	Combination ultraviolet/infrared
	Infrared detector
	Ultraviolet detector
	Visible radiation detector
Gas Detection Types:	
	Gas detector/sensor basic shape XX = gas type
	Carbon dioxide detector
	Carbon monoxide detector

Table 8.3 ***Continued***

Symbol	Description
	Hydrogen chloride detector
	Methane detector
Heat Detection Types:	
	Heat detector/sensor — XX = type basic shape
	Combination rate of rise/fixed temperature
	Fixed temperature
	Heat detector — line type
	Heat detector/sensor (thermal detection) orientation not to be changed
	Rate compensation
	Rate of rise only
Interface and Supervisory Devices:	
$\boxed{\text{EOL}}_{C}$	End of line device — capacitor
$\boxed{\text{EOL}}_{D}$	End of line device — diode
$\boxed{\text{EOL}}_{Rl}$	End of line device — relay

Table 8.3 ***Continued***

Symbol	Description
$\boxed{\text{EOL}}_{Re}$	End of line device — resistor
$\boxed{\text{WF}}$	Flow detector/switch
$\boxed{\text{HT}}$	High temperature switch
$\boxed{\text{LS}}$	Level detector/switch
$\boxed{\text{LT}}$	Low temperature switch
$\boxed{\text{MR}}$	Main/Reserve
$\boxed{\text{MD}}$	Maintenance/Disconnect switch
$\boxed{\text{RL}}$	Non-addressable output relay
$\boxed{\text{PS}}$	Pressure detector/switch
	Solenoid valve
$\boxed{\text{SS}}$	Surge suppressor
$\boxed{\text{TSS}}$	Temperature supervisory switch
	Transfer switch — automatic with handle
	Transfer switch — manual with handle

(continues)

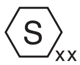
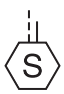
Table 8.3 *Continued*

Symbol	Description
VS	Valve supervisory switch
VS	Valve with integral supervisory switch
W	Water detector
Manual Fire Alarm Box Types:	
	Manual station — basic shape
A	Aerosol
CO_2	Carbon dioxide
CA	Clean agent
DL	Deluge fire sprinkler
DK	Drill key
DC	Dry chemical
MB	Fire alarm master box
FO	Foam
HL	Halon
PRE	Preaction

Table 8.3 *Continued*

Symbol	Description
F	Pull station/fire alarm box
WM	Water mist
WC	Wet chemical
Smoke Detection/Sensor Types:	
S	Smoke detector/sensor — basic shape orientation not to be changed
S AS	Air sampling
S ID	In duct
S I	Ionization
S P	Photoelectric
S R	Relay base
S R CO	Smoke/heat detector/carbon monoxide detector
S R	Smoke/heat detector/sensor combination
SS	Smoke alarm (single station)

Table 8.3 *Continued*

Symbol	Description
	Smoke detector/sensor— beam receiver
	Smoke detector/sensor — beam transmitter
	Smoke detector/sensor — XX = type
	Smoke detector/sensor for duct
	Sounder base

8.4 Notification Appliances.

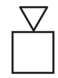
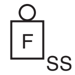
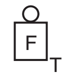
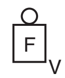
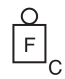
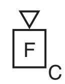
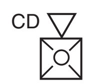
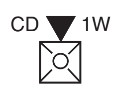
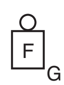
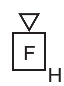
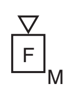
8.4.1 Notification appliance subscripts shall be applied to symbols as required for clarification *(see Table 8.4.1)*.

Table 8.4.1 Notification Appliance Subscripts

Subscript	Meaning
C	Ceiling mount
H	High audible setting
L	Low audible setting
MNS	Mass notification system
P	Pendent
RI	Remote indicator
SL	Signal light
nW	Wattage setting (*n* = speaker tap)
WP	Weatherproof
WG	Wire guard

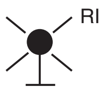
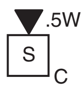
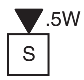
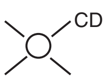
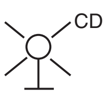
8.4.2 Notification Appliances. Symbols for notification appliances shall be as given in Table 8.4.2.

Table 8.4.2 Symbols for Notification Appliances

Symbol	Description
	Audible appliance — basic shape
	Bell — single stroke
	Bell — trouble
	Bell — vibrating
	Ceiling mount indicator
	Chime
	Chime — electronic
	Combination horn/visible CD = candela rating/setting
	Combination speaker/visible W = wattage CD = candela rating/setting
	Gong
	Horn only
	Mini-horn

(continues)

Table 8.4.2 *Continued*

Symbol	Description
	Remote alarm indicating and test switch
	Remote indicator
	Rotating beacon
	Speaker only, ceiling mount — denote wattage tap
	Speaker only, wall mount — denote wattage tap
	Visible only (strobe) — ceiling mount CD = candela rating/setting
	Visible only (strobe) — wall mount CD = candela rating/setting

8.4.3 Emergency Communications Notification Appliances. Symbols for emergency communication appliances shall be as given in Table 8.4.3.

Table 8.4.3 Symbols for Emergency Communications Notification Appliances

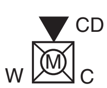
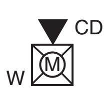
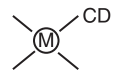
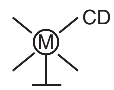
Symbol	Description
	Combination speaker/visible — ceiling mount CD = candela rating/setting, W = wattage
	Combination speaker/visible — wall mount CD = candela rating/setting, W = wattage
	Emergency textual visible appliance

Table 8.4.3 *Continued*

Symbol	Description
	Visible only (strobe) — ceiling mount CD = candela rating/setting
	Visible only (strobe) — wall mount CD = candela rating/setting

8.5 Related Equipment. Symbols for related equipment shall be as given in Table 8.5.

Table 8.5 Symbols for Related Equipment

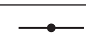
Symbol	Description
	Air sampling detector piping
	Door closer
	Door holder
	End of line resistor
	Fire service or emergency phone station — accessible
	Fire service or emergency phone station — basic shape
	Fire service or emergency phone station — handset
	Fire service or emergency phone station — jack
	Floor Warden Station

Table 8.5 *Continued*

Symbol	Description
	Integrated smoke sensor and door closer
JB	Junction box
SA	Sync adapter module (strobe synchronization)
WT	Watchman's tour station

8.6 Symbols for Smoke/Pressurization Control. Symbols for smoke/pressurization controls shall be as given in Table 8.6.

Table 8.6 Symbols for Smoke/Pressurization Controls

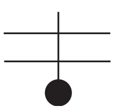
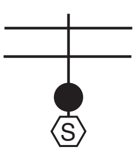
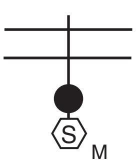
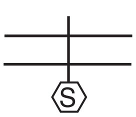
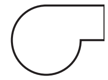
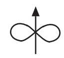
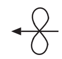
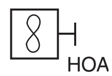
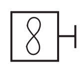
Symbol	Description	Comments
	Dampers — barometric	
	Dampers — fire	
	Dampers — fire/smoke	
	Dampers — motorized fire/smoke	
	Dampers — smoke	

Table 8.6 *Continued*

Symbol	Description	Comments
	Fans — duct	Arrow indicates direction of flow
	Fans — general	Arrow indicates direction of flow
	Fans — roof	Arrow indicates direction of flow
	Fans — wall	Arrow indicates direction of flow
	Hand (manual)/off-automatic	
	Pressurized stairwell	Orient as required for base or head injection
	Purge controls — manual control	
	Ventilation openings	Orient as required for intake or exhaust

Chapter 9 Symbols for Use in Pre-Incident Planning Sketches

9.1 Introduction.

9.1.1* This chapter presents symbols that shall be used in pre-incident planning sketches.

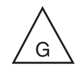
9.1.2* Symbol Shapes. The symbol shapes shall be chosen for their ease of reproduction by either freehand drawing or with the use of templates.

9.2* Access Features, Assessment Features, Ventilation Features, and Utility Shutoffs. Symbols for access features, assessment features, ventilation features, and utility shutoffs shall be as given in Table 9.2.

Table 9.2 Symbols for Access Features, Assessment Features, Ventilation Features, and Utility Shutoffs

Symbol	Description	Comments
	Access features, assessment features, ventilation features, and utility shutoffs	Basic shape
	Access feature — fire department access point	
	Access feature — fire department key box	
	Access feature — roof access	
	Assessment feature — fire alarm annunciator panel	
	Assessment feature — fire alarm reset panel	
	Assessment feature — fire alarm voice communication panel	
	Assessment feature — smoke control and pressurization panel	
	Assessment feature — sprinkler system water flow bell	
	Ventilation feature — skylight	
	Ventilation feature — smoke vent	
	Utility shutoff — electric	

Table 9.2 *Continued*

Symbol	Description	Comments
	Utility shutoff — domestic water	
	Utility shutoff — gas	
	Specific variations — LP-Gas shutoff	
	Specific variations — natural gas shutoff	
	Specific variations — compressed natural gas shutoff	

9.3 Detection/Extinguishing Equipment. Symbols for detection/extinguishing equipment shall be as given in Table 9.3.

Table 9.3 Symbols for Detection/Extinguishing Equipment

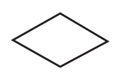
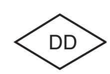
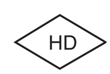
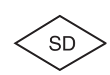
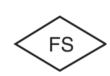
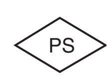
Symbol	Description	Comments
	Detection/ extinguishing equipment	Basic shape
	Duct detector	
	Heat detector	
	Smoke detector	
	Flow switch (water)	
	Manual station — pull station/fire alarm box	

Table 9.3 ***Continued***

Symbol	Description	Comments
◇ TS	Tamper switch	
◇ HL	Halon system	
◇ DC	Dry chemical system	
◇ CO_2	Carbon dioxide system	
◇ WC	Wet chemical system	
◇ FO	Foam system	
◇ CA	Clean agent system	
◇ BSD	Beam smoke detector	

9.4 Water Flow Control Valves and Water Sources. Symbols for water flow control valves and water sources shall be as given in Table 9.4.

Table 9.4 Symbols for Water Flow Control Valves and Water Sources

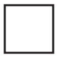
Symbol	Description	Comments
○	Water flow control valves and water sources	Basic shape
○ PIV	Post-indicator valve	
○ RV	Riser valve	

Table 9.4 ***Continued***

Symbol	Description	Comments
○ ZV	Sprinkler zone valve	
○ SCV	Sectional control valve	
○ HC	Hose cabinet or connection	
○ WH	Wall hydrant	
○ TH	Test header (fire pump)	
○ TC	Inspector's test connection	
○ FH	Fire hydrant	
○ FDC	Fire department connection	
○ DS	Drafting site	
○ WT	Water tank	

9.5 Equipment Rooms. Symbols for equipment rooms shall be as given in Table 9.5.

Table 9.5 Symbols for Equipment Rooms

Symbol	Description	Comments
	Equipment rooms	Basic shape
AC	Air-conditioning equipment room	AHUs = air-handling units
EE	Elevator equipment room	
EG	Emergency generator room	
FP	Fire pump room	
TE	Telephone equipment room	
BR	Boiler room	
ET	Electrical/ transformer room	

9.6* Identification of Hazardous Materials. NFPA 704 shall be permitted to be used to identify the location of hazardous materials within a structure.

Chapter 10 Symbology for Emergency Management Mapping

10.1 Damage Operational Symbols. Table 10.1 shall be used to cross-reference the damage operational symbols with their definitions.

Table 10.1 Damage Operational Symbology Reference

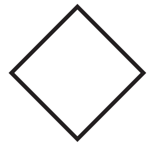
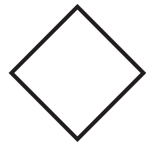
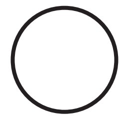
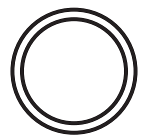
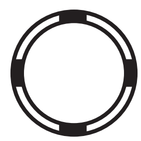
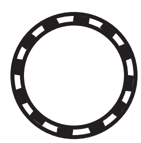
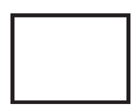
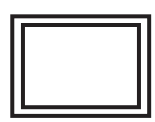
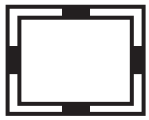
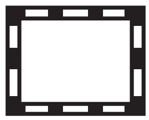
Symbol Types and Terms	Symbols	Definitions
Incident (No levels) (violet)		Not applicable
Natural Event (No levels) (black)		Not applicable
Operation (Level 1) (green)		Fully operational/open
Operation (Level 2) (blue)		Operational, but filled to capacity or otherwise closed
Operation (Level 3) (orange)		Operational, but partially damaged or partially incapacitated
Operation (Level 4) (red)		Destroyed or totally incapacitated
Infrastructure (Level 1) (green)		Fully operational/open
Infrastructure (Level 2) (blue)		Operational, but filled to capacity or otherwise closed

Table 10.1 *Continued*

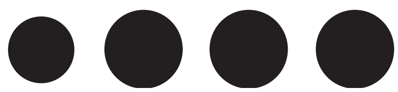
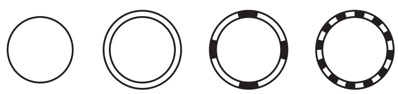
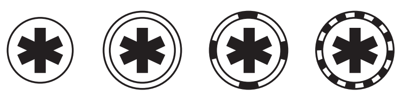
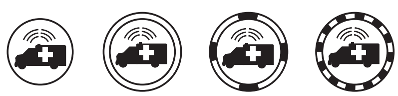
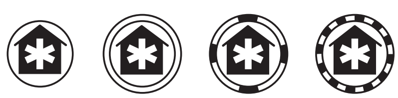
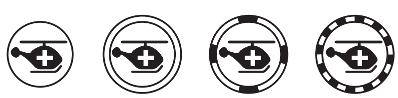
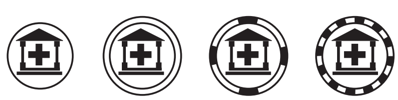
Symbol Types and Terms	Symbols	Definitions
Infrastructure (Level 3) (orange)		Operational, but partially damaged or partially incapacitated
Infrastructure (Level 4) (red)		Destroyed or totally incapacitated

10.2 Operations Symbology.

10.2.1 Organizations, services, capabilities, or resources available during or implemented due to an emergency management situation.

10.2.2 Table 10.2.2 shall be used to cross-reference the operations symbols with their definitions.

Table 10.2.2 Operations Symbology Reference

Symbol Types and Terms	Symbols	Keystroke	Definitions
Operations Background Symbol (Background)		!	The background fill shape for the Operations symbol, Level 1
Operations Frame Symbol (Frame)		#	The frame shape for the Operations symbol, Level 1
Emergency Medical Operation (Theme)		A	Urgent and unexpected medicinal treatment and/or transport during serious situations that require immediate action[1]
Ambulance (Emergency Medical Feature)		B	A vehicle for taking sick or wounded people to and from a hospital
EMT Station Locations (Emergency Medical Feature)		C	The locus of an emergency medical team
Medical Evacuation Helicopter Station (Emergency Medical Feature)		D	The locus of an emergency helicopter landing pad, utilized to transport severely injured persons
Health Department Facility (Emergency Medical Feature)		E	The locus of a facility operated by a public institution that is dedicated to promotion of health and prevention of disease at the community, county, state, or national level[2]

(continues)

Table 10.2.2 *Continued*

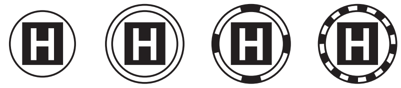
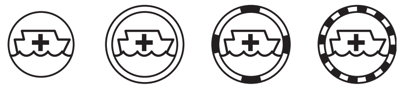
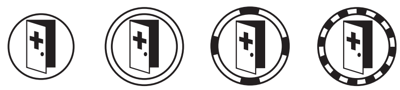
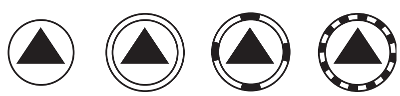
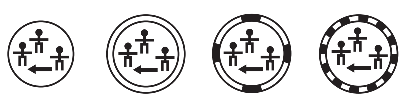
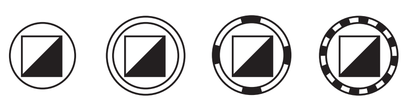
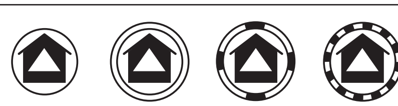
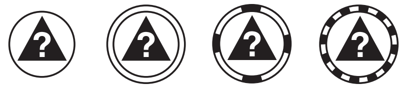
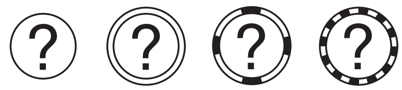
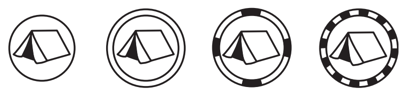
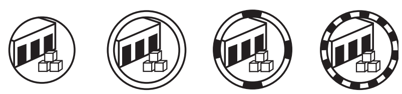
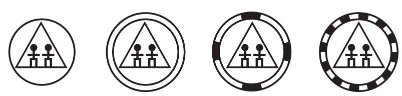
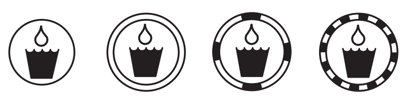
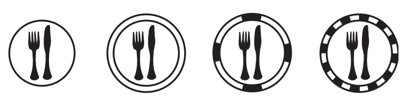
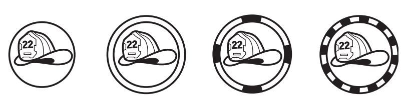
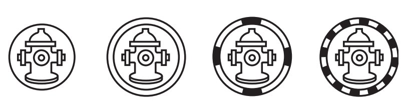
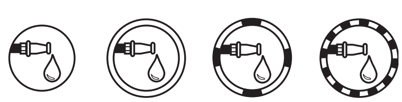
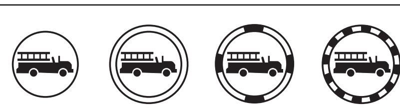
Symbol Types and Terms	Symbols	Keystroke	Definitions
Hospital (Emergency Medical Feature)		F	The locus of an institution where the sick or injured are given medical or surgical care
Hospital Ship (Emergency Medical Feature)		G	The locus of a ship where the sick or injured are given medical or surgical care
Medical Facilities Outpatient (Emergency Medical Feature)		H	The locus of a facility providing medical treatment to patients whose sickness or injury does not require hospitalization
Morgue (Emergency Medical Feature)		I	The locus of a place where the bodies of persons found dead are kept until identified and claimed by relatives or released for burial[3]
Pharmacies (Emergency Medical Feature)		J	The locus of a place where medicines are compounded or dispensed[3]
Triage (Emergency Medical Feature)		K	The locus of a place where sorting and allocation of treatment to patients (especially victims of war or disaster) are performed according to a system of priorities designed to maximize the number of survivors[3]
Emergency Operation (Theme)		L	Those actions taken during the emergency period to protect life and property, care for the people affected, and temporarily restore essential community services[4]
Emergency Collection/Evacuation Point (Emergency Operation Feature)		M	A designated place where displaced persons or victims of war or disaster are assembled and/or evacuated from
Emergency Incident Command Center (Emergency Operation Feature)		N	The physical location from which an incident commander manages an incident[5]
Emergency Operations Center (Emergency Operation Feature)		O	The physical location where an organization comes together during an emergency to coordinate response and recovery actions and resources and make management decisions[6]

Table 10.2.2 *Continued*

Symbol Types and Terms	Symbols	Keystroke	Definitions
Emergency Public Information Center (Emergency Operation Feature)		P	No definition
Emergency Public Service Center (Emergency Operation Feature)		Q	No definition
Emergency Shelters (Emergency Operation Feature)		R	The locus of a designated emergency/relief shelter
Emergency Staging Areas (Emergency Operation Feature)		S	A designated place where emergency response forces, equipment, and supplies are assembled prior to engagement in operations
Emergency Teams (Emergency Operation Feature)		T	The locus of an emergency response team
Emergency Water Distribution Center (Emergency Operation Feature)		U	A place where potable water is distributed to displaced persons or victims of war or disaster
Emergency Food Distribution Centers (Emergency Operation Feature)		V	A place where food is distributed to displaced persons or victims of war or disaster
Fire Suppression Operation (Theme)		W	The extinguishing of a burning (and flaming) object by means of applying an agent, such as water[7]
Fire Hydrant (Fire Suppression Feature)		X	A discharge pipe with a valve and spout from which water can be drawn from a water main in sufficient volume and at sufficient pressure for fire-fighting purposes[8]
Other Water Supply Location (Fire Suppression Feature)		Y	Any source of water other than a fire hydrant that is sufficient for the purpose of fire fighting
Fire Station (Fire Suppression Feature)		Z	A facility housing fire-fighting equipment and/or personnel

(continues)

Table 10.2.2 ***Continued***

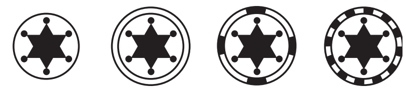
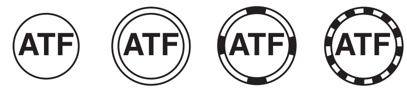
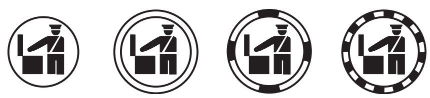
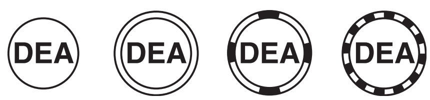
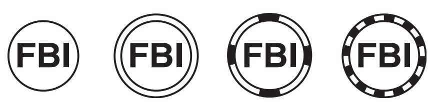
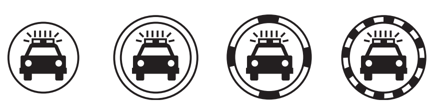
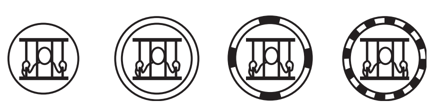
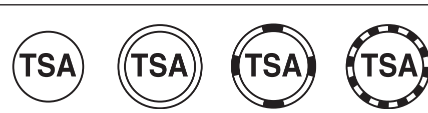
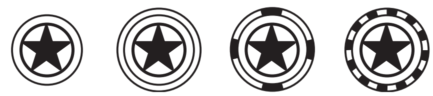
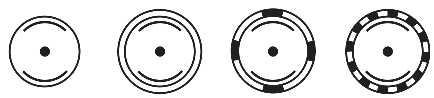
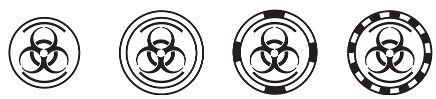
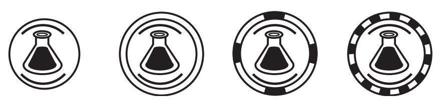
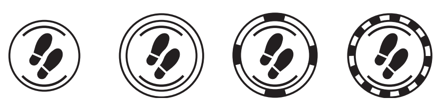
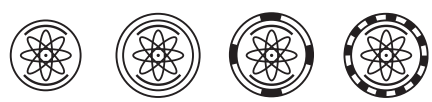
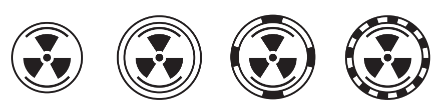
Symbol Types and Terms	Symbols	Keystroke	Definitions
Law Enforcement Operation (Theme)		a	Act of ensuring obedience to the laws[9]
ATF (Law Enforcement Feature)		b	A locus of U.S. Bureau of Alcohol, Tobacco, and Firearms facilities, equipment, or personnel
Border Patrol (Law Enforcement Feature)		c	A locus of U.S. Border Patrol facilities, equipment, or personnel
Customs Service (Law Enforcement Feature)		d	A locus of U.S. Customs Service facilities, equipment, or personnel
DEA (Law Enforcement Feature)		e	A locus of U.S. Drug Enforcement Administration facilities, equipment, or personnel
DOJ (Law Enforcement Feature)		f	A locus of U.S. Department of Justice facilities, equipment, or personnel
FBI (Law Enforcement Feature)		g	A locus of Federal Bureau of Investigation facilities, equipment, or personnel
Police (Law Enforcement Feature)		h	A locus of federal, state, or local police facilities, equipment, or personnel
Prison (Law Enforcement Feature)		i	A facility for the confinement of persons convicted of serious crimes[3]
Secret Service (Law Enforcement Feature)		j	A locus of U.S. Secret Service facilities, equipment, or personnel
TSA (Law Enforcement Feature)		k	A locus of U.S. Transportation Security Administration facilities, equipment, or personnel

Table 10.2.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definitions
U.S. Coast Guard (Law Enforcement Feature)		l	A locus of U.S. Coast Guard facilities, equipment, or personnel
U.S. Marshals Service (Law Enforcement Feature)		m	A locus of U.S. Marshals Service facilities, equipment, or personnel
Sensor Operation (Theme)		n	A device that receives and responds to a signal or stimulus[9]
Biological Sensor (Sensor Operation Feature)		o	A device designed to respond to the presence of one or more biological substances and to transmit a resulting impulse[10]
Chemical Sensor (Sensor Operation Feature)		p	A device designed to respond to the presence of one or more chemicals and to transmit a resulting impulse[10]
Intrusion Sensor (Sensor Operation Feature)		q	A device designed to respond to physical penetration of, or attempts to physically penetrate, a protected area or spatial volume and to transmit a resulting impulse[10]
Nuclear Sensor (Sensor Operation Feature)		r	A device designed to respond to one or more decay product(s) of one or more radioactive nuclides and to transmit a resulting impulse[11]
Radiological Sensor (Sensor Operation Feature)		s	A device designed to respond to one or more decay product(s) of one or more radioactive nuclides and to transmit a resulting impulse[11]

[1] *Source:* www.dictionary.com; combined definition of *emergency* and *medical*.
[2] *Source:* Based on the APHA public health mission statement.
[3] *Source: Merriam-Webster Online*.
[4] *Source:* Adapted from San Diego State University Emergency Plan Glossary, http://bfa.sdsu.edu/emergencyplan/glossary.htm.
[5] *Source:* Commonwealth of Virginia ICS, www.vdfp.state.va.us/components.htm.
[6] *Source:* EMS web site, www.emsresponder.com.
[7] *Source:* Adapted from www.firewise.org glossary of terms.
[8] *Source:* Adapted from *Merriam-Webster Online* definition of *hydrant*.
[9] *Source:* www.dictionary.com.
[10] *Source:* Adapted from *Merriam-Webster Online* definition of *sensor*.
[11] *Source:* Adapted from *Merriam-Webster Online* definition of *sensor* and knowledge of the process, detection, and measurement of radioactivity.

10.3 Incidents Symbology.

10.3.1 Table 10.3.2 shall be used to depict 8 themes and 42 features that symbolize a "cause of action" or a "source of disaster."

10.3.2 Table 10.3.2 shall be used to cross-reference the incidents symbols with their definitions.

Table 10.3.2 Incidents Symbology Reference

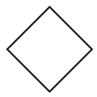
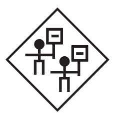
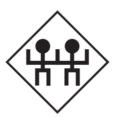
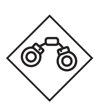
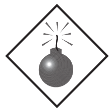
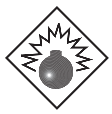
Symbol Types and Terms	Symbols	Keystroke	Definitions
Incidents Stage 01 Background Symbol (Background)		!	The background fill shape for the Incidents symbol, Level 1
Incidents Stage 01 Frame Symbol (Frame)		#	The frame shape for the Incidents symbol, Level 1
Civil Disturbance Incident (Theme)		A	Human activities resulting in the disrupting of services or requiring varying levels of support, law enforcement, or attention
Civil Demonstrations (Civil Disturbance Feature)		B	A public display of group feelings toward a person or cause[1]
Civil Displaced Population (Civil Disturbance Feature)		C	Persons or groups of people who have been forced or obliged to flee or to leave their homes or places of habitual residence, in particular as a result of or in order to avoid the effects of armed conflict, violations of human rights, or natural or human-made disasters[2]
Civil Rioting (Civil Disturbance Feature)		D	A public disturbance involving (1) an act or acts of violence by one or more persons part of an assemblage of three or more persons, which act or acts shall constitute a clear and present danger of, or shall result in, damage or injury to the property of any other person or to the person of any other individual, or (2) a threat or threats of the commission of an act or acts of violence by one or more persons part of an assemblage of three or more persons having, individually or collectively, the ability of immediate execution of such threat or threats, where the performance of the threatened act or acts of violence would constitute a clear and present danger of, or would result in, damage or injury to the property of any other person or to the person of any other individual[3]
Criminal Activity Incident (Theme)		E	An unlawful pursuit or action in which an individual participates[4]

Table 10.3.2 *Continued*

Symbol Types and Terms	Symbols	Keystroke	Definitions
Bomb Threat (Criminal Activity Feature)		F	A warning of the possible presence of a bomb or expression of the intention to detonate a bomb
Bomb (Criminal Activity Feature)		G	An explosive device fused to detonate under specific conditions[5]
Bomb Explosion (Criminal Activity Feature)		H	A violent outburst resulting from detonation of a chemical or nuclear explosive or from the loss of a high pressure vessel's integrity
Looting (Criminal Activity Feature)		I	Burglary committed within an affected area during an emergency[6]
Poisoning (Criminal Activity Feature)		J	Use of a poisonous substance to injure or kill[1]
Shooting (Criminal Activity Feature)		K	Use of a firearm to kill or injure or to damage property[1]
Fire Incident (Theme)		L	The destructive act of something burning, caused by electrical or technological malfunction, lightning, arson, human error, or human negligence
Hot Spot (Fire Incident Feature)		P	An area of intensified fire activity and increased heat or a particularly active part of a fire
Non-Residential Fire (Fire Incident Feature)		Q	A fire that originates at or affects a non-residential or commercial facility, resulting in partial damage or total destruction of the structure and/or bodily injury, smoke inhalation, or death
Origin (Fire Incident Feature)		R	Location of where the fire started[7]

(continues)

Table 10.3.2 *Continued*

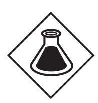
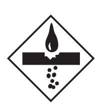
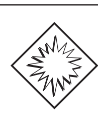
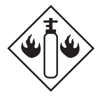
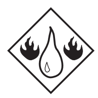
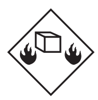
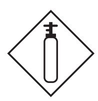
Symbol Types and Terms	Symbols	Keystroke	Definitions
Residential Fire (Fire Incident Feature)		S	A fire affecting a home or housing complex, resulting in partial or total destruction of the structure and/or bodily injury, smoke inhalation, or death
School Fire (Fire Incident Feature)		T	A fire that originates at or affects an educational facility, resulting in partial or total destruction of the structure and/or bodily injury, smoke inhalation, or death
Smoke (Fire Incident Feature)		U	The visible products of combustion rising above the fire[8]
Special Needs Fire (Fire Incident Feature)		V	A fire that affects special treatment facilities, such as nursing homes or assisted living centers, resulting in partial or total destruction of the structure and/or bodily injury, smoke inhalation, or death
Wild Fire (Fire Incident Feature)		W	An uncontrolled fire in a wooded area[9]
Hazardous Incident (Theme)		X	See footnote.[10]
Chemical Agent (Hazardous Incident Feature)		Y	A chemical substance that is intended for use in military operations to kill, resulting in psychological disorientation, serious injury, incapacitation, or death[11]
Corrosive Material (Hazardous Incident Feature)		Z	Uncontrolled or potentially dangerous presence of a liquid or solid that causes full thickness destruction of human skin at the site of contact within a specified period of time
Dangerous When Wet (Hazardous Incident Feature)		a	Uncontrolled or potentially dangerous presence of a material that, by contact with water, is liable to become spontaneously flammable or to give off flammable or toxic gas at a rate greater than 1 L/hr per kilogram of the material per hour (0.48 qt/hr/lb)
Explosive (Hazardous Incident Feature)		b	Uncontrolled or potentially dangerous presence of any substance or article, including a device that is designed to function by explosion (i.e., an extremely rapid release of gas and heat) or that, by chemical reaction within itself, is able to function in a similar manner even if not designed to function by explosion

Table 10.3.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definitions
Flammable Gas (Hazardous Incident Feature)		c	Uncontrolled or potentially dangerous presence of any material that is a gas at 20°C (68°F) or less and 101.3 kPa (14.7 psia) of pressure [a material that has a boiling point of 20°C (68°F) or less at 101.3 kPa (14.7 psia)], that is ignitible at 101.3 kPa (14.7 psia) when in a mixture of 13 percent or less by volume with air, or that has a flammable range at 101.3 kPa (14.7 psia) with air of at least 12 percent regardless of the lower limit
Flammable Liquid (Hazardous Incident Feature)		d	Uncontrolled or potentially dangerous presence of a liquid having a flash point of not more than 60.5°C (141°F)
Flammable Solid (Hazardous Incident Feature)		e	Uncontrolled or potentially dangerous presence of desensitized explosives that when dry are explosives of Class 1, which are wetted with sufficient water, alcohol, or plasticizer to suppress explosive properties
Nonflammable Gas (Hazardous Incident Feature)		f	Uncontrolled or potentially dangerous presence of any material (or mixture) that exerts in the packaging an absolute pressure of 280 kPa (40.6 psia) or greater at 20°C (68°F) and is not classified as a flammable gas
Organic Peroxides (Hazardous Incident Feature)		g	No definition
Oxidizers (Hazardous Incident Feature)		h	Uncontrolled or potentially dangerous presence of a material that can, generally by yielding oxygen, cause or enhance the combustion of other materials
Radioactive Material (Hazardous Incident Feature)		i	Uncontrolled or potentially dangerous presence of any material having a specific activity greater than 70 Bq/g (17 μCi/oz)
Spontaneously Combustible (Hazardous Incident Feature)		j	Uncontrolled or potentially dangerous presence of a liquid or solid that, even in small quantities and without an external ignition source, can ignite within five (5) minutes after coming in contact with air or a material that, when in contact with air and without an energy supply, is liable to self-heat
Toxic Gas (Hazardous Incident Feature)		k	Uncontrolled or potentially dangerous presence of a gas that presents a hazard to human health

(continues)

Table 10.3.2 ***Continued***

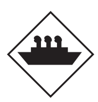
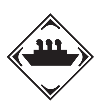
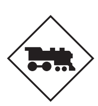
Symbol Types and Terms	Symbols	Keystroke	Definitions
Toxic and Infectious (Hazardous Incident Feature)		l	Uncontrolled or potentially dangerous presence of a poisonous substance that is a specific product of the metabolic activities of a living organism and is usually very unstable and can easily be transferred between organisms
Unexploded Ordnance (Hazardous Incident Feature)		m	Uncontrolled or potentially dangerous presence of an unexploded weapon or ammunition
Air Incident (Theme)		n	An event involving aircraft resulting in damage, bodily injury, death, or the disruption of transportation service
Air Accident (Air Incident Feature)		o	A sudden, unexpected event involving aircraft resulting in fuselage damage, bodily injury, death, and/or the disruption of transportation service, prompting emergency landing procedures or uncontrolled impact with the ground
Air Hijacking (Air Incident Feature)		p	The unexpected, unlawful, and forceful seizure of control aboard an aircraft by an individual or group of individuals resulting in passenger and crew endangerment, injury or death, and/or the redirection of flight destination[12]
Marine Incident (Theme)		q	An event involving a boat or ship and resulting in damage, bodily injury, death, or the disruption of transportation service
Marine Accident (Marine Incident Feature)		r	A sudden, unexpected event involving a boat or ship and resulting in vessel submerging, damage, bodily injury, death, and/or the disruption of transportation service
Marine Hijacking (Marine Incident Feature)		s	The unexpected, unlawful, and forceful seizure of control aboard a boat or ship by an individual or group of individuals resulting in passenger and crew endangerment, injury or death, and/or the redirection of destination[12]
Rail Incident (Theme)		t	An event involving a train and resulting in damage, bodily injury, death, or the disruption of transportation service
Rail Accident (Rail Incident Feature)		u	A sudden, unexpected event involving a wheeled or tracked vehicle resulting in derailment, damage, bodily injury, death, and/or the disruption of transportation service

Table 10.3.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definitions
Rail Hijacking (Rail Incident Feature)		v	The unexpected, unlawful, and forceful seizure of control aboard a wheeled or tracked vehicle by an individual or group of individuals resulting in passenger and crew endangerment, injury or death, and/or the redirection of destination[12]
Vehicle Incident (Theme)		w	An event involving a wheeled or tracked vehicle and resulting in damage, bodily injury, death, or the disruption of transportation service
Vehicle Accident (Vehicle Incident Feature)		x	A sudden, unexpected event involving a vehicle and resulting in damage, bodily injury, death, and/or the disruption of transportation service
Vehicle Hijacking (Vehicle Incident Feature)		y	The unexpected, unlawful, and forceful seizure of control aboard a vehicle by an individual or group of individuals resulting in passenger and crew endangerment, injury or death, and/or the redirection of destination[12]

Notes:
[1] *Source: Merriam-Webster Online Dictionary*.
[2] *Source:* United Nations *Guiding Principles on Internally Displaced Persons*, 1998.
[3] *Source:* 18 *USC* Section 2102.
[4] *Source:* www.dictionary.com; combined definitions of *criminal* and *activity*.
[5] *Source:* International military definition.
[6] *Source:* http://peace-officers.com glossary.
[7] *Source:* U.S. Department of Agriculture, Forest Service, www.fs.fed.us.
[8] *Source:* www.firewise.org
[9] *Source:* www.realdictionary.com.
[10] All the proposed definitions for *hazardous incident* are from the Office of Hazardous Materials Safety, Hazmat Regulations and Interpretations.
[11] *Source:* Adapted from NATO definition, www.nato.int/docu/stanag/aap006/aap6.htm.
[12] *Source:* www.dictionary.com, definition of *hijack*.

10.4 Natural Events Symbology.

10.4.1 A natural event shall be a phenomenon found in or created by naturally occurring conditions.

10.4.2 Table 10.4.2 shall be used to cross-reference the natural events symbols with their definitions.

Table 10.4.2 Natural Events Symbology Reference

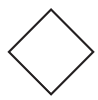
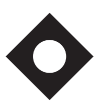
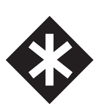
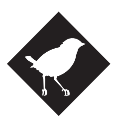
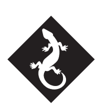
Symbol Types and Terms	Symbols	Keystroke	Definition
Natural Events Stage 01 Background Symbol (Background)		!	The background fill shape for the Natural Events symbol, Level 1
Natural Events Stage 01 Frame Symbol (Frame)		#	The frame shape for the Natural Events symbol, Level 1
Geologic (Theme)	Reserved		
Aftershock (Geologic Feature)		A	An earthquake that follows a larger earthquake and originates at or near the latter's focus[1]
Avalanche (Geologic Feature)		B	A large mass of snow, ice, soil, or rock, or mixtures of these materials, falling, sliding, or flowing very rapidly under the force of gravity[1]
Earthquake Epicenter (Geologic Feature)		C	The point on the earth's surface directly above the focus of an earthquake[1]
Landslide (Geologic Feature)		D	A general term for a wide variety of processes and landforms involving the down slope movement under the force of gravity of masses of soil and rock material[1]
Subsidence (Geologic Feature)		E	Sinking or downward settling of the Earth's surface[1]
Volcanic Eruption (Geologic Feature)		F	The ejection of volcanic materials (lava, pyroclasts, and volcanic gases) from a vent or fissure in the Earth's crust[1]
Volcanic Threat (Geologic Feature)		G	A vent or fissure in the Earth's crust where volcanic eruption is believed to be imminent[2]

Table 10.4.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definition
Hydro-Meteorologic (Theme)	Reserved		
Drizzle (Hydro-Meteorologic Feature)		H	Sometimes called *mist*; very small, numerous, and uniformly dispersed water droplets that appear to float while following air currents and that, unlike fog droplets, fall to the ground
Drought (Hydro-Meteorologic Feature)		I	A period of abnormally dry weather sufficiently prolonged for the lack of water to cause a serious hydrologic imbalance across the affected area. Drought severity depends upon the degree of moisture deficiency, the duration, and (to a lesser extent) the size of the affected area. In general, the term should be reserved for periods of moisture deficiency that are relatively extensive in both space and time.
Flood (Hydro-Meteorologic Feature)		J	A relatively high stream flow that overtops the stream banks in any part of its course, covering land that is not normally under water[1]; a condition that occurs when water overflows the natural or artificial confines of a stream or other body of water, or accumulates by drainage over low-lying areas
Fog (Hydro-Meteorologic Feature)		K	A visible aggregate of minute water droplets suspended in the atmosphere near the Earth's surface [According to international definition, fog reduces visibility to less than 1 km ($\frac{5}{8}$ mi). Fog differs from clouds only in that the base of the fog is at the Earth's surface, while clouds are above the surface.]
Hail (Hydro-Meteorologic Feature)		L	Precipitation in the form of circular or irregular-shaped lumps of ice[3]
Inversion (Hydro-Meteorologic Feature)		M	A departure from the standard decrease or increase with altitude of value of an atmosphere property; almost always used to mean temperature inversion
Rain (Hydro-Meteorologic Feature)		N	Precipitation in the form of liquid water drops that have diameters greater than 0.5 mm (0.2 in.)
Sand Dust Storm (Hydro-Meteorologic Feature)		O	A strong wind carrying sand through the air, the diameter of most of the particles ranging from 0.08 mm to 1 mm (0 to 0.04 in.); in contrast to a dust storm, sand particles mostly confined to the lowest 0.6 m (2 ft) and rarely rising more than 15.2 m (50 ft) above the ground
Snow (Hydro-Meteorologic Feature)		P	Precipitation composed of white or translucent ice crystals, chiefly of complex branched hexagonal form and often agglomerated into snowflakes

(continues)

Table 10.4.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definition
Thunderstorm (Hydro-Meteorologic Feature)		Q	A consequence of atmospheric instability that constitutes an overturning of layers in order to achieve a more stable atmosphere; generally produces lightning, thunder, strong gusts of wind, heavy rain, and sometimes hail
Tornado (Hydro-Meteorologic Feature)		R	A violently rotating column, or funnel, of air in contact with the ground and extending from the base of a thunderstorm[3]
Tropical Cyclone (Hydro-Meteorologic Feature)		S	The general term for a cyclone that originates over the tropical oceans
Tsunami (Hydro-Meteorologic Feature)		T	A great sea wave produced by an earthquake or volcanic eruption, characterized by high speed of propagation, long wavelength, long period, and low observable amplitude on the open ocean[1]; can reach enormous dimensions and has sufficient energy to travel across entire oceans; no connection with tides, as can be inferred from the commonly used term *tidal wave*
Infestation (Theme)	Reserved		
Bird Infestation (Infestation Feature)		U	A harassing or troublesome invasion of birds[4]
Insect Infestation (Infestation Feature)		V	A harassing or troublesome invasion of insects
Microbial Infestation (Infestation Feature)		W	A harassing or troublesome invasion of microbes
Reptile Infestation (Infestation Feature)		X	A harassing or troublesome invasion of reptiles
Rodent Infestation (Infestation Feature)		Y	A harassing or troublesome invasion of rodents

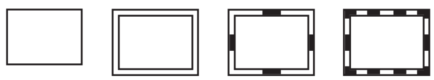
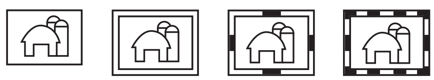
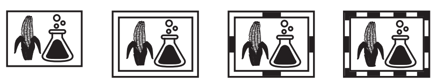
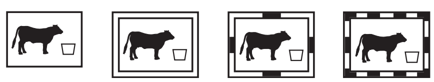
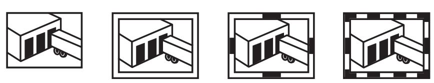
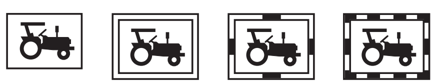
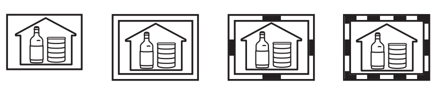
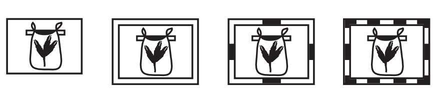
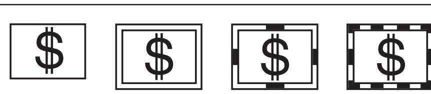
Notes:
[1] *Source: Dictionary of Geological Terms,* 3rd edition.
[2] *Source:* Logical extension of *volcanic eruption.*
[3] *Source:* Adapted from National Weather Service glossary, www.nws.noaa.gov/glossary.htm.
[4] *Source:* Derived from the definition of *infestation* in FactMonster.com dictionary.

10.5 Infrastructures Symbology.

10.5.1 Infrastructure shall be the basic facilities, services, and installations needed for the functioning of a community or society, such as transportation and communications systems, water and power lines, and public institutions, including schools, post offices, and prisons.

10.5.2 Table 10.5.2 shall be used to cross-reference the infrastructures symbols with their definitions.

Table 10.5.2 Infrastructure Symbology Reference

Symbol Types and Terms	Symbols	Keystroke	Definitions
Infrastructures Background Symbol (Background)		!	The background fill shape for the Infrastructures symbol, Level 1
Infrastructures Frame Symbol (Frame)		#	The frame shape for the Infrastructures symbol, Level 1
Agriculture and Food Infrastructure (Theme)		$	Production and retail services of foodstuffs
Agricultural Laboratory (Agriculture and Food Feature)		%	Facilities used for scientific research in farming
Animal Feedlot (Agriculture and Food Feature)		&	Area designated for feeding livestock
Commercial Food Distribution Center (Agriculture and Food Feature)		(	Facility used for the disbursement of marketable foodstuffs
Farm/Ranch (Agriculture and Food Feature)		)	A piece of land on which crops or animals are raised
Food Production Center (Agriculture and Food Feature)		*	The locus where foodstuffs are produced
Food Retail (Agriculture and Food Feature)		+	Facility where foodstuffs are sold for a profit
Grain Storage (Agriculture and Food Feature)		’	Facility used for the housing of cereal seeds such as corn, wheat, or barley
Banking, Finance, and Insurance Infrastructure (Theme)		–	The management of money and other assets and their protection[1]

(continues)

Table 10.5.2 ***Continued***

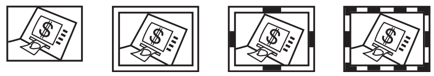
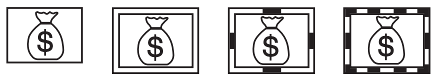
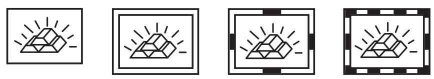
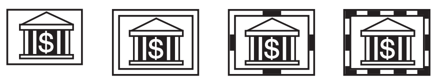
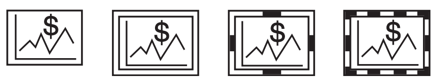
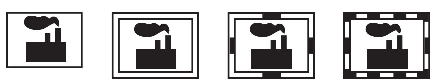
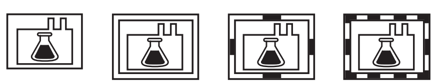
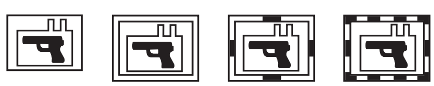
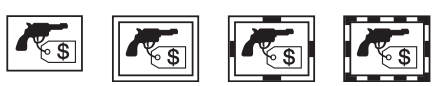
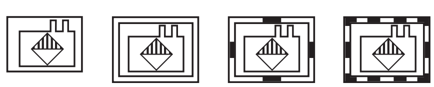
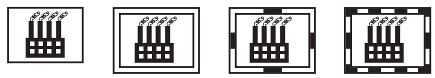
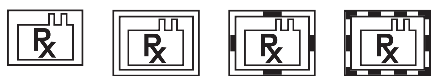
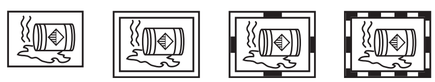
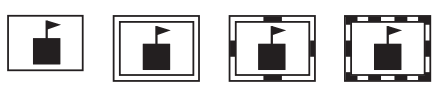
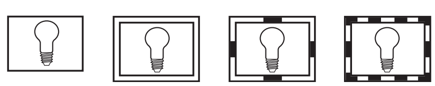
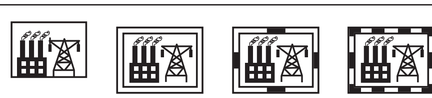
Symbol Types and Terms	Symbols	Keystroke	Definitions
ATM (Banking, Finance, and Insurance Feature)		.	An unattended machine commonly located at a bank's exterior that dispenses money when a personal coded card is inserted[2]
Bank (Banking, Finance, and Insurance Feature)		/	A business establishment in which money is kept for saving for commercial purposes or is invested, supplied for loans, or exchanged[1]
Bullion Storage (Banking, Finance, and Insurance Feature)		0	A facility used to deposit and warehouse gold or silver bars or ingots[3]
Federal Reserve Bank (Banking, Finance, and Insurance Feature)		1	One of twelve regional banks that monitor and act as depositories for banks in their region[2]
Financial Exchange (Banking, Finance, and Insurance Feature)		2	A marketplace in which shares, options, and futures on stocks, bonds, commodities, and indexes are traded[4]
Financial Service Other (Banking, Finance, and Insurance Feature)		3	A business establishment, other than a bank, for the provision of financial or monetary-related products and services; a location that deals with money management business
Commercial Infrastructure (Theme)		4	The locus of where a business enterprise is undertaken[2]
Chemical Plant (Commercial Infrastructure Feature)		5	An industrial site where chemical substances and/or compounds are produced[2]
Firearm Manufacturer (Commercial Infrastructure Feature)		6	A location where hand weapons of explosive force when shot are mass produced[5]
Firearm Retailer (Commercial Infrastructure Feature)		7	A location where hand weapons of explosive force when shot are sold[6]
Hazardous Material Production (Commercial Infrastructure Feature)		8	The locus of where hazardous chemicals and/or substances are produced and stored under regulated conditions

Table 10.5.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definitions
Hazardous Material Storage (Commercial Infrastructure Feature)		9	A storing location for a substance or combination of substances that, because of quantity, concentration, or physical, chemical, radiological, explosive, or infectious characteristics, poses a potential danger to humans and/or the environment[7]
Industrial Site (Commercial Infrastructure Feature)		:	The locus of an industrial facility or facilities used for the commercial production and selling of manufactured goods[1]
Landfill (Commercial Infrastructure Feature)		;	An area of land or an excavation in which wastes are placed for permanent disposal, and which is not a land application unit, surface impoundment, injection well, or waste pile[8]
Pharmaceutical Manufacturer (Commercial Infrastructure Feature)		=	The location where medicinal drugs are mass produced[9]
Superfund Site National Priorities List (Commercial Infrastructure Feature)		?	A location in the United States that has been contaminated by hazardous waste and identified by the Environmental Protection Agency as a candidate for cleanup because it poses a risk to human health and/or the environment[10]
Toxic Release Inventory (Commercial Infrastructure Feature)		@	The location according to a publicly available database of chemical and other toxic waste releases[10]
Educational Facilities Infrastructure (Theme)		A	A building or collection of buildings or places in which knowledge is provided[11]
College/University (Educational Facilities Feature)		B	An institution of higher learning offering courses of studies leading to bachelor's, master's, or doctoral degrees[12]
School (Educational Facilities Feature)		C	A facility for the primary and secondary education of children[13]
Energy Facilities Infrastructure (Theme)		D	A building or collection of buildings and/or places that generates and provides electrical power
Generation Station (Energy Facilities Feature)		E	A facility equipped with special equipment used for the production of heat or electricity[14]

(continues)

Table 10.5.2 *Continued*

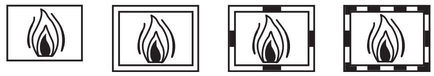
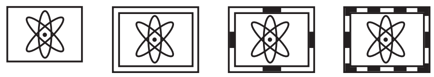
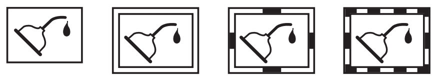
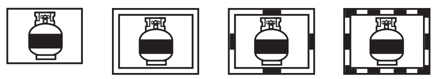
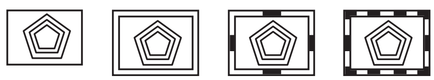
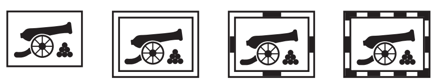
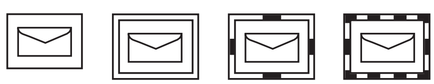
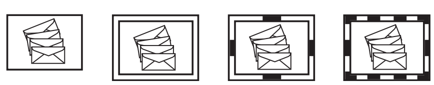
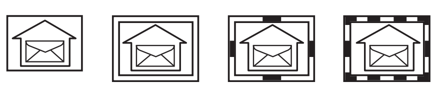
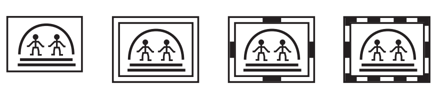
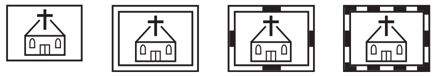
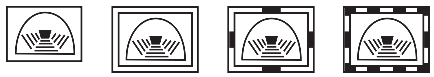
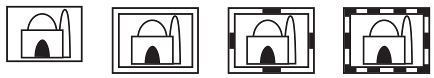
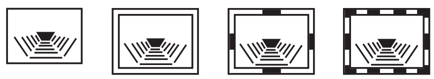
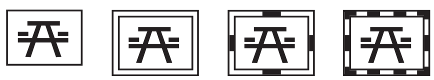
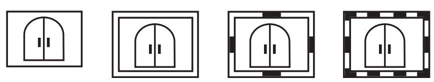
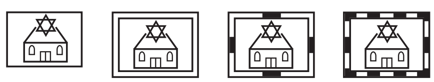
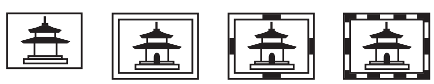
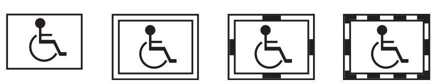
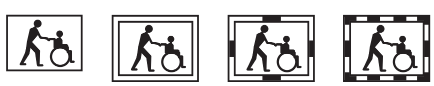
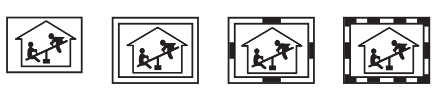
Symbol Types and Terms	Symbols	Keystroke	Definitions
Natural Gas Facility (Energy Facilities Feature)		F	A location equipped with special equipment used to generate natural gas power
Nuclear Facility (Energy Facilities Feature)		G	A location equipped with special equipment used to generate nuclear power
Petroleum Facility (Energy Facilities Feature)		H	A building or place that provides and distributes petroleum gas
Propane Facility (Energy Facilities Feature)		I	A building or place that provides and distributes propane gas
Government Site Infrastructure (Theme)		J	The locus of where executive, legislative, and/or judicial activities take place in the service of the government
Military Infrastructure (Theme)		K	Refers collectively to the four major branches of the United States' armed forces as associated with armed services as contrasted with civilians
Military Armory (Military Feature)		L	A military structure where arms and ammunition and other military equipment are manufactured and stored, and also where training is given in the use of arms[2]
Military Base (Military Feature)		M	The locus of where military personnel, weapons, and supplies are located and also where attacks and other operations are coordinated and launched
Postal Service Infrastructure (Theme)		N	The system whereby letters and other parcels are transmitted and delivered via the post office
Postal Distribution Center (Postal Feature)		O	A U.S. Postal Service (USPS) facility where mail is sorted and routed
Post Office (Postal Feature)		P	A U.S. Postal Service (USPS) facility that directly delivers postal services to the public
Public Venue Infrastructure (Theme)		Q	An unrestricted place or places and events for a large gathering of people[1]

Table 10.5.2 *Continued*

Symbol Types and Terms	Symbols	Keystroke	Definitions
Church (Public Venues Feature)		R	A building for public and especially Christian worship[13]
Enclosed Facility (Public Venues Feature)		S	A roofed facility with walls
Mosque (Public Venues Feature)		T	A building used for public worship by Muslims[13]
Open Facility (Public Venues Feature)		U	An open-air facility with or without walls, for example, a stadium or a parking lot
Recreational Area (Public Venues Feature)		V	A place dedicated to the refreshment of strength and spirits after work[13]
Religious Institution (Public Venues Feature)		W	Any place of worship where religious services are held or prayers are said by a congregation loyal to a belief
Synagogue (Public Venues Feature)		X	The house of worship and communal center of a Jewish congregation[13]
Temple (Public Venues Feature)		Y	A building for Mormon sacred ordinances[13]
Special Needs Infrastructure (Theme)		Z	Of or relating to people who have specific needs, such as those associated with a disability[1]
Adult Day Care (Special Needs Feature)		[	The locus of a nonresidential facility that provides supervision and assisted living services to adults, typically during the daylight hours
Child Day Care (Special Needs Feature)		]	A service involving care for other people's children[1]
Elder Care (Special Needs Feature)		^	The locus of a nursing home or a residential assisted-living facility in which full-time care is provided for the chronically ill, disabled, and elderly

(continues)

Table 10.5.2 *Continued*

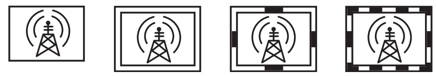
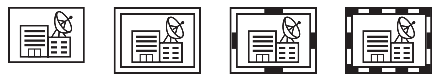
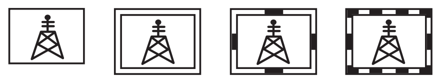
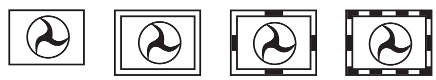
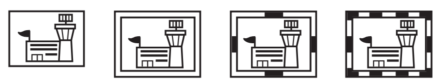
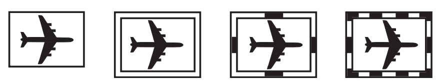
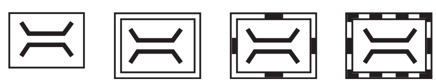
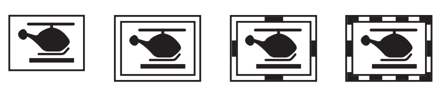
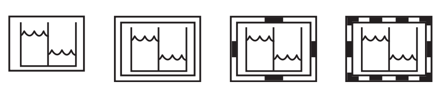
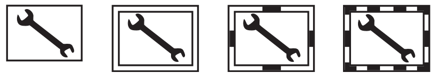
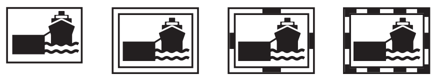
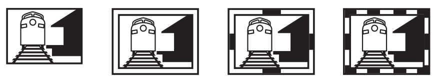
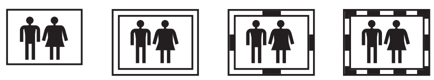
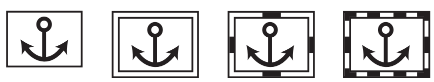
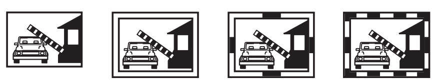
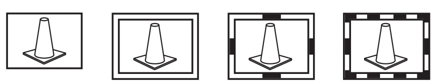
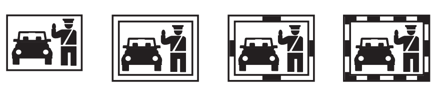
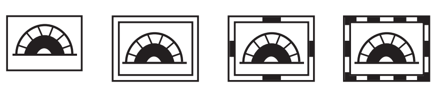
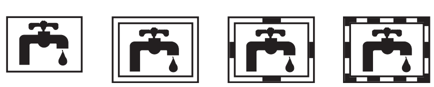
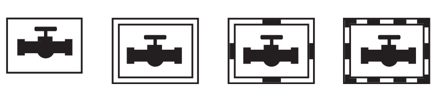
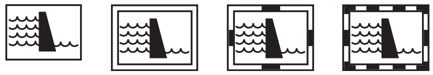
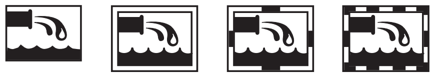
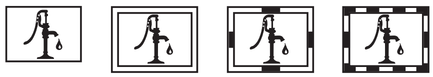
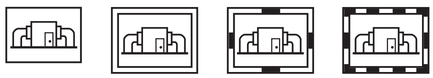
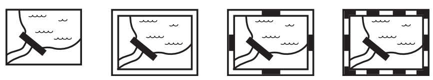
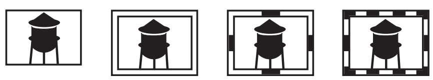
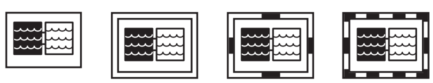
Symbol Types and Terms	Symbols	Keystroke	Definitions
Telecommunications Infrastructure (Theme)		‘	The electronic systems used in transmitting messages, as by telegraph, cable, telephone, radio, television, or computer[1]
Telecommunications Facility (Telecommunications Feature)		a	Any facility housing telecommunications equipment, studios, control rooms, or personnel
Telecommunications Tower (Telecommunications Feature)		b	A structure typically higher than its diameter and high relative to its surroundings to which telecommunications antennae are affixed[13]
Transportation Infrastructure (Theme)		c	Infrastructure, means of transport, and equipment necessary for the movement of passengers and/or goods
Air Traffic Control Facility (Transportation Feature)		d	A facility operated by the appropriate authority to promote the safe, orderly, and expeditious flow of air traffic[8]
Airport (Transportation Feature)		e	An area of land or other hard surface, excluding water, that is used or intended to be used for the landing and takeoff of aircraft and includes its buildings and facilities, if any[8]
Bridge (Transportation Feature)		f	A structure built over a gap to connect and maintain transportation flow between both sides of the gap[15]
Bus Station (Transportation Feature)		g	A terminal that serves bus passengers[2]
Ferry Terminal (Transportation Feature)		h	The location of a vehicle-carrying and commuter boat line terminus[1]
Helicopter Landing Site (Transportation Feature)		i	A site within a landing zone that contains one or more points for helicopters to land[16]
Lock (Transportation Feature)		j	An enclosed part of a canal or river equipped with gates for raising or lowering the level of water so that boats and other vessels can pass[15]

Table 10.5.2 *Continued*

Symbol Types and Terms	Symbols	Keystroke	Definitions
Maintenance Facility (Transportation Feature)		k	A location where vehicles, machines, or any other mechanical devices are serviced for inspection or repair[2]
Port (Transportation Feature)		l	A location on a waterway with facilities for loading and unloading ships and other vessels[1]
Rail Station (Transportation Feature)		m	A depot where tracked transport vehicles or trains load and/or unload passengers or goods[17]
Rest Stop (Transportation Feature)		n	A roadside facility at which motorists can purchase refreshments, use restrooms, and/or acquire area information
Ship Anchorage (Transportation Feature)		o	A location suitable for securely anchoring ships and other vessels[1]
Toll Facility (Transportation Feature)		p	A gate or booth at which money is collected before and/or after motorists enter or exit a toll road (turnpike)[15]
Traffic Control Point (Transportation Feature)		q	The location of absolute signals controlled by an operator to regulate and maintain transportation flow
Traffic Inspection Facility (Transportation Feature)		r	Permanent facility equipped with scales where motor (shipping) vehicles transporting goods on public highways are required to stop and obtain gross vehicle and/or axle weights[18]
Tunnel (Transportation Feature)		s	An underground passageway used to connect and maintain transportation flow between physical or human-built obstructions[15]
Water Supply Infrastructure (Theme)		t	The storage, disinfection, filtration, and provision of drinking water to the consumer/community by means of pipelines, pumps, water towers, wells, and other appurtenances[19]
Critical Valve (Water Supply Feature)		u	A valve that regulates the speed, flow, or pressure of a fluid[20]

(continues)

Table 10.5.2 ***Continued***

Symbol Types and Terms	Symbols	Keystroke	Definitions
Dam (Water Supply Feature)		v	A barrier constructed across a waterway to control the flow or raise the level of water[1]
Discharge Outfall (Water Supply Feature)		w	The volume of effluent that is released into receiving waters at a given location and within a given period of time[21]
Ground Well (Water Supply Feature)		x	An artificial excavation drilled into the ground for the purposes of withdrawing water from underground aquifers[22]
Pumping Station (Water Supply Feature)		y	Facility that lifts water up and over hills[23]
Reservoir (Water Supply Feature)		z	An off-steam water storage facility that is filled with water pumped from a river or stream[24]
Storage Tower (Water Supply Feature)		{	A large (usually metallic) container for holding gases or liquids[2]
Surface Water Intake (Water Supply Feature)		}	A pipe through which wastewater is transferred directly to another site[25]
Water Treatment Facility (Water Supply Feature)		~	A place designed to receive the wastewater from domestic sources and to remove materials that damage water quality and threaten public health and safety when discharged into receiving streams or bodies of water[22]

Notes:
[1] *Source:* Adapted from www.dictionary.com.
[2] *Source:* Adapted from www.hyperdictionary.com.
[3] *Source:* www.hyperdictionary.com; combined definitions of *bullion* and *storage*.
[4] *Source:* Yahoo! Finance glossary, http://biz.yahoo.com/f/g.
[5] *Source: Webster's New World Dictionary*; combined definitions of *firearm* and *manufacture*.
[6] *Source: Webster's New World Dictionary*; combined definitions of *firearm* and *retail*.
[7] *Source:* San Diego State University Emergency Plan Glossary, http://bfa.sdsu.edu/emergencyplan/glossary.htm.
[8] *Source:* Federal Aviation Administration glossary, www.faa.gov/library/glossaries.
[9] *Source: Webster's New World Dictionary*; combined definitions of *pharmaceutical* and *manufacture*.
[10] *Source:* Environmental Protection Agency, www.epa.gov.
[11] *Source:* www.hyperdictionary.com; combined definitions of *educational* and *facility*.
[12] *Source:* Adapted from *Merriam-Webster Online* definitions of *college* and *university*.
[13] *Source:* Adapted from *Merriam-Webster Online*.
[14] *Source:* www.hyperdictionary.com; combined definitions of *generation* and *station*.
[15] *Source:* Adapted from *Webster's New World Dictionary*.
[16] *Source:* J. Reimer Training and Doctrine Digital Library, military terms glossary, www.adtdl.army.mil/cgi-bin/atdl.dll/fm/3-21.38/gloss.htm.

[17] *Source:* www.hyperdictionary.com, adapted definition of *depot*.
[18] *Source:* Nextlinx, www.nextlinx.com/global%5Fcontent/traderefs/glossary.shtml, definition of *weigh station*.
[19] *Source:* County of Maui (Hawaii) Water Supply glossary, www.mauiwater.org/glossary.html, combined definitions of *water system* and *treated water*.
[20] *Source:* "Valve World" glossary, www.valve-world.net/glossary/index.asp, definition of *control valve*.
[21] *Source:* Combined definitions of *outfall* from the Ohio Environmental Protection Agency glossary and *discharge* from the U.S. Geologic Survey, www.epa.state.oh.us/ddagw/documents/swapdocglo.pdf and http://ga.water.usgs.gov/edu/dictionary.html.
[22] *Source:* Adapted from the U.S. Geological Survey Water Science glossary, http://ga.water.usgs.gov/edu/dictionary.html.
[23] *Source:* Ridenbaugh Press, www.ridenbaugh.com.
[24] *Source:* Ohio Environmental Protection Agency glossary (term *upground reservoir*), http://www.epa.state.oh.us/ddagw/documents/swapdocglo.pdf.
[25] *Source:* U.S. Geological Survey Water Resources of New Hampshire and Vermont glossary. Combined definitions of *intake pipe* and *surface water return flow*, http://nh.water.usgs.gov/Publications/OFR01-328/ofr01-328_glossary.pdf.

Chapter 11 Emergency Evacuation Diagrams and Plans

11.1 Introduction. This chapter shall provide requirements on the preparation of floor diagrams and plans, posted within a building, to show the egress evacuation paths and locations of equipment used during an emergency. Building emergency information shall be provided to instruct or guide occupants in how to report an emergency; when to evacuate to the outside evacuation assembly area, to a designated area of refuge, to an area of rescue assistance, or to a designated shelter area; when to remain in place; or when to employ any combination of these options.

11.2 Composition.

11.2.1 The composition of the diagrams shall be clear and simple and able to be quickly understood by occupants within the building. To avoid language barriers, graphic representation and symbols shall be used.

11.2.2* A plan shall show a minimum of two ways to exit from the location of where the diagram/plan is posted, when possible, show the entire floor plan, but when unable to provide a key plan highlighting the area shown in accordance with NFPA *101.* A plan shall show a minimum of two ways to exit from the location of where the diagram/plan is posted, showing the entire floor plan in accordance with NFPA *101.* When unable to show the entire floor plan, provide a key plan highlighting the area.

11.2.3 The symbols of this standard shall be used to make sure that a legend is provided on the diagram/plan explaining their meaning.

11.2.4 The size of text, symbols, and information shall allow visibility by all occupants.

11.2.5 The diagram shall be located at a height above the floor to be viewable by all occupants. Diagrams shall be located such that all employees and visitors will pass by during their stay in the building.

11.3* Orientation.

11.3.1 All diagrams shall be oriented with the top in the direction that the viewer is facing.

11.3.2 There shall be a notation showing the location of the viewer and their orientation with the "you are here" notation pointing up to the sign location. This shall be the most dominant graphic on the diagram.

11.4 Information Shown.

11.4.1 The information in 11.4.1.1 and 11.4.1.2 shall be shown on the plan area of the diagram or plan. Additional information shall be permitted to be added if it does not confuse the viewer during an emergency.

11.4.1.1 The means of egress from the viewers' location shall be shown. This shall include all exit locations, exit access paths, stairways, elevators, elevator lobbies, areas of refuge, areas of rescue assistance, shelter areas, and exterior outside evacuation assembly areas.

11.4.1.2 The equipment used during an emergency shall be shown in a key or legend. This key or legend shall include fire alarm pull stations, emergency phones, defibrillators (AED), fire extinguishers (if trained to use properly), or any other building-specific emergency equipment.

11.4.2 The diagram or plan shall provide emergency phone numbers.

11.4.3 The diagram or plan shall provide emergency evacuation guidelines describing the different emergency alert signals of when and what to do when the signals are sounded. If there are not any signals, the guidelines shall describe how the occupants will be instructed what to do in case of an emergency.

11.5 Construction. The diagram shall be constructed with materials that protect it from fading and wear.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.3 Referent. A referent can be abstract, such as a condition concept, function, relationship, fact, or action.

A.3.3.5 Supplementary Indicators. Effectiveness of symbols can be supplemented by figures, numbers, subscripts, or letter abbreviations. These supplementary indicators can be placed inside of, or adjacent to, the symbol as seen fit. A legend of these indicators, with their meaning, should accompany each set of documents on which they are used.

A.3.3.6 Symbol. Ideally, a symbol should be graphically simple, should be readily understood, should have a strong impact, and should be easily remembered.

A.4.1.2.3 Changes in line thickness, scale, or details are not recommended. In practice, symbols can be combined with other symbols or devices such as words and lighted panels to provide optimal visual alerting. This chapter does not specify viewing distance, size, or optimal combinations of symbols, words, or other presentations. The user is referred to other standards, such as those prepared by the NFPA Committee on Safety to Life and the ANSI Z535 Committee on Safety Signs and Colors, for such information.

A.4.1.3 Reflective material or self-luminous or photoluminescent materials can be used. Consideration needs to be given to the proper mounting of self-luminous or photoluminescent symbols in well-lighted locations to ensure charging by exposure to ambient light.

A.4.1.3.2.1 See Figure A.4.1.3.2.1.

A.4.1.3.4 Examples of combinations of symbols that can be used include Exit Symbol Arrow, Exit Symbol with International Symbol of Accessibility, and Exit Symbol with Arrow and International Symbol of Accessibility.

A.4.2 Use of the symbols is not restricted to the examples cited.

A.5.1.1 The purpose of this chapter is to present uniform fire-fighting symbols in order to improve communication wherever symbology is employed in order to provide information to fire fighters and other emergency responders.

This chapter provides uniformity in the selection of symbols that are intended to assist fire fighters in locating utilities and fire-fighting equipment.

A.5.1.2 In practice, symbols can be combined with other devices, such as words and lighted panels, to provide optimal visual alerting. This chapter does not specify viewing distance, size, or optimal combinations of symbols, words, and other presentations.

A.5.1.3 Reflective material or self-luminous or photoluminescent materials can be used. Consideration needs to be given to the proper mounting of self-luminous or photoluminescent symbols in well-lighted locations to ensure charging by exposure to ambient light.

A.5.1.3.1 Drawing scale, line thickness, and so forth are the subject of standards on drawing practice.

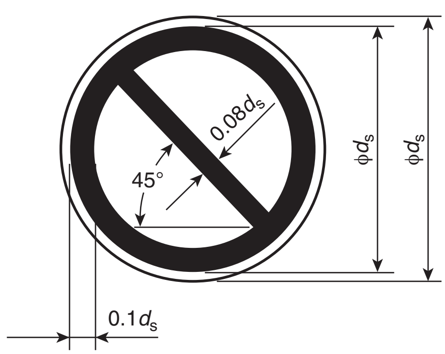
A.5.2 Use of the symbols is not restricted to the examples cited.

The symbol for fire hydrant (all types) shown in Table 5.2 can be of particular use where vehicles or snowfall frequently obscures hydrant locations.

A.6.1 This chapter on architectural and engineering symbols draws heavily on the symbols already developed by various societies, agencies, and industry.

The purpose of this chapter is to provide uniformity in the use of fire safety and related symbols in the preparation of drawings and diagrams.

The symbols in this chapter are intended to be simple, transferable by use of templates, and limited to those referents that are used repetitively in a set of drawings.



The colors of the sign shall be as follows:

Background color:	white
Circular band and diagonal bar:	red
Graphical symbol:	black
Border:	white

The safety color red shall cover at least 35 percent of the total area of the sign.

FIGURE A.4.1.3.2.1 Example of a Prohibition Symbol.

The symbols in this chapter are intended for, but not limited to, architectural and engineering drawings, fire detection and suppression drawings, and fire risk and/or loss analysis diagrams.

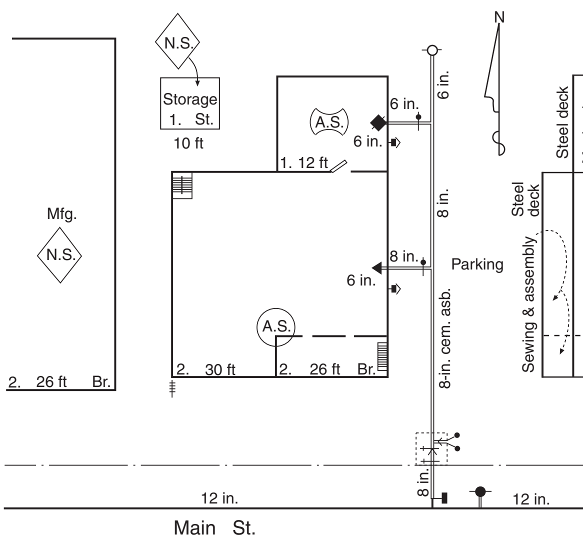
The effectiveness of the symbols in this chapter can be enhanced by the use of supplementary figures, subscripts, numbers, or letter abbreviations.

Devices infrequently used in a given set of drawings and diagrams are not standardized by this document. They usually are accompanied by narrative description, either on the drawing or in specifications.

A.6.1.2 Where appropriate, diagrams include, but are not limited to, the following *(see Figure A.6.1.2)*:

(1) Title block indicating the following:
  (a) Name of company or organization
  (b) Person making drawing and date of drawing
  (c) Name and location of facility involved
(2) "North" direction arrow properly oriented to the position of buildings shown.
(3) Scale of diagram, if used, or "not to scale." Scale can be given with a bar measurement if reduction copies are to be made.

A.6.1.2.1 Drawing scale, line thickness, and so forth, are the subject of standards on drawing practice.



For SI units: 1 in. = 25 mm; 1 ft = 0.305 m.

FIGURE A.6.1.2 Example of the Use of Symbols for Risk Analysis Diagram.

A.6.1.2.4 See Figure A.6.1.2.4(a) and Figure A.6.1.2.4(b) for examples of symbol orientation.

A.6.2.1.2 See Figure A.6.2.1.2 for examples of open-walled structures.

A.6.2.3 See Figure A.6.2.3 for an example of a street.

A.6.2.4 See Figure A.6.2.4 for examples of bodies of water.

A.6.2.5.2 See Figure A.6.2.5.2 for an example of a fence with a gate.

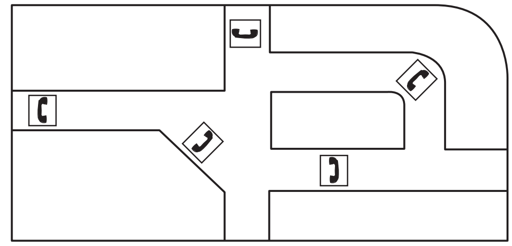


FIGURE A.6.1.2.4(a) Symbol Orientation — Example 1.

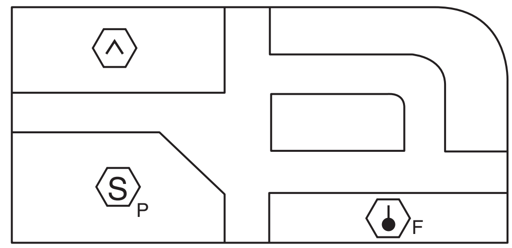


FIGURE A.6.1.2.4(b) Symbol Orientation — Example 2.

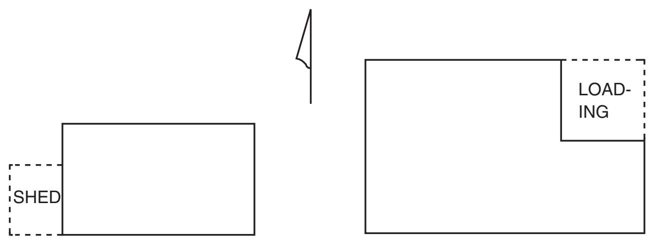


FIGURE A.6.2.1.2 Examples of Open-Walled Structures.

FIGURE A.6.2.3 Example of a Street.

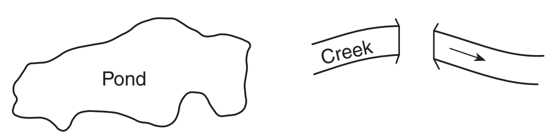


FIGURE A.6.2.4 Examples of Bodies of Water.

FIGURE A.6.2.5.2 Example of a Fence with a Gate.

A.6.3.1 See Figure A.6.3.1 for an example of building construction identification. *(See NFPA 220.)*

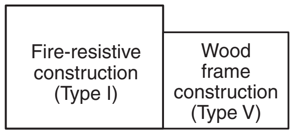
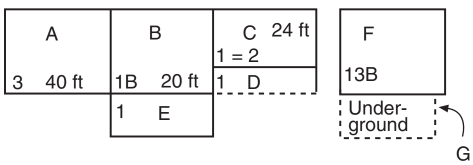


FIGURE A.6.3.1 Example of Building Construction Identification.

A.6.3.2 See Figure A.6.3.2 for an example of height symbols used for a building.



A Three stories, no basement, 40 ft to eaves
B One story with basement, 20 ft to eaves
C One-equals-two stories, no basement, 24 ft to eaves
D One-story open porch or shed
E One-story addition
F Thirteen stories with basement
G Underground structure

FIGURE A.6.3.2 Examples of Building Height Symbols. (Figure includes copyrighted material of Insurance Services Office with its permission. Copyright, Insurance Services Office, 1975.)

A.6.3.3 See Figure A.6.3.3(a) and Figure A.6.3.3(b) for examples of wall symbols.

See Figure A.6.3.3(a) for examples of parapet symbols used for a building.

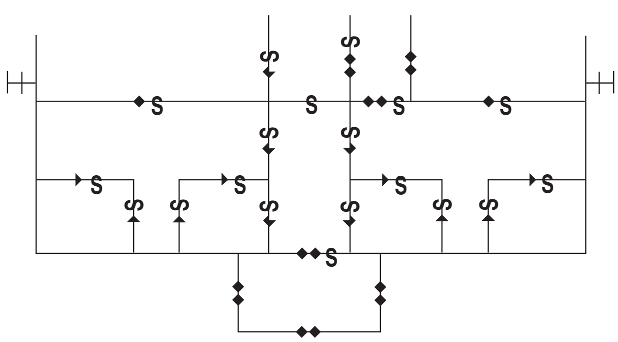


FIGURE A.6.3.3(a) Symbols Used to Note Wall Ratings and Parapets on Life Safety Plans and Risk Analysis Plans and Cross-Sections.

A.6.3.5 See Figure A.6.3.5 for an example of cross-section symbols used for a building.

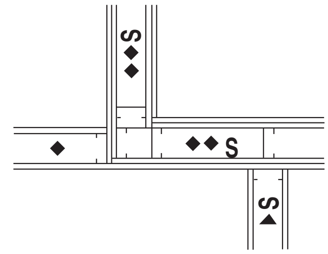


FIGURE A.6.3.3(b) Symbol Used to Note Wall Ratings on Design and Construction Documents.

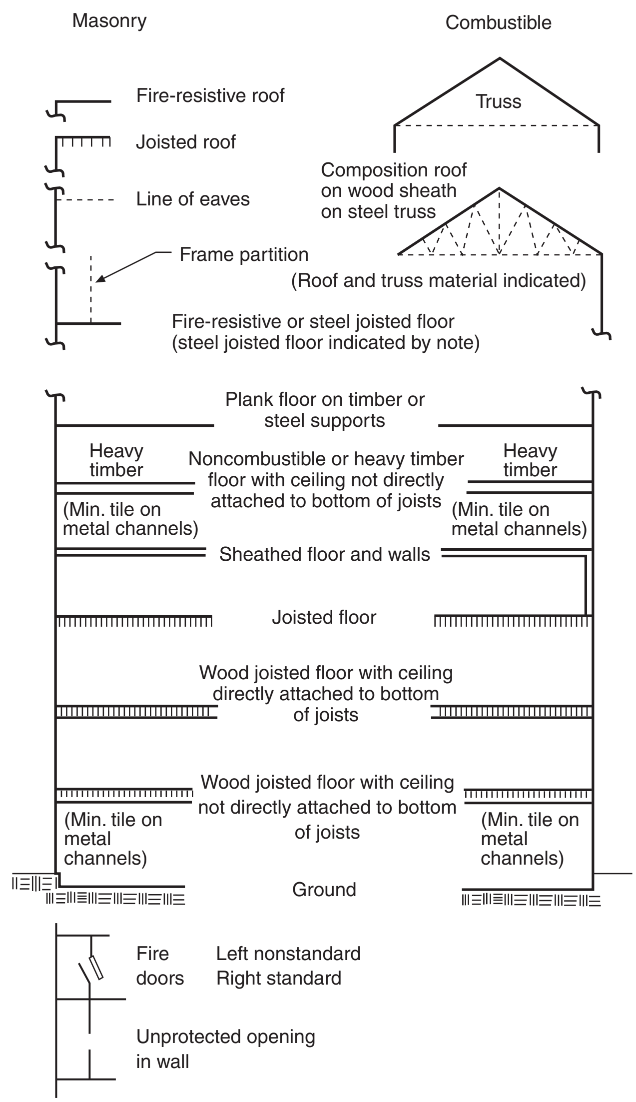


FIGURE A.6.3.5 Examples of Symbols and Notations Used for Fire Risk Analysis Cross Section. (Figure includes copyrighted material of Insurance Services Office with its permission. Copyright, Insurance Services Office, 1975.)

A.7.1 See A.6.1.

A.7.1.2 See A.6.1.2.

A.7.1.2.1 See A.6.1.2.1.

A.7.1.2.4 See A.6.1.2.4.

A.7.2 For private hydrant, one hose outlet; public hydrant, two hose outlets; public hydrant, two hose outlets and pumper connection; wall hydrant, two hose outlets; and private housed hydrant, two hose outlets, all shown in Table 7.2, symbol elements can be utilized in any combination to fit the type of hydrant.

A.7.6 These symbols are intended for use in identifying the type of system installed to protect an area within a building.

A.7.6.2 For sprinklers shown in Table 7.6.2, the temperature rating of the sprinkler and other characteristics can be shown via legends where a limited number of an individual type of sprinkler is called for by the design.

A.7.6.3 See also Table 7.2 for related symbols.

A.7.9 The electrothermal link (ETL) is a multipurpose dual-response fusible link/release device. These devices are used in various applications, such as smoke/damper control and door closures. The symbol should be shown with its rated thermal point.

A.8.1 See A.6.1.

A.8.1.2 See A.6.1.2.

A.8.1.2.1 See A.6.1.2.1.

A.8.1.2.4 See A.6.1.2.4.

A.8.3 Additional subscript identifiers can be included with a slash after the primary subscript to indicate such things as, for example, WP for weatherproof or EP for explosionproof.

For the manual station symbol shown in Table 8.3, electrical or mechanical actuation can be shown.

See NFPA 2001 for a generic list of clean agents.

The telephones referred to in the fire service or emergency telephone station symbols, shown in Table 8.3, are those for a dedicated system for fire and related emergencies.

Temperature rating of heat detectors, in Table 8.3, can be shown.

Velocity can be shown for the smoke detector for duct symbol shown in Table 8.3.

For the gas detector symbol shown in Table 8.3, the drawing should show the type of gas or gases being monitored. The drawing should indicate the lower explosive limit (LEL) and/or the upper explosive limit (UEL) of gas or gases.

A.9.1.1 The purpose of this chapter is to provide uniformity in the use of fire safety and related symbols in the preparation of pre-incident planning sketches.

The symbols in this chapter are provided to assist fire service or emergency response personnel who are responsible for preparing and using pre-incident planning sketches.

A.9.1.2 Triangle symbols are used for access features, assessment features, ventilation features, and utility shutoffs and can point at a specific location or direction. Diamond symbols identify a specific location by touching a wall. Circle symbols are used for all piping system components, such as valves, since most pipes are round.

Square symbols are used for room designations, as they represent most rooms having four sides.

A.9.2 For Section 9.2 through Section 9.5, other features to complete the pre-incident planning sketch can be used as appropriate.

A.9.6 Figure A.9.6 shows an example of hazardous identification.

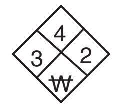


FIGURE A.9.6 Example of Hazardous Identification.

A.11.2.2 It is advisable to show the whole building floor plan with all exits, when possible.

A.11.3 See Figure A.11.3.

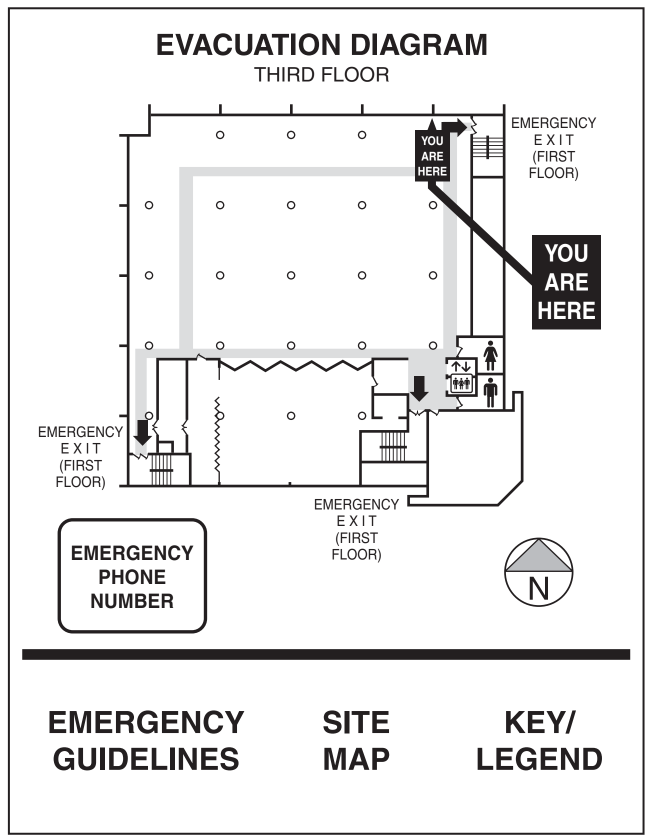


FIGURE A.11.3 Example of Proper Orientation.

Annex B Additional Explanatory Information on Chapters 1 Through 6

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Reserved.

B.2 Reserved.

B.3 Additional Explanatory Information on Chapter 4.

B.3.1 Symbol Testing. Two or more versions of a symbol were developed for the referents listed in Chapter 4. The effectiveness of each of these symbols was evaluated by testing its meaningfulness (i.e., understandability) with groups of different participants. On the basis of these results, a symbol was selected for each referent. In some cases, the symbols were refined graphically to incorporate modifications suggested by the test results. Symbol development and refinement included the efforts of research psychologists, graphic designers, safety engineers, and fire professionals.

The life safety symbols were tested in the course of several different research projects during a 7-year period. These results are referenced in a series of publications by the National Bureau of Standards.

Although a variety of testing procedures were used to assess understandability, the basic method consisted of asking people either to write down short definitions or to pick the correct definition from a set of carefully selected choices. In several studies, data on symbol preference and rated effectiveness also were obtained.

For these testing efforts, one set of participants consisted of 222 industrial personnel and 78 students; another set consisted of 271 miners and mine personnel; and another set consisted of 94 paid volunteers. No major differences between participant groups were observed for the symbols selected for Chapter 4.

In addition to the studies of understandability, a detailed assessment was made of exit symbol visibility. This study used a laboratory optical viewing system to present a set of exit symbols included in a much larger set (108) of safety and information symbols. Three viewing conditions that simulated smoke were used (luminance of 0.085, 0.060, and 0.032 candela/m^2). Forty-two participants were familiarized with a randomly selected set of exit symbols to identify the separate effects of understandability and visibility. The symbol given in Chapter 4 was the symbol that was most frequently identified correctly under all three viewing conditions. In addition, the identification data were virtually the same whether participants had been familiarized with the symbol or not — suggesting that the symbol has high initial understandability. (This suggestion is reinforced by the high percentages of correct identification found in those studies that evaluated understandability.)

The results of the visibility testing program are important because an exit symbol must be both well understood and visible when under degraded viewing conditions such as smoke.

The goal of the overall testing program was to identify versions or elements of symbols for the selected referents that appeared to be most effective in communicating the intended message. It is recognized that further education and/or supplemental word messages can be useful in optimizing the effectiveness of these symbols with the general public. Nevertheless, the symbols selected have demonstrated good initial understandability. Symbols for the referents generally showed good understandability (better than 85 percent correct identification). Symbols that presented some understandability problems included "No Exit" and "Fire Alarm Call Point." The examples shown herein, however, represent the imagery that was best understood. It is hoped that use of these images will strengthen public recognition.

It also should be noted that the symbol for handicapped accessibility was not tested in this program. It is, however, in an existing ANSI standard, A117.1, *Specifications for Making Buildings and Facilities Accessible to and Usable by Physically Handicapped People,* and has achieved wide use and good recognition.

B.4 Additional Explanatory Information on Chapter 5.

B.4.1 Symbol Testing. At least two versions of a symbol were developed for each of the following referents:

(1) Fire department automatic sprinkler connection — siamese
(2) Fire department standpipe connection
(3) Fire department combined automatic sprinkler/standpipe connection
(4) Fire hydrant (all types)
(5) Automatic sprinkler control valve
(6) Electric panel or electric shutoff

The following referents are discussed in this section:

(1) Gas shutoff valve
(2) Fire-fighting hose or standpipe outlet
(3) Fire extinguisher
(4) Directional arrow
(5) Diagonal directional arrow

Subsequently, the effectiveness of the symbols was evaluated by testing their meaningfulness to groups of fire professionals; the procedures are outlined in this section. On the basis of the test results, a symbol was selected for each referent. This set of symbols was further refined graphically, incorporating modifications suggested by the test results. Symbol development and refinement through a Subcommittee on Visual Alerting Symbols included the efforts of fire professionals, graphic artists and designers, research psychologists, and safety engineers.

Symbols for gas shutoff valve, fire-fighting hose or standpipe outlet, fire extinguisher, directional arrow, and diagonal directional arrow were adapted from International Organization for Standardization (ISO) publications. The fire extinguisher symbol was included in the test procedure. Although the standpipe outlet symbol was not tested in isolation, it was incorporated as an element in two of the tested symbols (fire department standpipe connection and fire department combined automatic sprinkler/standpipe connection).

Participants in the test program included fire professionals attending a national convention or local (Maryland) training classes and totaled 86 participants. The test procedure involved two phases. In the first phase, the participants were shown one symbol at a time, in slide form, and were asked to write down a short definition of what they thought each symbol meant. In the second phase, two symbolic versions of each referent were shown together, and their intended meaning was provided; the participants indicated which version (if either) of each pair they felt better conveyed the meaning. They also were asked to give the reason for their preference and were free to offer any suggestions for improvement.

The goal of the testing program was to identify versions or elements of symbols for the selected referents that were most effective in visually alerting fire fighters. It is recognized that education might be required to optimize the effectiveness of the symbols for fire fighters. Nevertheless, it is important to select symbols that initially are meaningful. Symbols for seven of the nine referents tested showed good recognizability (85 to 100 percent) and no serious confusion with other possible meanings. However, for two referents — wall hydrant and gas control valve — recognition was poor, and confusion was common for both symbolic versions of each message. Therefore, no symbol for these two referents is presented in this standard. Graphic improvements and alternative conceptions are being sought. (A symbol for a gas shutoff valve was accepted for the 1991 edition of NFPA 170.)

B.4.2 The NFPA Committee on Fire Safety Symbols was able to identify a set of shapes for symbols to be used to direct responding fire fighters.

B.5 Additional Explanatory Information on Chapter 6.

B.5.1 Symbol Selection Procedure. See Figure B.5.1 for an example of the procedures involved in selecting fire safety symbols.

B.5.2 Discussion of Basic Symbols.

B.5.2.1 Symbol Testing. Inevitably, when a new standard is introduced to a field in which standardized symbols are not established and everyone is acting independently, controversy looms over the effort as to which (whose) alleged "standard" should be used. Such controversy can be met only with a national logic for meeting the standardization task. Such logic was used in developing former NFPA 172 now incorporated into Chapter 6.

B.5.2.2 This symbology effort ultimately employed the following steps:

(1) Identify problem. Is a standard for fire protection symbols needed?
(2) Identify referents. What devices should be symbolized? Consider applicability to fire protection and frequency of use.
(3) Identify symbols' availability. What symbols exist, and how widely are they used for fire protection and other disciplines?
(4) Develop a system of symbol selection. Can a system be identified so that referents and symbols can be rationally selected or developed? *(See B.5.1.)*
(5) Can a scheme of basic shapes be utilized in developing symbol sets for categories of referents?
(6) Adhere to the scheme. Make exceptions only where an overwhelming level of usage makes changes unreasonable.
(7) Avoid conflicts. Are there other practices and/or standards with which the proposed standard might be in conflict?

B.5.2.3 To accomplish step B.5.2.2(5), two factors had to be considered. First, there is very little agreement on symbols throughout North America. For the most part, various industry segments disagree on symbols and even on basic shapes. Second, the ISO Committee on Fire Protection Symbols for Use on Drawings completed most of its work on this subject before 1980 and proposed a set of basic symbol shapes.

B.5.2.4 With the two foregoing considerations, the NFPA Committee on Fire Safety Symbols was able to develop a set of basic shapes for symbols to be used on fire protection drawings. The basic shapes shown in Table B.5.2.4 were selected by uniting the ISO-proposed basic shapes and, where existent, the North American common practice. Thus, the collection of shapes (menu) represents a compromise with the sole major objective of developing a symbols standard aimed at a common language to improve future communication among users of fire protection drawings worldwide.

B.5.2.5 The collection of basic shapes in Table B.5.2.4 is broken down into a major classification of symbol elements and a supplementary set of symbol elements that can be used singly or in combination with other symbol elements. These basic symbol shapes and relative sizes are not exclusive of all the shapes and sizes that were used in developing former NFPA 172 (now incorporated into Chapter 6). They are a guide that was used in developing the family scheme.

It is recognized that the former NFPA 172 did not include all the fire safety symbols that can be required on architectural and engineering drawings. Table B.5.2.4 can therefore be used as a basis for future development of Chapter 6 or for the design of specialized symbols by the draftsperson.

Symbol elements have definite meanings and therefore should always be represented at the same relative size when used in different symbols.

B.5.2.6 The NFPA Committee on Fire Safety Symbols was able to identify a set of shapes for symbols to be used on fire protection drawings and diagrams *(see Table B.5.2.4)*. The shapes were selected through a reconciliation of the symbols presented in the former NFPA 172 (now incorporated into Chapter 6), the general shapes being drafted by the ISO, and, where existent, the common practice in North America. Thus, the family of shapes represents a compromise, with the major objective of developing a common language to improve future communication among users of fire protection diagrams worldwide.

B.5.3 Use of Color Coding.

B.5.3.1 General. The use of color coding to indicate various types of building construction is recommended and can be justified. Where used, color coding should be in conformity with this annex to maximize communication. Where color coding is not used, it is necessary to rely on printed detail.

B.5.3.2 Table B.5.3.2 presents a recommended system for color coding.

Table B.5.3.2 Color Coding of Construction Types

Construction Type*	Color
Fire resistive (Type I)	Light brown
Noncombustible/limited combustible (Type II)	Gray (brown border if masonry walls)
Heavy timber and ordinary (Type III and IV)	Pink
Wood frame (Type V)	Yellow

*See NFPA 220.

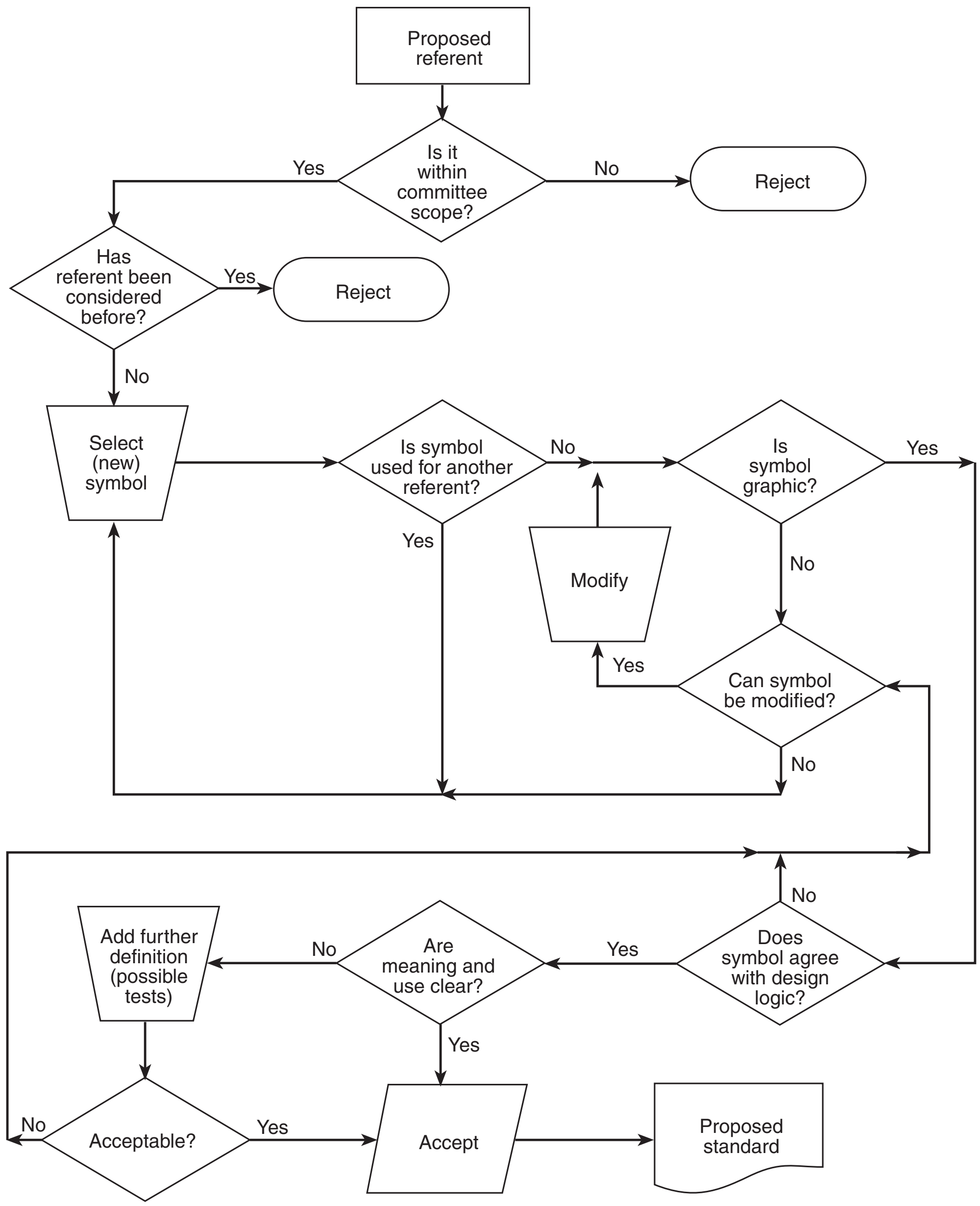
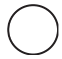
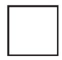
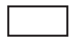
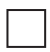


FIGURE B.5.1 Symbol Selection Procedure.

Table B.5.2.4 Basic Symbol Shapes and Relative Sizes

General Referent	Shape	Relative Size*	Comments
Major Elements			
Automatically actuating systems		4 mm (5/32 in.) diameter	Detection, extinguishment
Manually actuating systems		4 mm (5/32 in.) square	Manual alarm system
Control panel		4 mm × 8 mm (5/32 in. × 5/16 in.)	Supplementary element used to describe the panel
Portable fire extinguisher		5 mm (3/16 in.) sides	Supplementary element used to further describe the extinguisher
Fire-fighting equipment		6 mm (1/4 in.) sides	Supplementary element used to describe a specific device
Supplementary Elements			
Water system components		2 mm (3/32 in.) diameter	General shape, a circle; shading of element indicates wet device
Foam agent		5 mm (3/16 in.) diameter	
Dry chemical agent		2 mm (3/32 in.) square	
Gaseous agent		3 mm (1/8 in.) sides	
Nozzle			Used on pipe or other symbol
Pressure notation			Used with another symbol shape, such as a detector or a tank
Switch (electrical) or contact		2 mm (5/64 in.) diameter	
Valve		4 mm (5/32 in.) high	
Check valve		6 mm (1/4 in.) high (with arrow)	
Tamper detector		4 mm (5/32 in.) diameter	
Heat detector		1 mm (3/64 in.) diameter	
Flow detector		4 mm (5/32 in.) high	
1-hour fire rating		5 mm (3/16 in.) square	Used to indicate fire rating of walls in hours
Automatic detection and supervisory use devices		5 mm (3/16 in.) sides	Detection, supervisory

**Relative* is emphasized because it is not the intent here to specify actual dimensions. For comparisons, this column lists the suggested sizes of the symbols presented here.

Annex C Emergency Responder Map

This annex is not a part of the requirements of this NFPA document but is intended for informational purposes only.

C.1 Emergency Responder Plan. The plan shown in Figure C.1(a) and Figure C.1(b) provides emergency responders an example of maps showing the interior and exterior locations of the building using the symbols from Table 5.2 and information from Chapter 9. See Figure C.1(a) and Figure C.1(b).

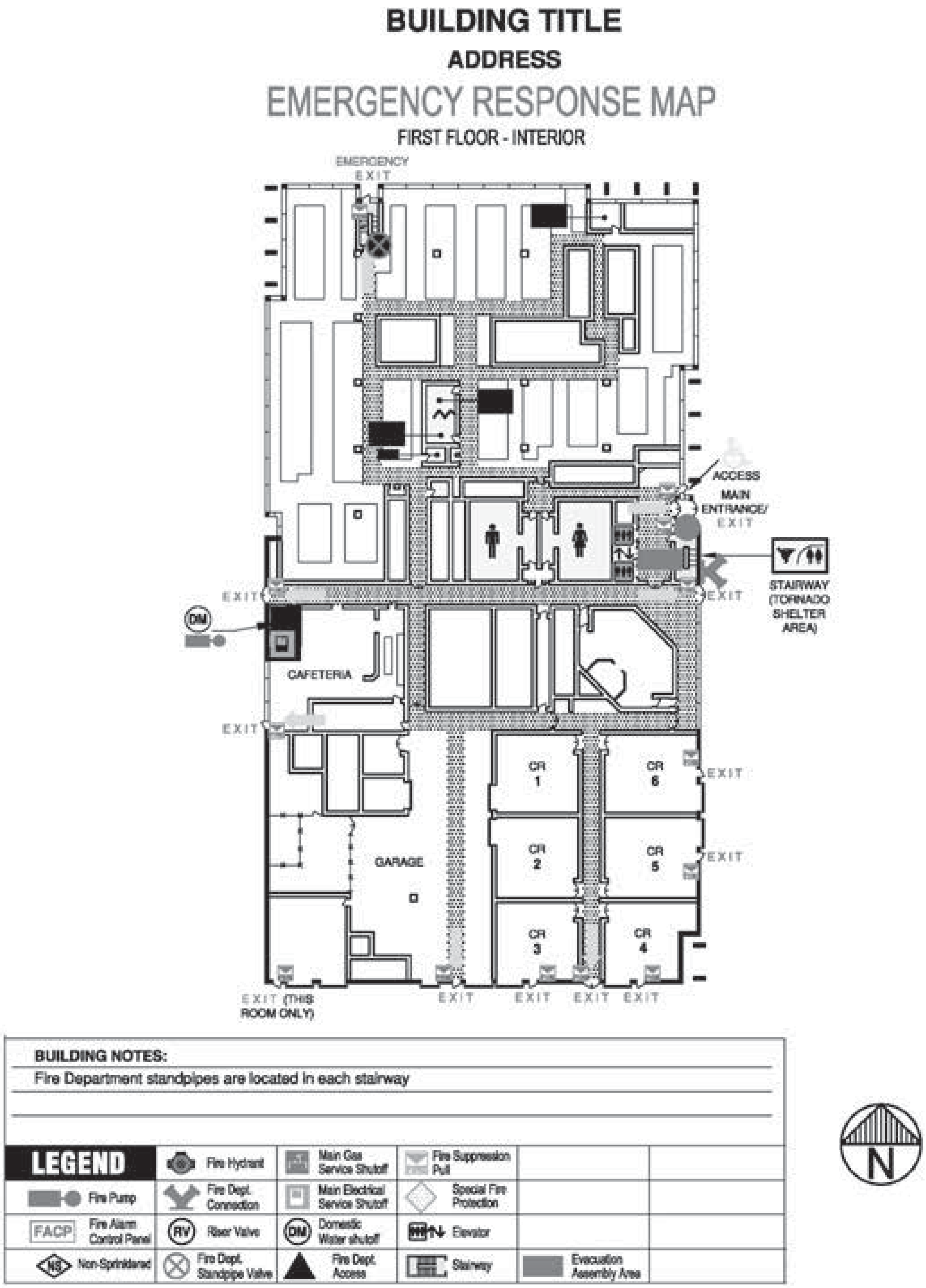


FIGURE C.1(a) Emergency Response Map First Floor, Interior.

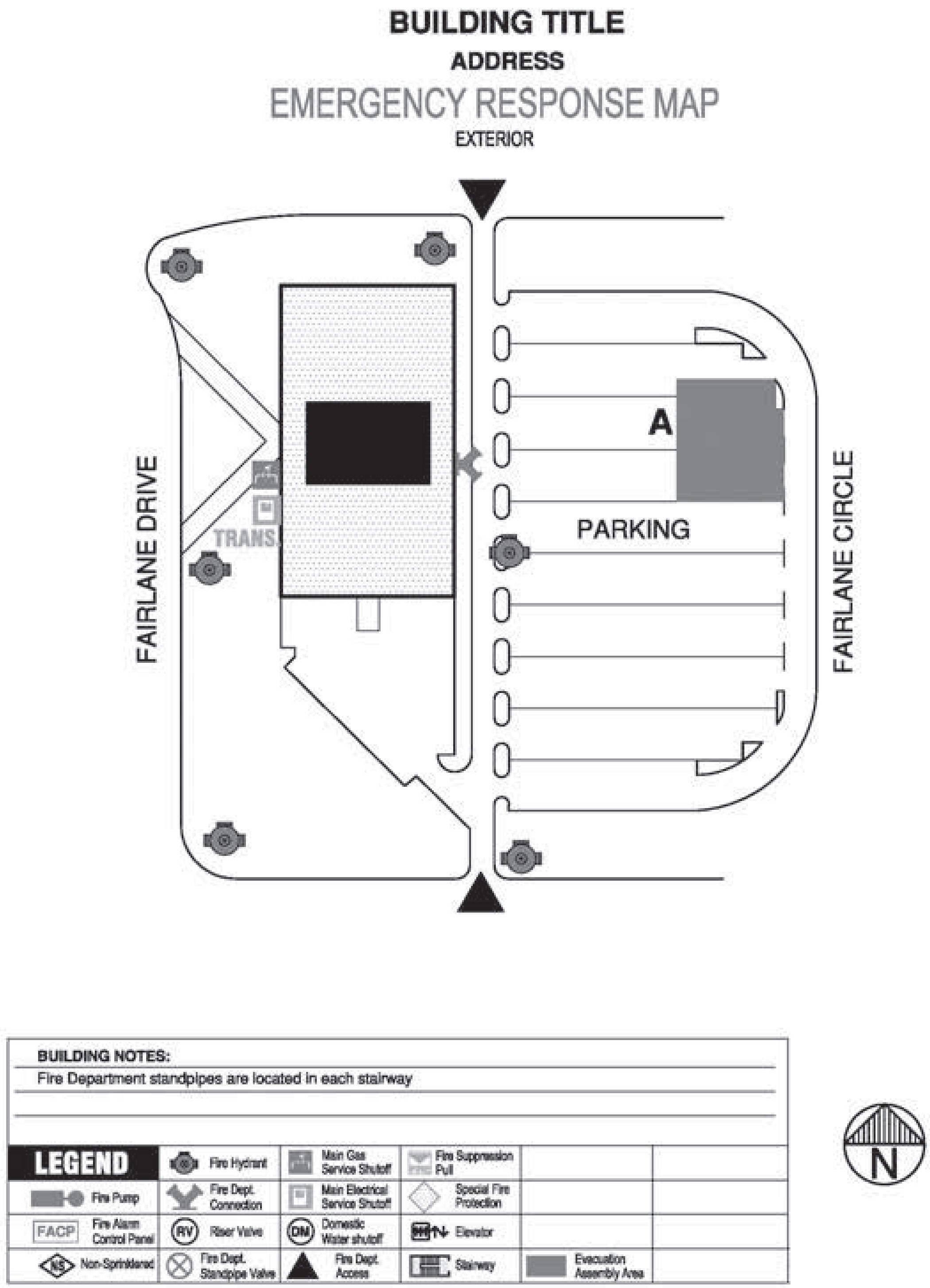


FIGURE C.1(b) Emergency Response Map Exterior.

Annex D Informational References

D.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

D.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

NFPA 2001, *Standard on Clean Agent Fire Extinguishing Systems*, 2015 edition.

D.1.2 Other Publications.

D.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI A117.1, *Accessible and Usable Buildings and Facilities,* 2009.

D.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

D.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

Fire Protection Handbook, 20th edition, 2008.

Fire and Life Safety Inspection Manual, 8th edition, 2002.

National Fire Codes®, 2014.

D.2.2 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th floor, New York, NY 10036.

ANSI Z535.1, *American National Standard for Safety Colors*, 2006.

ANSI Z535.3, *American National Standard Criteria for Safety Symbols*, 2007.

ANSI Z535.4, *American National Standard for Product Safety Signs and Labels*, 2007.

D.2.3 ISO Publications. International Organization for Standardization, 1, ch. de la Voie-Creuse, Case postale 56, CH-1211 Geneva 20, Switzerland.

ISO 3864, *Safety Colors and Safety Signs*, 1984.

ISO 6309, *Fire Protection — Safety Signs*, 1987.

ISO 6790, *Equipment for Fire Protection and Fire Fighting Graphical Symbols for Fire Protection Plans — Specification*, 1986.

D.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 204

Standard for

Smoke and Heat Venting

2015 Edition

This edition of NFPA 204, *Standard for Smoke and Heat Venting*, was prepared by the Technical Committee on Smoke Management Systems. It was issued by the Standards Council on November 11, 2014, with an effective date of December 1, 2014, and supersedes all previous editions.

This edition of NFPA 204 was approved as an American National Standard on December 1, 2014.

Origin and Development of NFPA 204

This project was initiated in 1956 when the NFPA Board of Directors referred the subject to the Committee on Building Construction. A tentative guide was submitted to NFPA in 1958. Revised and tentatively adopted in 1959 and again in 1960, the guide was officially adopted in 1961. In 1968, a revised edition was adopted that included a new section, Inspection and Maintenance.

In 1975, a reconfirmation action failed as concerns over use of the guide in conjunction with automatic sprinklered buildings surfaced. Because of this controversy, work on a revision to the guide continued at a slow pace.

The Technical Committee and Subcommittee members agreed that the state of the art had progressed sufficiently to develop improved technology-based criteria for design of venting; therefore, the 1982 edition of the document represented a major advance in engineered smoke and heating venting, although reservations over vent and sprinkler applications still existed.

At the time the guide was formulated, the current venting theory was considered unwieldy for this format; consequently, the more adaptable theory as described herein was adopted. Appreciation must be extended to Dr. Gunnar Heskestad at the Factory Mutual Research Corporation (now FM Global) for his major contribution to the theory applied in this standard, which is detailed in Annex B.

The 1985 edition again revised Chapter 6 on the subject of venting in sprinklered buildings. Test data from work done at the Illinois Institute of Technology Research, which had been submitted to the Committee as part of a public proposal, did not permit consensus to be developed on whether sprinkler control was impaired or enhanced by the presence of automatic roof vents of typical spacing and area. The revised wording of Chapter 6 encouraged the designer to use the available tools and data referenced in the document while the use of automatic venting in sprinklered buildings was under review.

The 1991 edition made minor changes to Chapter 6 to acknowledge that a design basis existed for using sprinklers and automatic heat venting together but that such had not received wide recognition.

The 1998 edition represented a complete revision of the guide. The rewrite deleted the previous tables that listed vent areas and incorporated engineering equations and referenced computer models, such as LAVENT and DETACT, to provide the designer with the necessary tools to develop vent designs based on performance objectives. This rewrite was based extensively on state-of-the-art technology published in the references. In many cases, the authors of these references participated in the task group's rewrite efforts.

The 2002 edition of NFPA 204 was converted from a guide to a standard, thus implementing mandatory requirements and updated language. The document was also updated to meet Manual of Style for NFPA Technical Committee Documents requirements.

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The 2007 edition included a number of technical changes. New provisions on air entrainment into the fire plume, the effect of wind on the location of air vents, sizing of air paths, air velocity limitations, and plugholing were provided. Information on the use of vents as air inlets and a better description of the smoke layer interface were added. Revisions with regard to how heat release rates, discharge coefficients, exhaust rates, and the number of exhaust inlets are to be determined were incorporated. Reference to international standards on vents, mechanical smoke extract, and draft curtains, as well as updated annex text on recent research efforts, were provided.

The 2012 edition was updated to include additional requirements and annex material for venting in sprinklered buildings.

The 2015 edition includes revised provisions on draft curtains. These requirements create consistency with NFPA 92.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design, installation, testing, operation, and maintenance of systems for the control, removal, or venting of heat or smoke from fires in buildings.

NFPA 204

Standard for

Smoke and Heat Venting

2015 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex G. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex G.

Chapter 1 Administration

1.1 Scope.

1.1.1* This standard shall apply to the design of venting systems for the emergency venting of products of combustion from fires in buildings. The provisions of Chapters 4 through 10 shall apply to the design of venting systems for the emergency venting of products of combustion from fires in nonsprinklered, single-story buildings using both hand calculations and computer-based solution methods as provided in Chapter 9. Chapter 11 shall apply to venting in sprinklered buildings.

1.1.2* This standard shall not specify under which conditions venting is to be provided or required.

1.1.3 Where a conflict exists between a general requirement and a specific requirement, the specific requirement shall be applicable.

1.2 Purpose. (Reserved)

1.3 Application.

1.3.1* This standard shall not apply to ventilation within a building designed for regulation of environmental air for personnel comfort, to regulation of commercial cooking operations, to regulation of odor or humidity in toilet and bathing facilities, to regulation of cooling of production equipment, or to venting for explosion pressure relief.

1.3.2 This standard shall apply to building construction of all types.

1.3.3 This standard shall apply to venting fires in building spaces with ceiling heights that permit the design fire plume and smoke layer to develop.

1.3.4* This standard shall apply to situations in which the hot smoke layer does not enhance the burning rate of the fuel array. Vent designs developed with this standard shall not be valid for those time intervals where smoke layer temperatures exceed 600°C (1112°F).

1.3.5* This standard shall not be valid for fires having heat release rates greater than $Q_{feasible}$ as determined in accordance with the following equation:

$$Q_{feasible} = 12{,}000\left(z_s\right)^{5/2} \qquad \textbf{[1.3.5]}$$

where:

$Q_{feasible}$ = feasible fire heat release rate (kW)
z_s = height of the smoke layer boundary above the fire base (m)

1.3.6* The engineering equations or computer-based models incorporated into this standard shall be used to calculate the time duration that the smoke layer boundary is maintained at or above the design elevation in a curtained area, relative to the design interval time.

1.4 Retroactivity.

1.4.1 The provisions of this standard shall not be required to be applied retroactively.

1.4.2 Where a system is being altered, extended, or renovated, the requirements of this standard shall apply only to the work being undertaken.

1.5 Equivalency. Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard. Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Units and Formulas. The following symbols define the variables in the equations used throughout the body of this standard:

A = area (of burning surface)
A_i = inlet area for fresh air, below design level of smoke layer boundary
A_v = total vent area of all vents in a curtained area
α = thermal diffusivity, $k/\rho c$
α_g = fire growth coefficient
γ = exhaust location factor (dimensionless)
c_p = specific heat
$C_{d,v}$ = vent discharge coefficient
$C_{d,i}$ = inlet discharge coefficient
d = smoke layer depth
d_c = depth of draft curtain
D = base diameter of the fire
g = acceleration of gravity
H = ceiling height above base of fire
h_c = heat of combustion
h_g = heat of gasification

K = fraction of adiabatic temperature rise
k = thermal conductivity
$k_e\beta$ = constant used in Equation E.5.1
$k\rho c$ = thermal inertia
l = thickness
L = mean flame height above the base of the fire
L_f = flame length, measured from leading edge of burning region
L_v = length of vent opening in the longer direction
$\dot{m}$ = mass burning rate
$\dot{m}''$ = mass burning rate per unit area
$\dot{m}''_\infty$ = mass burning rate per unit area for an infinite diameter pool
$\dot{m}_v$ = mass flow rate through vent
$\dot{m}_p$ = mass flow rate in the plume
$\dot{m}_{pL}$ = mass flow rate in the plume at mean flame height (L)
$\dot{q}''_i$ = incident heat flux per unit area
Q = total heat release rate
Q'' = total heat release rate per unit floor area
Q_c = convective heat release rate = $\chi_c Q$
$Q_{feasible}$ = feasible fire heat release rate (kW)
r = radius from fire axis
RTI = response time index $\tau u^{1/2}$
τ = time constant of heat-responsive element for convective heating
ρ = density
ρ_o = ambient air density
S = center to center spacing of vents
t = time
t_d = time to detector activation
t_g = growth time of fire
t_{ig} = time to ignition
t_r = design interval time
t_{sa} = time to sprinkler activation
t_{vo} = time to vent opening
ΔT = gas temperature rise (from ambient) at detector site
ΔT_a = adiabatic temperature rise
ΔT_e = temperature rise (from ambient) of heat-responsive element
T = smoke layer temperature (K)
T_o = ambient air temperature
T_{ig} = ignition temperature
T_s = surface temperature
u = gas velocity at detector site
W_{min} = lateral fire spread by radiation
W_s = largest horizontal dimension of fire
W_v = width of vent opening in the shorter direction
V = flame spread velocity
χ_c = convective fraction of total heat release rate (fraction carried as heat in plume above flames) where χ_c is a convective-heat fraction between 0.6 and 0.7
χ_r = radiant fraction of total heat release rate
y = elevation of smoke layer boundary
y_{ceil} = elevation of ceiling
y_{curt} = elevation of bottom of draft curtain
y_{fire} = elevation of the base of the fire above the floor
z_s = height of the smoke layer boundary above base of fire
z_{si} = height of the smoke layer interface above the base of the fire
z_o = height of virtual origin above base of fire (below base of fire, if negative)

Chapter 2 Referenced Publications

2.1* General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2013 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

2.3 Other Publications.

2.3.1 FM Publications. FM Global Technologies LLC, 1301 Atwood Avenue, P.O. Box 7500, Johnston, RI 02919.

FM 4430, *Approval Standard for Heat and Smoke Vents,* 2012.

2.3.2 NIST Publications. National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899-1070.

DETACT-QS (Detector Actuation — quasi-steady) software.

DETACT-T2 (Detector Actuation — time squared) software.

LAVENT (Link-Actuated VENTS) software.

2.3.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 793, *Standard for Automatically Operated Roof Vents for Smoke and Heat*, 2008, revised 2011.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 92, *Standard for Smoke Control Systems,* 2015 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities,* 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Ceiling Jet. A flow of smoke under the ceiling, extending radially from the point of fire plume impingement on the ceiling.

3.3.2 Clear (Air) Layer. The zone within a building containing air that has not been contaminated by the smoke produced from a fire in the building, and that is located between the floor and the smoke layer boundary.

3.3.3* Clear Layer Interface. The boundary between a smoke layer and smoke-free air.

3.3.4 Continuously Growing Fires. Fires that, if unchecked, will continue to grow over the design interval time.

3.3.5 Curtained Area. An area of a building that has its perimeter delineated by draft curtains, full height partitions, exterior walls, or any combinations thereof.

3.3.6 Design Depth of the Smoke Layer. The difference between the height of the ceiling and the minimum height of the smoke layer boundary above the finished floor level that meets design objectives.

3.3.7 Design Fire. As used in this standard, the time-rate heat release history selected as the input for the calculations prescribed herein.

3.3.8 Design Interval Time. The duration of time for which a design objective is to be met, measured from the time of detector activation.

3.3.9* Draft Curtain. A fixed or deployable barrier that protrudes downward from the ceiling to channel, contain, or prevent the migration of smoke.

3.3.10* Effective Ignition. The time at which a *t*-squared design fire starts.

3.3.11 Fuel Array. A collection and arrangement of materials that can support combustion.

3.3.12 Heat Detector. A fire detector that detects either abnormally high temperature or rate of temperature rise, or both. [**72,** 2013]

3.3.13 Limited-Growth Fires. Fires that are not expected to grow beyond a predictable maximum heat release rate.

3.3.14 Mechanical Smoke Exhaust System. A dedicated or shared-duty fan system designed and suitable for the removal of heat and smoke.

3.3.15 Plastics.

3.3.16 Plugholing. The condition where air from below the smoke layer is pulled through the smoke layer into the smoke exhaust due to a high exhaust rate. [**92,** 2015]

3.3.17 Smoke. The airborne solid and liquid particulates and gases evolved when a material undergoes pyrolysis or combustion, together with the quantity of air that is entrained or otherwise mixed into the mass. [**318,** 2012]

3.3.18* Smoke Layer. The accumulated thickness of smoke below a physical or thermal barrier. [**92,** 2015]

3.3.19* Smoke Layer Boundary. An effective boundary centered in a transition zone between the dense portion of the smoke layer and the first indication of smoke.

3.3.20 Vent. As used in this standard, a device or construction that, when activated, is an opening directly to the exterior at or near the roof level of a building that relies on the buoyant forces created by a fire to exhaust smoke and heat.

3.3.21 Vent System. A system used for the removal of smoke and heat from a fire that utilizes manually or automatically operated heat and smoke vents at roof level and that exhausts smoke from a reservoir bounded by exterior walls, interior walls, or draft curtains to achieve the design rate of smoke mass flow through the vents, and that includes a provision for makeup air.

Chapter 4 Fundamentals

4.1* Design Objectives. The design objectives to be achieved over the design interval time by a vent system design during a design fire or design fires shall include the following:

(1) The minimum allowable smoke layer boundary height
(2) The maximum allowable smoke layer temperature

4.2* Design Basis. A design for a given building and its combustible contents and their distribution shall comprise selecting a design basis (limited-growth versus continuous-growth fire) and establishing the following parameters:

(1) Layout of curtained areas
(2) A draft curtain depth
(3) Type detector and specific characteristics
(4) Detector spacing
(5) A design interval time, t_r, following detection for maintaining a clear layer (for continuous-growth fires)
(6) Total vent area per curtained area
(7) Distribution of individual vents
(8) An air inlet area

4.3 Determination of Contents Hazard.

4.3.1 The determination of contents hazard shall take into account the fuel loading and the rate of heat release anticipated from the combustible materials or flammable liquids contained within the building.

4.3.2 The heat release rate of the design fire shall be quantified in accordance with Chapter 8.

4.4 Venting.

4.4.1 Design Objectives. In order to satisfy design objectives, a vent system shall be designed to slow, stop, or reverse the descent of a smoke layer produced by fire in a building, by exhausting smoke to the exterior.

4.4.2* Vent System Designs and Smoke Production.

4.4.2.1 Vent systems shall be designed in accordance with this standard by calculating the vent area required to achieve a mass rate of flow through the vents that equals the mass rate of smoke production.

4.4.2.2 Vent system designs shall limit the descent of the smoke layer to the design elevation of the smoke layer boundary.

4.4.2.3 Alternative vent system designs shall be permitted to be developed in accordance with this standard by calculating the vent area required to achieve a mass rate of flow through the vents that is less than the mass rate of smoke production, such that the descent of the smoke layer is slowed to meet the design objectives.

4.4.3* Vent Mass Flow. Vent system designs shall be computed on the basis that the mass flow rate through a vent is determined primarily by buoyancy pressure.

4.5 Smoke Production.

4.5.1* Base of the Fire. For the purposes of the equations in this standard, the base of the fire shall be at the bottom of the burning zone.

4.5.2* Fire Size. Burning and entrainment rates of possible fire scenarios shall be considered before establishing the conditions of the design fire.

4.5.3* Entrainment.

4.5.3.1 The entrainment formulas specified in this standard shall be applied only to a single fire origin.

4.5.3.2* Virtual Origin. Predicted plume mass flow above the top of the flame shall take into account the virtual origin, z_o, of the fire as determined in 9.2.3.2.

4.6 Vent Flows.

4.6.1* Buoyancy and Vent Flow.

4.6.1.1 Flow through a vent shall be calculated on the basis of buoyancy pressure difference, assuming that no pressure is contributed by the expansion of gases.

4.6.1.2* Beneficial wind effects shall not be taken into account when calculating vent areas.

4.6.1.3 Air inlets and vents shall be located to avoid adverse wind effects.

4.6.2* Inlet Air.

4.6.2.1 Predicted vent flows shall take into account the area of inlet air openings.

4.6.2.2 Inlet air shall be introduced below the smoke layer boundary.

4.6.2.3 Wall and ceiling leakage above the smoke layer boundary in the curtained area shall not be included in vent flow calculations. *(See Chapter 6 for information on air inlets.)*

Chapter 5 Vents

5.1* Listed Vents. Normally closed vents shall be listed and labeled in accordance with ANSI/UL 793, *Standard for Automatically Operated Roof Vents for Smoke and Heat*; FM 4430, *Approval Standard for Heat and Smoke Vents*; or other approved, nationally recognized standards.

5.2 Vent Design Constraints.

5.2.1* The means of vent actuation shall be selected with regard to the full range of expected ambient conditions.

5.2.2* Vents shall consist of a single unit (vent), in which the entire unit (vent) opens fully with the activation of a single detector, or multiple units (vents) in rows or arrays (ganged vents) in which the units (vents) open simultaneously with the activation of a single heat detector, a fusible link, a smoke detector, a sprinkler waterflow switch, or other means of detection to satisfy the venting requirements for a specific hazard.

5.2.3* Where the hazard is localized, vents shall open directly above such hazard.

5.2.4 Vents, and their supporting structure and means of actuation, shall be designed so that they can be inspected visually after installation.

5.3 Methods of Operation.

5.3.1* Normally, closed vents shall be designed to open automatically in a fire to meet design objectives or to comply with performance objectives or requirements.

5.3.2* Vents, other than thermoplastic drop-out vents, shall be designed to fail in the open position such that failure of a vent-operating component results in an open vent.

5.3.3 Vents shall be opened using gravity or other approved opening force.

5.3.4 The opening mechanism shall not be prevented from opening the vent by snow, roof debris, or internal projections.

5.3.5* All vents shall be designed to open by manual means. Means of opening shall be either internal or external, as approved by the authority having jurisdiction.

5.3.6 Vents designed for remote operation shall utilize approved fusible links and shall also be capable of actuation by an electric power source, heat-responsive device, or other approved means.

5.3.7 Vents designed to activate by smoke detection, sprinkler waterflow, or other activation methods external to the vent shall be approved in accordance with Section 5.1.

5.4 Dimensions and Spacing of Vents.

5.4.1 The dimensions and spacing of vents shall meet the requirements of 5.4.1.1 and 5.4.1.2 to avoid plugholing.

5.4.1.1 The area of a unit vent shall not exceed $2d^2$, where d is the design depth of the smoke layer.

5.4.1.2* For vents with $L_v/W_v > 2$, the width, W_v, shall not exceed the design depth of the smoke layer, d.

5.4.2* In plan view, the center-to-center spacing of vents in a rectangular matrix, S, as shown in Figure 5.4.2(a), within a curtained area shall not exceed $4H$, where H is the ceiling height as shown in Figure 5.4.2(b), parts (a) through (d).

5.4.3* The spacing of vents, in plan view, shall be such that the horizontal distance from any point on a wall or draft curtain to the center of the nearest vent, within a curtained area, does not exceed $2.8H$ as indicated in Figure 5.4.3.

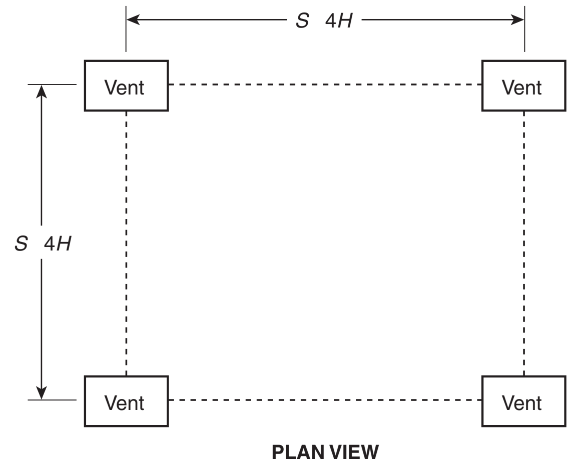

FIGURE 5.4.2(a) Vent Spacing in Rectangular Matrix (plan view).

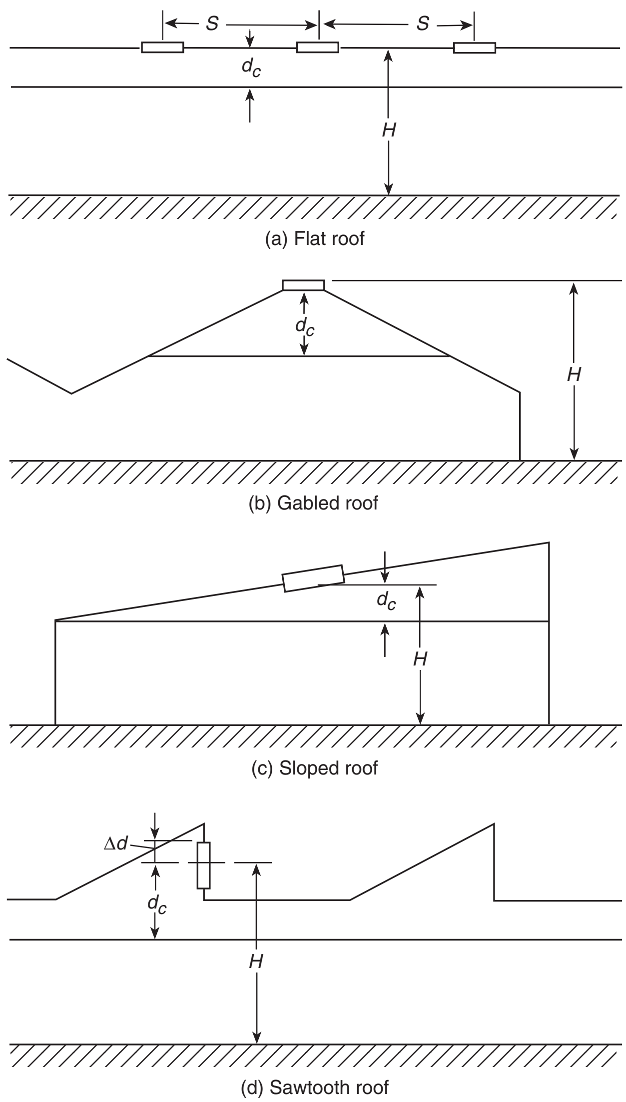

FIGURE 5.4.2(b) Measurement of Ceiling Height *(H)* and Curtain Board Depth *(d_c)*.

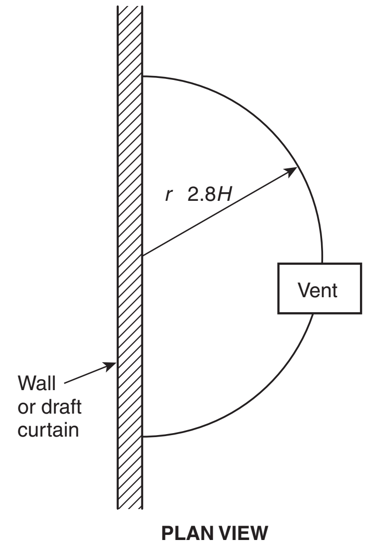

FIGURE 5.4.3 Vent Location near a Wall or Draft Curtain (plan view).

5.4.4 The total vent area per curtained area shall be sized to meet the design objectives and the performance objectives relative to the design fire, determined in accordance with Chapter 8.

5.5 Mechanical Smoke Exhaust Systems. Mechanical smoke exhaust systems shall be designed in accordance with Chapter 10.

Chapter 6 Air Inlets

6.1* General. Air inlets shall be provided for supplying makeup air for vent systems.

6.2 Construction. Air inlets consisting of louvers, doors, dampers, windows, shutters, or other approved openings shall be designed and constructed to provide passage of outdoor air into the building.

6.3* Location. Air inlets shall be installed as indicated in 6.3.1 or 6.3.2.

6.3.1 Air inlets shall be installed in external walls of the building below the height of the design level of the smoke layer boundary and shall be clearly identified or marked as air inlets.

6.3.2 In larger buildings where there is more than one curtained area, air inlets shall be permitted to be provided by vents in other nonadjacent curtained areas.

6.4 Installation.

6.4.1 Materials of construction and methods of installation for air inlets shall resist expected extremes of temperature, wind, building movement, rain, hail, snow, ice, sunlight, corrosive environment, internal and external dust, dirt, and debris.

6.4.2 The means of air inlet actuation shall be selected with regard to the full range of expected ambient conditions.

6.4.3 To satisfy the vent system requirements, air inlets shall consist of one of the following:

(1) A single unit (air inlet) in which the entire unit (air inlet) opens fully with the activation of a single detector
(2) Multiple units (air inlets) in rows or arrays (ganged air inlets) in which the units (air inlets) open simultaneously with the activation of a single heat detector, a fusible link, a smoke detector, a sprinkler waterflow switch, or other means of detection to satisfy the vent system requirements

6.4.4 Air inlets and their supporting structures and means of actuation shall be designed such that they can be inspected visually after installation.

6.5 Methods of Operation.

6.5.1 Air inlets shall be either constantly open or automatically placed in the open position after a fire is detected.

6.5.2 Air inlets shall be designed to open in a fire to meet design objectives or to comply with performance objectives or requirements.

6.5.3 Air inlets shall be designed to fail in the open position such that failure of an air inlet–operating component results in an open air inlet.

6.5.4 Air inlets shall be opened using an approved means as the opening force.

6.5.5 Air inlet opening mechanisms shall not be prevented from opening the air inlet by snow, debris, or internal projections.

6.5.6 Operating mechanisms for air inlets shall be jam-proof, corrosion-resistant, dust-resistant, and resistant to pressure differences arising from applicable positive or negative loading resulting from environmental conditions, process operations, overhead doors, or traffic vibrations.

6.5.7 Air inlets designed for remote operation shall be activated by approved devices and shall be capable of actuation by an electrical power source, heat-responsive device, or other approved means.

6.6 Dimensions and Spacing of Air Inlets.

6.6.1 The total inlet area per curtained area shall be sized to meet the design objectives and the performance objectives or requirements specified relative to the design fire, determined in accordance with Chapter 8.

6.6.2 One inlet area shall be permitted to serve more than one curtained area.

6.6.3* The air velocity at the plume shall not exceed 1 m/s (3.28 ft/s).

6.7 Air Paths. Air paths from an air inlet opening to the curtained area where smoke is being exhausted shall be at least three times the size of the air inlet opening.

Chapter 7 Draft Curtains

7.1* General. Where the spacing between walls exceeds the limits in Section 7.4, draft curtains shall be provided.

7.2* Construction.

7.2.1 Draft curtains shall remain in place and shall confine smoke when exposed to the maximum predicted temperature for the design interval time, assuming a design fire in close proximity to the draft curtain.

7.3 Location and Depth.

7.3.1* Draft curtains shall extend vertically downward from the ceiling the minimum distance required so that the value of d_c, as shown in Figure 5.4.2(a), is a minimum of 20 percent of the ceiling height, H, measured as follows:

(1) For flat roofs and sawtooth roofs with flat ceiling areas, from the ceiling to the floor
(2) For sloped roofs, from the center of the vent to the floor

7.3.2 Where there are differing vent heights, H, each vent shall be calculated individually.

7.4 Spacing.

7.4.1* Neither the length nor the width of a curtained area shall exceed eight times the ceiling height.

7.4.2* Where draft curtains extend to a depth of less than 30 percent of the ceiling height, the distance between draft curtains shall be not less than one ceiling height.

Chapter 8 The Design Fire

8.1* General.

8.1.1 The design fire shall be selected from among a number of challenging candidate fires, consistent with the building and its intended use, considering all of the following factors that tend to increase the challenge:

(1) A low-level flame base (usually floor level)
(2) Increasing fire growth rate
(3) Increasing ultimate heat release rate in the design interval time

8.1.2 The candidate fire that produces a vent system design meeting the design objectives for all candidate fires shall be selected as the design fire.

8.2 Steady (Limited-Growth) Fires.

8.2.1 For steady fires, or fires that do not develop beyond a maximum size, the required vent area per curtained area shall be calculated based on the maximum calculated heat release rate (Q and Q_c), the associated distance from the fire base to the design elevation of the smoke layer boundary (z_s), and the predicted fire diameter (D).

8.2.2* Steady fires shall be permitted to include special-hazard fires and fires in occupancies with concentrations of combustibles separated by aisles of sufficient width to prevent the spread of fire by radiation beyond the initial fuel package or initial storage array.

8.2.3 The minimum aisle width required to prevent lateral fire spread by radiation, W_{min}, shall be calculated for radiant heat flux from a fire based on an ignition flux of 20 kW/m^2 (2.5 hp/ft^2) in accordance with the following equation:

$$W_{min} = 0.042 Q_{max}^{1/2} \quad \textbf{[8.2.3]}$$

where:
W_{min} = minimum aisle width required to prevent lateral fire spread by radiation (m)
Q_{max} = maximum anticipated heat release rate (kW)

8.2.4 The fire diameter, *D*, shall be the diameter of a circle having the same area as the floor area of the fuel concentration.

8.2.5 The heat release rate shall be the heat release rate per unit area times the floor area of the fuel concentration, using the maximum storage height above the fire base and associated heat release rate.

8.2.6* The heat release rate per unit area shall be determined by test or from published data acceptable to the AHJ.

8.3 Growing (Continuous-Growth) Fires.

8.3.1* For fuel configurations that have been tested, the fire growth shall be modeled to follow the test results acceptable to the AHJ. For other fuel configurations that have not been tested, a *t*-squared fire growth as shown in Figure 8.3.1 shall be used with a fire growth coefficient based on published data acceptable to the AHJ and in accordance with the following equation:

$$Q = 1055\left(\frac{t}{t_g}\right)^2 \quad \text{[8.3.1]}$$

where:
Q = heat release rate of fire (kW)
t = time from effective ignition following an incubation period (s)
t_g = time at which the fire exceeds an intermediate size of 1055 kW (s)

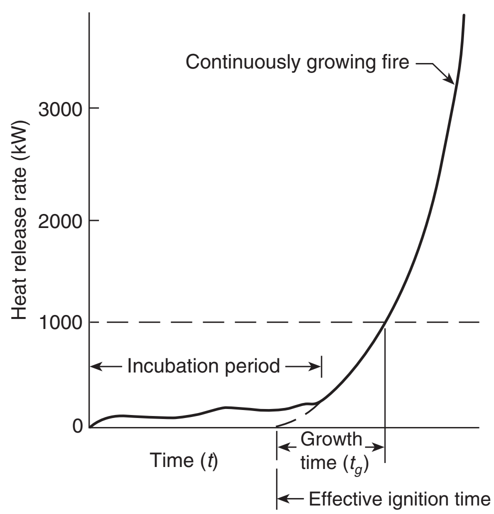

FIGURE 8.3.1 Conceptual Illustration of Continuous-Growth Fire.

8.3.2* A *t*-squared fire growth shall be permitted to be expressed in terms of a fire growth coefficient, α_g, in lieu of growth time, t_g, as follows:

$$Q = \alpha_g t^2 \quad \text{[8.3.2]}$$

where:
Q = heat release rate of fire (kW)
α_g = fire growth coefficient (kW/s^2)
t = time (s)

8.3.3 The instantaneous heat release rate per unit height of the storage array shall be considered to be constant, regardless of the storage height. Accordingly, for different storage heights, the growth time, t_g, shall be calculated as being inversely proportional to the square root of the storage height, and the fire growth coefficient, α_g, shall be calculated as being directly proportional to the storage height. *(See Section F.1.)*

8.3.4* The vent system shall maintain the smoke boundary layer above the design elevation from the time of effective ignition until the end of the design interval time, t_r, where t_r is measured from the time of detection, t_d.

8.3.5 The heat release rate at the end of the design interval time shall be calculated in accordance with the following equation:

$$Q = 1055\left(\frac{t_r + t_d}{t_g}\right)^2 \quad \text{[8.3.5]}$$

where:
Q = heat release rate (kW)
t_r = time at end of design interval (s)
t_d = time of detection (s)
t_g = time at which fire exceeds 1055 kW (s)

8.3.6 The end of the design interval time, t_r, shall be selected to correspond to the design objectives as determined for the specific project design.

8.3.7 The instantaneous diameter of the fire needed for the calculation of L and z_o shall be calculated from the instantaneous heat release rate, Q, and data on the heat release rate per unit floor area, Q'', where Q'' is proportional to storage height in accordance with the following equation:

$$D = \left(\frac{4Q}{\pi Q''}\right)^{1/2} \quad \text{[8.3.7]}$$

where:
D = instantaneous fire diameter (m)
Q = instantaneous heat release rate (kW)
Q'' = heat release rate per unit floor area (kW/m^2)

Chapter 9 Sizing Vents

9.1* General.

9.1.1* The design vent area in a curtained area shall equal the vent area required to meet the design objectives for the most challenging fire predicted for the combustibles within the curtained area.

9.1.2 Vent areas shall be determined using hand calculations in accordance with Section 9.2 or by use of a computer-based model in accordance with Section 9.3.

9.1.3 The design fire used in the evaluation of a proposed vent design in accordance with Section 9.1 shall be determined in accordance with Chapter 8.

9.1.4* Vent systems shall be designed specifically for the hazard of each curtained area in a building.

9.2 Hand Calculations.

9.2.1 Vent System Designs. Vent systems, other than those complying with Section 9.3, shall be sized and actuated to meet design objectives in accordance with Section 9.2.

9.2.2 Design Concepts.

9.2.2.1* Equilibrium shall be assumed as illustrated in Figure 9.2.2.1, where symbols are as defined in Section 1.6.

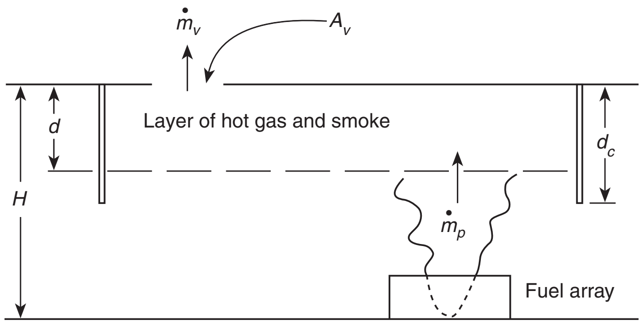

FIGURE 9.2.2.1 Schematic of Venting System.

9.2.2.2 The smoke layer boundary shall be at or above the bottom of the draft curtains.

9.2.2.3 At equilibrium, the mass flow rate into the smoke layer shall be equal to the mass flow rate out of the vent or vents ($\dot{m}_p = \dot{m}_v$).

9.2.3 Mass Flow Rate in Plume.

9.2.3.1* The mean flame height shall be calculated in accordance with the following equation:

$$L = -1.02D + 0.235\,Q^{2/5} \qquad \textbf{[9.2.3.1]}$$

where:
L = mean flame height above the base of the fire (m)
D = base diameter of fire (m)
Q = total heat release rate (kW)

9.2.3.2 The virtual origin, z_o, is the effective point source of the fire plume and shall be calculated in accordance with the following equation:

$$z_o = 0.083Q^{2/5} - 1.02D \qquad \textbf{[9.2.3.2]}$$

where:
z_o = virtual fire origin
Q = total heat release rate (kW)
D = base diameter of fire (m)

9.2.3.3 Smoke entrainment relationships shall be applicable to axisymmetric plumes.

9.2.3.4 For line-like fires where a long, narrow plume is created by a fuel or storage array, the smoke production calculated in accordance with this standard shall be applicable only if the height of the smoke layer boundary above the base of the fire (z_s) is greater than or equal to four times the largest horizontal dimension of the fire, W_s.

9.2.3.5 If z_s is smaller than $4W_s$, the smoke production rates calculated in accordance with this standard shall be increased by the factor $[4W_s/(z_s)]^{2/3}$.

9.2.3.6 When the mean flame height, L, is below the smoke layer boundary ($L < z_s$), the mass flow rate in the fire plume shall be calculated in accordance with the following equation:

$$\dot{m}_p = \left[0.071\,Q_c^{1/3}\left(z_s - z_o\right)^{5/3}\right]\left[1 + 0.027\,Q_c^{2/3}\left(z_s - z_o\right)^{-5/3}\right] \qquad \textbf{[9.2.3.6]}$$

where:
$\dot{m}_p$ = mass flow rate in the plume (kg/s)
Q_c = convective heat release rate = $0.7Q$ (kW)
z_s = height of the smoke layer boundary above the base of the fire (m)
z_o = height of virtual origin above the base of the fire (if below the base of the fire, z_o is negative) (m)

9.2.3.7 When the mean flame height (L) is equal to or above the smoke layer boundary ($L \geq z_s$), the mass flow rate shall be calculated in accordance with the following equation:

$$\dot{m}_p = \left(0.0056Q_c\right)\frac{z_s}{L} \qquad \textbf{[9.2.3.7]}$$

where:
$\dot{m}_p$ = mass flow rate in the plume (kg/s)
Q_c = convective heat release rate = $0.7Q$ (kW)
z_s = height above the base of the fire (m)
L = mean flame height (m)

9.2.3.8 The base of the fire shall be the lowest point of the fuel array.

9.2.4* Mass Flow Rate Through Vents.

9.2.4.1* The mass flow through the vent shall be calculated in accordance with the following equation:

$$\dot{m}_v = \frac{C_{d,v}A_v}{\sqrt{1 + \dfrac{C_{d,v}^2 A_v^2}{C_{d,i}^2 A_i^2}\left(\dfrac{T_o}{T}\right)}}\sqrt{\left(2\rho_o^2 gd\right)}\sqrt{\frac{T_o\left(T - T_o\right)}{T^2}} \qquad \textbf{[9.2.4.1]}$$

where:
$\dot{m}_v$ = mass flow through vent (kg/s)
$C_{d,v}$ = vent discharge coefficient
A_v = vent area (m^2)
ρ_o = ambient density (kg/m^3)
g = acceleration due to gravity (9.81 m/s^2)
d = smoke layer depth (m)
T_o = ambient temperature (K)
T = smoke layer temperature (K)
$C_{d,i}$ = inlet discharge coefficient
A_i = inlet area (m^2)

9.2.4.2* The discharge coefficients for the vents and inlets used shall be those provided by the vent or inlet manufacturer. If no data are available, the discharge coefficient shall be taken from Table 9.2.4.2 unless an analysis or data acceptable to the AHJ are provided by the designer to validate the use of an alternative value.

9.2.4.3 The smoke layer temperature, T, used in 9.2.4.1 shall be determined from the following equation:

$$T = T_o + \frac{KQ_c}{c_p \dot{m}_p} \qquad \textbf{[9.2.4.3]}$$

where:
T = smoke layer temperature (K)
T_o = ambient temperature (K)
K = fraction of convected energy contained in the smoke layer gases *(see 9.2.4.4)*
Q_c = convective heat release rate (kW)
c_p = specific heat of the smoke layer gases (kJ/kg-K)
$\dot{m}_p$ = plume mass flow rate (kg/s) *(see 9.2.3)*

Table 9.2.4.2 Default Discharge Coefficients for Vents and Inlets

Vent or Inlet Type	Discharge Coefficient [(*d*, *v*) and (*d*, *i*)]
Louvered with blades at 90 degrees to airflow	0.55
Flap type or door open at least 55 degrees	
Drop-out vent leaving clear opening	
Flap type or door open at least 30 degrees	0.35
Fixed weather louver with blades at 45 degrees	0.25

9.2.4.4 The value of K used in Equation 9.2.4.3 shall be 0.5, unless an analysis acceptable to the AHJ is provided by the designer to validate the use of an alternative value.

9.2.5 Required Vent Area and Inlet Area.

9.2.5.1 Vent Area. The required vent area shall be the minimum total area of all vents within a curtained area required to be open to prevent the smoke from descending below the design level of the smoke layer boundary when used in conjunction with the required inlet area.

9.2.5.2 Inlet Area. The required inlet area shall be the minimum total area of all inlets required to be open to prevent the smoke from descending below the design level of the smoke layer boundary when used in conjunction with the required vent area(s).

9.2.5.3 Area Calculation. The required vent area and inlet areas shall be calculated by equating the plume mass flow rate determined in 9.2.3 and the vent mass flow rates determined in 9.2.4.

9.2.5.4 Detection and Activation.

9.2.5.4.1* Detection, for the purpose of automatically actuating vents, shall be by one of the following methods:

(1) By either heat or smoke at the vent location
(2) By activation of fire protection systems
(3) By heat or smoke detectors installed on a regular matrix within the curtained area in accordance with *NFPA 72*
(4) By other approved means shown to meet design objectives

9.2.5.4.2 For calculating both the detection time, t_d, of the first detector to operate and the detection time, t_{vo}, of the detector controlling the actuation of the last vent to operate in a curtained area prior to the end of the design interval time, the location of the design fire shall be assumed to be the farthest distance possible from both the first and last detectors to operate the vents within the curtained area.

9.2.5.4.2.1* Detection times for heat detectors or fusible links shall be determined in accordance with *NFPA 72*.

9.2.5.4.3 Detection times for smoke detectors shall be determined as the time to reach a certain temperature rise, ΔT, at activation. In the case of continuous-growth, *t*-squared fires, gas temperatures shall be determined in accordance with the following equation, where ΔT is assumed to be 0 when the numerator of the first bracket is zero or negative:

$$\Delta T = \frac{3575}{t_g^{4/5} H^{3/5}} \left[\frac{t / \left(t_g^{2/5} H^{4/5} \right) - 0.442 \left(1 + r / H \right)}{1 + 1.65 r / H} \right]^{4/3} \quad \textbf{[9.2.5.4.3]}$$

where:
T = temperature (C)
t_g = fire growth time (s)
H = ceiling height above the base of the fire (m)
r = radius from fire axis (m)

9.2.5.4.3.1* The temperature rise for activation shall be based on dedicated tests, or the equivalent, for the combustibles associated with the occupancy and the detector model to be installed.

9.2.5.4.3.2 Where the data described in 9.2.5.4.3.1 are not available, a minimum temperature rise of 20°C (68°F) shall be used.

9.2.5.4.4 Detection Computer Programs.

9.2.5.4.4.1* As an alternate to the calculations specified in 9.2.5.4.2, DETACT-T2 shall be permitted to be used to calculate detection times in continuous-growth and *t*-squared fires.

9.2.5.4.4.2* As an alternative to the calculations specified in 9.2.5.4.2, DETACT-QS shall be permitted to be used to calculate detection times in fires of any fire growth history.

9.2.5.4.4.3 Other computer programs determined to calculate detection times reliably shall be permitted to be used when approved by the AHJ.

9.3 Models.

9.3.1 Vents, other than vent systems designed in accordance with Section 9.2, shall be sized and actuated to meet design objectives in accordance with Section 9.3.

9.3.2 The computer model LAVENT or other approved mathematical models shall be used to assess the effects of the design fire and to establish that a proposed vent system design meets design objectives. *(See Section F.2.)*

9.3.3 When models other than LAVENT are used, evidence shall be submitted to demonstrate efficacy of the model to evaluate the time-varying events of a fire and to calculate the effect of vent designs reliably in terms of the design objectives.

9.3.4 The design fire used in the evaluation of a proposed vent system design in accordance with Section 9.3 shall be determined in accordance with Chapter 8.

Chapter 10 Mechanical Smoke Exhaust Systems

10.1* General.

10.1.1* Mechanical smoke exhaust systems shall be permitted in lieu of the vent systems described in Chapter 9.

10.1.2 Mechanical smoke exhaust systems and vent systems shall not serve the same curtained area.

10.1.3 Mechanical smoke exhaust systems shall be designed in accordance with Sections 10.2 through 10.4.

10.2 Exhaust Rates. Exhaust rates per curtained area shall be not less than the mass plume flow rates, $\dot{m}_p$, as determined in accordance with 9.2.3, unless it can be demonstrated that a lower exhaust rate will prevent the smoke from descending below the design level of the smoke layer boundary during the design period.

10.3 Fire Exposure.

10.3.1 Mechanical smoke exhaust systems shall be capable of functioning under the expected fire exposure.

10.3.2 The temperature of the smoke layer shall be determined in accordance with 9.2.4.3 and 9.2.4.4.

10.4* Number of Exhaust Inlets.

10.4.1 The minimum number of exhaust inlets shall be determined so that the maximum flow rates for exhaust without plugholing are not exceeded.

10.4.2 More than the minimum number of exhaust inlets required shall be permitted.

10.4.3* The maximum volumetric flow rate that can be exhausted by a single exhaust inlet without plugholing shall be calculated using Equation 10.4.3.

$$V_{max} = 4.16\gamma d^{5/2}\left(\frac{T_s - T_o}{T_o}\right)^{1/2} \quad \textbf{[10.4.3]}$$

where:

V_{max} = maximum volumetric flow rate without plugholing at T_s (m^3/sec)
γ = exhaust location factor (dimensionless)
d = depth of smoke layer below the lowest point of the exhaust inlet (m)
T_s = absolute temperature of the smoke layer (K)
T_o = absolute ambient temperature (K)

10.4.4* For exhaust inlets centered no closer than twice the diameter from the nearest wall, a value of 1 shall be used for γ.

10.4.5* For exhaust inlets centered less than twice the diameter from the nearest wall, a value of 0.5 shall be used for γ.

10.4.6* For exhaust inlets on a wall, a value of 0.5 shall be used for γ.

10.4.7* The ratio d/D_i shall be greater than 2, where D_i is the diameter of the inlet.

10.4.8 For rectangular exhaust inlets, D_i shall be calculated using Equation 10.4.8 as follows:

$$D_i = \frac{2ab}{a+b} \quad \textbf{[10.4.8]}$$

where:

D_i = diameter of exhaust inlet
a = length of the inlet
b = width of the inlet

10.4.9 Where multiple exhaust inlets are required to prevent plugholing *(see 10.4.1)*, the minimum separation distance shall be calculated using Equation 10.4.9 as follows:

$$S_{min} = 0.9V_e^{1/2} \quad \textbf{[10.4.9]}$$

where:

S_{min} = minimum edge-to-edge separation between inlets (m)
V_e = volumetric flow rate of one exhaust inlet (m^3/s)

10.5 Intake Air. Intake air shall be provided to make up air required to be exhausted by the mechanical smoke exhaust systems. *(See Chapter 6 for additional information on the location of air inlets.)*

Chapter 11 Venting in Sprinklered Buildings

11.1* Design. Where provided, the design of venting for sprinklered buildings shall be based on an engineering analysis acceptable to the AHJ, demonstrating that the established objectives are met. *(See Section F.3.)*

11.2* Automatic Sprinkler Systems. The automatic sprinkler system shall be designed in accordance with NFPA 13.

11.3* Storage Occupancies Protected by Control Mode Sprinklers.

11.3.1 Where draft curtains are provided, they shall be located over the longitudinal center of an aisle.

11.3.2 The aisle width shall not be less than 1.5 times the spacing between sprinklers in the direction perpendicular to the draft curtain.

11.3.3 Sprinklers shall be located on both sides of the curtain per NFPA 13 requirements for sprinkler placement with respect to walls.

11.3.4 The aisle width required by 11.3.2 shall not be required if a full height partition is used in lieu of a draft curtain.

Chapter 12 Inspection and Maintenance

12.1* General. Smoke and heat venting systems and mechanical smoke exhaust systems shall be inspected and maintained in accordance with Chapter 12.

12.2* Requirements.

12.2.1 Mechanically Opened Vents. Mechanically opened vents shall be provided with manual release devices that allow direct activation to facilitate inspection, maintenance, and replacement of actuation components.

12.2.2 Thermoplastic Drop-Out Vents. Thermoplastic drop-out vents do not allow nondestructive operation; however, inspection of installed units shall be conducted to ensure that the units are installed in accordance with the manufacturer's instructions and that all components are in place, undamaged, and free of soiling, debris, and extraneous items that might interfere with the operation and function of the unit.

12.2.3 Inspection and Maintenance. The inspection and maintenance of multiple-function vents shall ensure that other functions do not impair the intended fire protection operation.

12.3 Inspection, Maintenance, and Acceptance Testing.

12.3.1 Inspection Schedules.

12.3.1.1 A written inspection schedule and procedures for inspection and maintenance shall be developed.

12.3.1.2 Inspection programs shall provide written notations of the date and time of inspections and of discrepancies found.

12.3.1.3 All deficiencies shall be corrected immediately.

12.3.1.4* Vents shall be inspected and maintained in an operating condition in accordance with Chapter 12.

12.3.2 Mechanically Opened Vents.

12.3.2.1 An acceptance performance test and inspection of all mechanically opened vents shall be conducted immediately following installation to establish that all operating mechanisms function properly and that installation is in accordance with this standard and the manufacturer's specifications.

12.3.2.2* Mechanically opened vents shall be inspected and subjected to an operational test annually, following the manufacturer's recommendations.

12.3.2.3* All pertinent characteristics of performance shall be recorded.

12.3.2.4 Special mechanisms, such as gas cylinders, thermal sensors, or detectors, shall be checked annually or as specified by the manufacturer.

12.3.3 Thermoplastic Drop-Out Vents.

12.3.3.1* An acceptance inspection of all thermoplastic drop-out vents shall be conducted immediately after installation and shall include verification of compliance with the manufacturer's drawings and recommendations by visual examination.

12.3.3.2* Thermoplastic drop-out vents shall be inspected annually in accordance with 12.4.2 and the manufacturer's recommendations.

12.3.3.3 Changes in appearance, damage to any components, fastening security, weather tightness, and the adjacent roof and flashing condition shall be noted at the time of inspection, and any deficiency shall be corrected.

12.3.3.4 Any soiling, debris, or encumbrances that could impair the operation of the vent shall be promptly removed without causing damage to the vent.

12.3.4 Inlet Air Sources. Where required for the operation of vent systems, intake air sources shall be inspected at the same frequency as vents.

12.4 Conduct and Observation of Operational Tests.

12.4.1 Mechanically Opened Vents and Air Inlets.

12.4.1.1 Mechanically opened vents and air inlets shall be operated during tests by simulating actual fire conditions.

12.4.1.2 The restraining cable at the heat-responsive device (or other releasing device) shall be disconnected, releasing the restraint and allowing the trigger or latching mechanism to operate.

12.4.1.3* When the heat-responsive device restraining cable for mechanically opened vents or air inlets is under tension, observation shall be made of its whip and travel path to determine any possibility that the vent, building construction feature, or service piping could obstruct complete release. Any interference shall be corrected by removal of the obstruction, enclosure of cable in a suitable conduit, or other appropriate arrangement.

12.4.1.4 Following any modification, the unit shall be retested for evaluation of adequacy of corrective measures.

12.4.1.5 Latches shall release smoothly and the vent or air inlet shall open immediately and move through its design travel to the fully opened position without any assistance and without any problems such as undue delay indicative of a sticking weather seal, corroded or unaligned bearings, or distortion binding.

12.4.1.6 Manual releases shall be tested to verify that the vents and air inlets operate as designed.

12.4.1.7 All operating levers, latches, hinges, and weather-sealed surfaces shall be examined to determine conditions, such as deterioration and accumulation of foreign material. An operational test shall be conducted after corrections are completed, when conditions are found to warrant corrective action.

12.4.1.8 Following painting of the interior or exterior of vents and air inlets or the addition of sealants or caulking, the units shall be opened and inspected to check for paint, sealants, or caulking that causes the parting surfaces to adhere to each other.

12.4.1.9 Heat-responsive devices coated with paint or other substances that could affect their response shall be replaced with devices having an equivalent temperature and load rating.

12.4.2 Thermoplastic Drop-Out Vents.

12.4.2.1 All weather-sealed surfaces on thermoplastic drop-out vents shall be examined to determine any adverse conditions, such as any indication of deterioration and accumulation of foreign material. Any adverse condition that interferes with normal vent operation, such as caulking or sealant bonding the drop-out vent to the frame, shall be corrected.

12.4.2.2 Following painting of the interior or exterior of the frame or flashing of the vents, the units shall be inspected for paint adhering surfaces together; any paint that interferes with normal operation shall be removed or the vent shall be replaced with a new, listed and labeled unit having comparable operating characteristics.

12.4.2.3 Manual releases shall be tested annually.

12.4.3 Inspection, Maintenance, and Testing of Mechanical Smoke-Exhaust Systems.

12.4.3.1 Component Testing.

12.4.3.1.1 The operational testing of each individual system component of the mechanical smoke-exhaust system shall be performed as each component is completed during construction.

12.4.3.1.2 It shall be documented in writing that each individual system component's installation is complete and that the component has been tested and found to be functional.

12.4.3.2 Acceptance Testing.

12.4.3.2.1 Acceptance tests shall be conducted to demonstrate that the mechanical smoke-exhaust system installation complies with and meets the design objectives and is functioning as designed.

12.4.3.2.2 Documentation from component system testing shall be available for review during final acceptance testing.

12.4.3.2.3 If standby power has been provided for the operation of the mechanical smoke-exhaust system, the acceptance testing shall be conducted while on both normal and standby power.

12.4.3.2.4 Acceptance testing shall be performed on the mechanical smoke-exhaust system by completing the following steps:

(1) Activate the mechanical smoke-exhaust system.
(2) Verify and record the operation of all fans, dampers, doors, and related equipment.

(3) Measure fan exhaust capacities, air velocities through inlet doors and grilles, or at supply grilles if there is a mechanical makeup air system.

12.4.3.2.5 Operational tests shall be performed on the applicable part of the smoke-exhaust system wherever there are system changes and modifications.

12.4.3.2.6 Upon completion of acceptance testing, a copy of all operational testing documentation shall be provided to the owner and shall be maintained and made available for review by the AHJ.

12.4.3.3 Periodic Testing.

12.4.3.3.1 Mechanical smoke-exhaust systems shall be tested semiannually by persons who are knowledgeable in the operation, testing, and maintenance of the systems.

12.4.3.3.2 The results of the tests shall be documented and made available for inspection.

12.4.3.3.3 Tests shall be conducted under standby power where applicable.

12.4.3.4 Exhaust System Maintenance.

12.4.3.4.1 During the life of the building, maintenance shall be performed to ensure that mechanical smoke-exhaust systems will perform their intended function under fire conditions.

12.4.3.4.2 Maintenance of the systems shall include the testing of all equipment, including initiating devices, fans, dampers, and controls.

12.4.3.4.3 Equipment shall be maintained in accordance with the manufacturer's recommendations.

12.4.3.5 Inspection Schedule.

12.4.3.5.1 A written inspection schedule and procedures for inspection and maintenance for mechanical smoke-exhaust systems shall be developed.

12.4.3.5.2 Inspection programs shall provide written notations of date and time of inspections and for discrepancies found.

12.4.3.5.3 All system components shall be inspected semiannually in conjunction with operational tests.

12.4.3.5.4 Any deficiencies noted in the system components or smoke-exhaust system performance shall be corrected immediately.

12.5 Air Inlets.

12.5.1 Air inlets necessary for operation of smoke and heat vents or mechanical smoke-exhaust systems shall be maintained clear and free of obstructions.

12.5.2 Operating air inlet louvers, doors, dampers, and shutters shall be examined and operated to assure movement to fully open positions.

12.5.3 Operating equipment shall be maintained and lubricated as necessary.

12.6 Ice and Snow Removal. Ice and snow shall be removed from vents promptly, following any accumulation.

Chapter 13 Design Documentation

13.1* Documentation Required. All of the following documents shall be generated by the designer during the design process:

(1) Design brief
(2) Conceptual design report
(3) Detailed design report
(4) Operations and maintenance manual

13.1.1 Design Brief. The design brief shall contain a statement of the goals and objectives of the vent system and shall provide the design assumptions to be used in the conceptual design.

13.1.1.1 The design brief shall include, as a minimum, all of the following:

(1) System performance goals and design objectives *(see Section 4.1 and 4.4.1)*
(2) Performance criteria (including design tenability criteria, where applicable)
(3) Building characteristics (height, area, layout, use, ambient conditions, other fire protection systems)
(4) Design basis fire(s) *(see 4.5.2 and Chapter 8)*
(5) Design fire location(s)
(6) Identified design constraints
(7) Proposed design approach

13.1.1.2 The design brief shall be developed in the first stage of the design process to assure that all stakeholders understand and agree to the goals, objectives, design fire, and design approach, so that the conceptual design can be developed on an agreed-upon basis. Stakeholders shall include, as a minimum, the building owner and the AHJ.

13.1.2 Conceptual Design Report. The conceptual design report shall provide the details of the conceptual design, based upon the design brief, and shall document the design calculations.

13.1.2.1 The conceptual design shall include, as a minimum, all of the following design elements and the technical basis for the design elements:

(1) Areas of curtained spaces
(2) Design depth of the smoke layer and draft curtain depth
(3) Detection method, detector characteristics, and spacing
(4) Design interval time (if applicable)
(5) Vent size and number per curtained area, method of vent operation, and vent spacing
(6) Inlet vent area(s), location(s), and operation method

13.1.2.2 The conceptual design report shall include all design calculations performed to establish the design elements, all design assumptions, and all building use limitations that arise out of the system design.

13.1.3 Detailed Design Report.

13.1.3.1 The detailed design report shall provide documentation of the vent system as it is to be installed.

13.1.3.2 The detailed design report shall include, as a minimum, all of the following:

(1) Vent and draft curtain specifications
(2) Inlet and vent operation system specifications

(3) Detection system specifications
(4) Detailed inlet, vent, and draft curtain siting information
(5) Detection and vent operation logic
(6) Systems commissioning procedures

13.1.4 Operations and Maintenance Manual. The operations and maintenance manual shall provide to the building owner the requirements to ensure the intended operation of the vent system over the life of the building.

13.1.4.1 The procedures used in the initial commissioning of the vent system shall be described in the manual, as well as the measured performance of the system at the time of commissioning.

13.1.4.2 The manual shall describe the testing and inspection requirements for the system and system components and the required frequency of testing. *(See Chapter 12 for testing frequency.)*

13.1.4.3 The manual shall describe the critical design assumptions used in the design and shall provide limitations on the building and its use that arise out of the design assumptions and limitations.

13.1.4.4 Copies of the operations and maintenance manual shall be provided to the owner and to the AHJ.

13.1.4.5 The building owner shall be responsible for all system testing and shall maintain records of all periodic testing and maintenance using the operations and maintenance manual.

13.1.4.6 The building owner shall be responsible for providing a copy of the operations and maintenance manual, including testing results, to all tenants of the space protected by the vent system.

13.1.4.7 The building owner and tenants shall be responsible for limiting the use of the space in a manner consistent with the limitations provided in the operations and maintenance manual.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1.1 This standard incorporates engineering equations (hand calculations) and references models to provide a designer with the tools to develop vent system designs. The designs are based on selected design objectives, stated in 4.4.1, related to specific building and occupancy conditions. Engineering equations are included for calculating vent flows, smoke layer depths, and smoke layer temperatures, based on a prescribed burning rate. Examples using the hand calculations and the LAVENT (Link-Actuated VENTs) computer model are presented in Annex D.

Previous editions of this document have included tables listing vent areas based on preselected design objectives. These tables were based on the hot upper layer at 20 percent of the ceiling height. Different layer depths were accommodated by using a multiplication factor. Draft curtain and vent spacing rules were set. Minimum clear visibility times were related to fire growth rate, ceiling height, compartment size, curtain depth, and detector activation times, using engineering equations.

The following list provides a general description of the significant phenomena that occur during a fire when a fire-venting strategy is implemented:

(1) Due to buoyancy, hot gases rise vertically from the combustion zone and flow horizontally below the roof until blocked by a vertical barrier (a wall or draft curtain), thus forming a layer of hot gases below the roof.
(2) The volume and temperature of gases to be vented are a function of the fire's rate of heat release and the amount of air entrained into the buoyant plume produced.
(3) As the depth of the layer of hot gases increases, the layer temperature continues to rise and the vents open.
(4) The operation of vents within a curtained area enables some of the upper layer of hot gases to escape and thus slows the thickening rate of the layer of hot gases. With sufficient venting area, the thickening rate of the layer can be arrested and even reversed. The rate of discharge through a vent of a given area is primarily determined by the depth of the layer of hot gases and the layer temperature. Adequate quantities of replacement inlet air from air inlets located below the hot upper layer are needed if the products of combustion-laden upper gases are to be exhausted according to design. See Figure A.1.1.1(a) for an illustration of the behavior of fire under a vented and curtained roof, and Figure A.1.1.1(b) for an example of a roof with vents.

The majority of the information provided in this standard applies to nonsprinklered buildings. A limited amount of guidance is provided in Chapter 11 for sprinklered buildings.

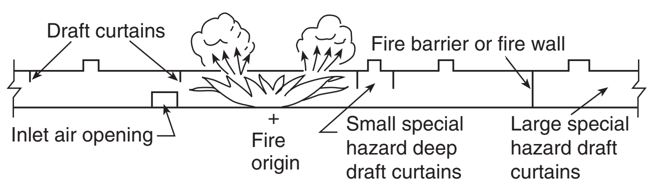

FIGURE A.1.1.1(a) Behavior of Combustion Products Under Vented and Curtained Roof.

FIGURE A.1.1.1(b) View of Roof Vents on Building.

The provisions of this standard can be applied to the top story of multiple-story buildings. Many features of these provisions would be difficult or impracticable to incorporate into the lower stories of such buildings.

A.1.1.2 The decision whether to provide venting in a building depends on design objectives set by a building owner or occupant or on local building code and fire code requirements.

A.1.3.1 See NFPA 90A for ventilation to regulate environmental air for personnel comfort. See NFPA 96 for regulation of commercial cooking operations. See NFPA 68 for venting for explosion pressure relief.

A.1.3.4 The distance from the fire base to the smoke layer boundary, z_s, is a dominant variable and should be considered carefully. Additionally, some design situations can result in smoke layer temperatures, as expressed in Equation 9.2.4.3, that exceed 600°C (1112°F). In such cases, the radiation from the smoke layer can be sufficient to ignite all of the combustibles under the curtained area at this temperature, and perhaps in the adjacent area, which is unacceptable.

A.1.3.5 The feasibility of roof venting should be questioned when the heat release rate approaches values associated with ventilation control of the burning process (i.e., where the fire becomes controlled by the inlet air replacing the vented hot gas and smoke). Ventilation-controlled fires might be unable to support a clear layer.

To maintain a clear layer, venting at heat release rates greater than $Q_{feasible}$ necessitates vent areas larger than those indicated by the calculation scheme provided in this standard.

A.1.3.6 Large, undivided floor areas present extremely difficult fire-fighting problems because the fire department might need to enter these areas in order to combat fires in central portions of the building. If the fire department is unable to enter because of the accumulation of heat and smoke, fire-fighting efforts might be reduced to an application of hose streams to perimeter areas while fire continues in the interior. Windowless buildings also present similar fire-fighting problems. One fire protection tool that can be a valuable asset for fire-fighting operations in such buildings is smoke and heat venting.

An appropriate design time facilitates such activities as locating the fire, appraising the fire severity and its extent, evacuating the building, and making an informed decision on the deployment of personnel and equipment to be used for fire fighting.

A.2.1 Some of these documents might also be referenced in this standard for specific informational purposes and are therefore also listed in Annex G.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.3 Clear Layer Interface. See Figure A.3.3.3 for a description of the smoke layer interface, smoke layer, and first indication of smoke.

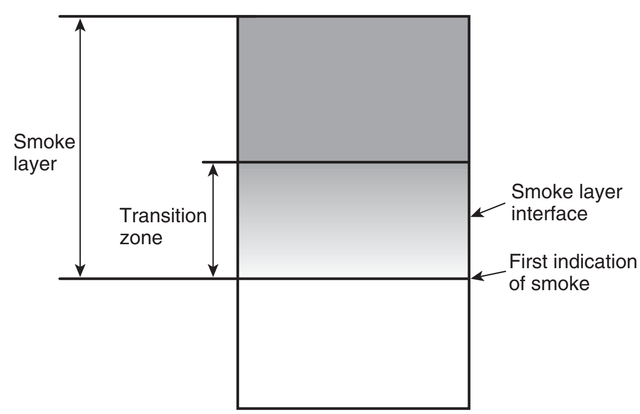

FIGURE A.3.3.3 First Indication of Smoke.

A.3.3.9 Draft Curtain. A draft curtain can be a solid fixed obstruction such as a beam, girder, soffit, or similar material. Alternately, a deployable barrier can be used that descends to a fixed depth during its operation.

A.3.3.10 Effective Ignition. See Figure 8.3.1 for a conceptual illustration of continuous fire growth and effective ignition time.

A.3.3.18 Smoke Layer. See Figure A.3.3.3 for a description of the clear layer interface, smoke layer, and smoke layer boundary.

A.3.3.19 Smoke Layer Boundary. See Figure A.3.3.3 for a description of the clear layer interface, smoke layer, and smoke layer boundary.

A.4.1 Design objectives for a vent system can include one or more of the following goals:

(1) To provide occupants with a safe path of travel to a safe area
(2) To facilitate manual fire fighting
(3) To reduce the damage to buildings and contents due to smoke and hot gases

A.4.2 Tests and studies provide a basis for the division of occupancies into classes, depending on the fuel available for contribution to fire. Wide variation is found in the quantities of combustible materials in the many kinds of buildings and areas of buildings.

A.4.4.2 The heat release rate of a fire, the fire diameter, and the height of the clear layer above the base of the fire are major factors affecting the production of smoke.

A.4.4.3 Mass flow through a vent is governed mainly by the vent area and the depth of the smoke layer and its temperature. Venting becomes more effective with smoke temperature differentials between ambient temperature and an upper layer of approximately 110°C (230°F) or higher. Where temperature differences of less than 110°C (230°F)are expected, vent flows might be reduced significantly; therefore, consideration should be given to using powered exhaust. NFPA 92 should be consulted for guidance for power venting at these lower temperatures.

The vent designs in this standard allow the fire to reach a size such that the flame plume enters the smoke layer. Flame height may be estimated using Equation 9.2.3.1.

A.4.5.1 The rate of smoke production depends on the rate of air entrainment into a column of hot gases produced by and located above a fire. Entrainment is affected by the fire diameter and rate of heat release, and it is strongly affected by the distance between the base of the fire and the point at which the smoke plume enters the smoke layer.

A.4.5.2 Because smoke production is related to the size of a fire, it follows that, all factors being equal, larger fires produce more smoke. Entrainment, however, is strongly affected by the distance between the base of a fire and the bottom of the hot layer. The base of the fire (where combustion and entrainment begin) should be selected on the basis of the worst case. It is possible for a smaller fire having a base near the floor to produce more smoke than a larger fire with a base at a higher elevation. Air entrainment is assumed to be limited to the clear height between the base of the fire and the bottom of the hot layer. The buoyant plume associated with a fire produces a flow into the hot upper layer. As the plume impinges on the ceiling, the plume turns and forms a ceiling jet. The ceiling jet flows radially outward along the ceiling.

A.4.5.3 Where the possibility of multiple fires and, therefore, multiple plumes exists, smoke production rates increase beyond the rate predicted for a single plume for a fire of equivalent output. Multiple fires are beyond the scope of this standard.

A.4.5.3.2 Plume mass flow above the flame level is based on the concept that, except for absolute scales, the shapes of velocity and temperature profiles at the mean flame height are invariable. This concept leads to an expression for mass flow above the flames that involves the so-called *virtual origin*, a point source from which the plume above the flames appears to originate. The virtual origin might be above or below the base of the fire.

A.4.6.1 It is assumed that openings exist to the outside and therefore no pressure results from the expansion of gases. Also, wind effects are not taken into account because wind might assist or interfere with vent flows, depending on specific circumstances. It is also assumed that the fire environment in a building space is divided into two zones — a hot upper layer and a relatively cool, clear (comparatively free of smoke) lower region. When a fire grows to a size approaching ventilation-limited burning, the building might no longer maintain a clear lower region, and this standard would no longer be applicable. Finally, caution must be exercised when using this standard for conditions under which the upper-gas-layer temperature approaches 600°C (1112°F), because flashover might occur within the area. When a fire develops to flashover or ventilation-limited burning, the relationships provided in this standard are not applicable.

Buoyancy pressure is related to the depth of the hot layer, the absolute temperature of the hot layer, the temperature rise above ambient of the hot layer, and the density of the ambient air. The mass rate of flow of hot gases through a vent is a function of vent area, layer depth, and hot layer temperature. The temperature of the hot layer above ambient affects mass flow through a vent. Maximum flow occurs at temperature differences of approximately 300°C (572°F)above ambient. Flows at other temperature differentials are diminished, as shown in Figure A.4.6.1.

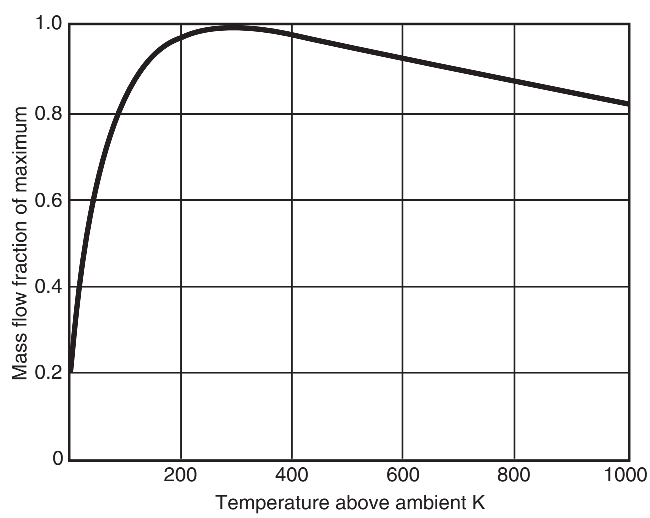

FIGURE A.4.6.1 Effect of Temperature on Mass Flow Through a Vent.

A.4.6.1.2 In order to provide a design that is not dependent on beneficial wind effects, design calculations are carried out that ignore wind effects and that are based only on buoyancy effects (and fan assistance for mechanical systems).

Nevertheless, it is important to consider wind effects since adverse wind effects can reduce or even reverse vent flow. Exhaust vents and air inlets should be located so that under any wind conditions there is an overall wind suction effect from inlet to exhaust.

This is normally achieved when the roof slope is 30 degrees or less and vents have a horizontal clear space at least three times the height difference from any taller structures such as parapets, roof lights, or taller roofs.

Otherwise, if the designer cannot show by calculation or by data that there will be no adverse wind effects, a mechanical smoke extract system should be used.

A.4.6.2 To function as intended, a building venting system needs sufficiently large fresh air inlet openings at low levels. It is essential that a dependable means for admitting or supplying inlet air be provided promptly after the first vent opens.

A.5.1 There is an ISO standard for vents (ISO DIS 21927-2, *Specification for natural smoke and heat exhaust ventilators*). The ISO standard is technically equivalent to European (EN) standards for these products. Products that carry the CE mark, which is mandatory for sale of these products within the European Union, are subject to independent testing and ongoing factory production control by Notified Bodies appointed by national governments. The standard is EN 12101-2, *Specification for natural smoke and heat exhaust ventilators.*

A.5.2.1 Compatibility between the vent-mounting elements (e.g., holding power, electrochemical interaction, wind lift, building movement) and the building structure to which they are attached needs to be ensured.

A.5.2.2 To avoid inadvertent operation, it is important that the actuating means be selected with regard to the full range of expected ambient conditions.

A.5.2.3 Dip tanks or discrete solvent storage areas are examples of localized hazards where the vents are to be located directly above such hazard.

A.5.3.1 An automatic mechanism for opening the roof vents is stipulated for effective release of heat, smoke, and gaseous by-products. The means of automatic vent actuation must take the anticipated fire into consideration, and an appropriate means of opening vents should be used. If design objectives cannot be met using heat-actuated devices, smoke detectors with appropriate linkages to open vents or other devices that respond more quickly should be considered for use.

A.5.3.2 Latching mechanisms should be jam-proof, corrosion-resistant, dust-resistant, and resistant to pressure differences arising from applicable positive or negative loading resulting from environmental conditions, process operations, overhead doors, or traffic vibrations.

A.5.3.5 The location of the manual device must be coordinated with tactics of the reporting fire department.

If not actually mounted on the vent, the manual device can be connected to the vent by mechanical, electrical, or any other suitable means, protected as necessary to remain operable for the design period.

A.5.4.1.2 See Figure 5.4.2(b) for the measurement of ceiling height and curtain board depth.

A.5.4.2 The spacing of vents is limited to 4*H* to assure that ceiling jet temperatures at the vent are sufficiently high to operate the thermal actuating mechanism at the vent. The spacing limit specified is designed to achieve ceiling jet temperature above ambient at the nearest vent, not less than half the plume temperature above ambient at the point of plume impact on the ceiling. (See Figure A.5.4.2, which reflects the maximum allowable spacing of 4*H*.)

A.5.4.3 The limitation on horizontal distance from a potential fire axis adjacent to a draft curtain or wall is intended to assure ceiling jet temperatures at the vent are sufficiently high to activate the thermal actuating mechanism. The spacing limit specified is designed to achieve ceiling jet temperature above ambient at the nearest vent, not less than half the plume temperature above ambient at the point of plume impact on the ceiling. *(See Figure A.5.4.3.)* This requirement does not reflect the potential for reduced entrainment for a fire adjacent to a wall. This conservatism was knowingly accepted.

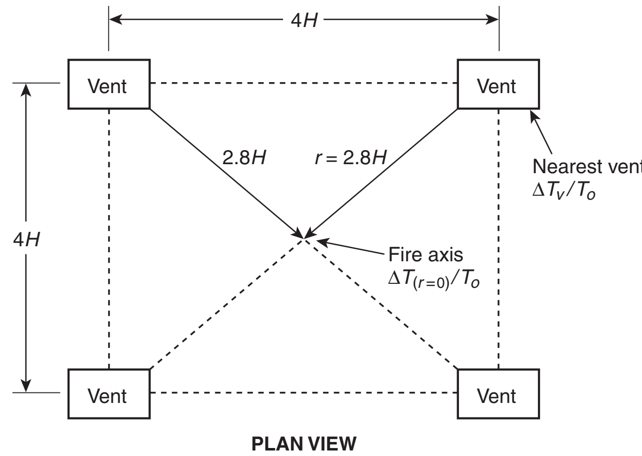

FIGURE A.5.4.2 Vent Spacing in Rectangular Matrix, When $r = 2.8H$, $(\Delta T_v/T_o) = 0.5\ (\Delta T(r = 0)/T_o)$ (plan view).

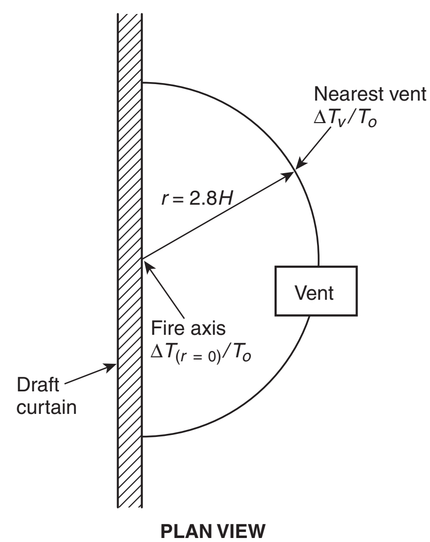

FIGURE A.5.4.3 Vent Spacing near a Draft Curtain, When $r = 2.8H$, $(\Delta T_v/T_o) = 0.5\ (\Delta T(r = 0/T_o)$ (plan view).

A.6.1 The simplest method of introducing makeup air into the space is through direct openings to the outside, such as doors and louvers, which can be opened upon system activation. Such openings can be coordinated with the architectural design and can be located as required below the design smoke layer. For locations having mechanical smoke exhaust systems where such openings are impractical, a powered supply system could be considered. This could possibly be an adaptation of the building's HVAC system if capacities, outlet grille locations, and velocities are suitable. For such systems, means should be provided to prevent supply systems from operating until exhaust flow has been established, to avoid pressurization of the fire area. For those locations where climates are such that the damage to the space or contents could be extensive during testing or frequent inadvertent operation of the system, consideration should be given to heating the makeup air. See NFPA 92 for additional information on mechanical systems.

A.6.3 Normal practice has been to provide air inlet from low-level air inlets as recommended in previous editions of this standard. In some buildings this may be difficult to achieve, due either to lack of suitable clear wall area or to concerns about loss of security when the air inlets open. In buildings containing more than one curtained area, it can be possible to open vents in curtained areas not affected by smoke to provide inlet air instead. If this is done, then the vents must meet all the requirements of Chapter 6.

A.6.6.3 The inlet air velocity should be limited for three reasons: (1) to avoid disturbing the fire plume and causing excess air entrainment, (2) to limit the degree of depressurization of the space and consequent effects on door opening and closing, and (3) to avoid incoming air hampering escape of occupants.

NFPA 92 sets a limit of 1.02 m/s (200 ft/min) to minimize disturbance of the plume, which will create more entrainment than anticipated.

Excess depressurization of the space will increase door opening forces for outward-opening doors and risk slamming closed for inward-opening doors. Neither situation is acceptable.

Research indicates that people can move reasonably freely against an airflow of up to 10 m/s (32.8 ft/s).

A.7.1 Draft curtains are provided for prompt activation of vents and to increase vent effectiveness by containing the smoke in the curtained area and increasing the depth of the smoke layer. A draft curtain is intended to be relatively smoke-tight. The function of a draft curtain is to intercept the ceiling jet and the entrained smoke produced by a fire in the building. The curtain should prevent the smoke from spreading along the underside of the roof deck to areas of the building located beyond the draft curtain and should create a hot smoke layer that develops buoyancy forces sufficient to exhaust the smoke through the vent openings in the roof. A full-height partition or wall, including an exterior wall, can serve as a draft curtain.

A.7.2 Materials suitable for use as draft curtains can include steel sheeting, cementitious panels, and gypsum board or any materials that meet the performance criteria in Section 7.2. There is an ISO standard for draft curtains (ISO DIS 21927-1, *Specification for smoke barriers*). The ISO standard is technically equivalent to the European (EN) standard for these products. Products that carry the CE mark, which is mandatory for sale of these products within the European Union, are subject to independent testing and ongoing factory production control by Notified Bodies appointed by national governments. The standard is EN 12101-1, *Specification for smoke barriers*.

A.7.3.1 If d_c exceeds 20 percent of H, $H–d_c$ should be not less than 3 m (9.8 ft). For Figure 5.4.2(b), parts (a) through (d), this concept is valid where $\Delta d/d_c$ is much less than 1.

Consideration should be given to minimizing of the expected smoke layer depth with respect to the occupancy. Such arrangement can allow the smoke layer to be maintained above the top of equipment or storage, thus maximizing visibility and reducing nonthermal damage to contents. For buildings of limited height, it can also allow the designer to utilize the primary structural frame to act as a draft curtain (if solid-webbed) or support one (if open-webbed), thus reducing costs.

Also, in a transient situation, prior to achieving equilibrium mass flow, if the smoke layer extends below the top of equipment or storage, that volume displaced by equipment or storage should be subtracted from available space for the smoke layer to accumulate, or the smoke layer depth will extend below that estimated.

A.7.4.1 To ensure that vents remote from the fire within the curtained compartment are effective, the distance between draft curtains or between walls must be limited.

A.7.4.2 From reanalysis of this issue based on Delichatsios [1981], Heskestad and Delichatsios [1978], and Koslowski and Motevalli [1994].

A.8.1 Chapter 8 presents techniques for predicting the heat release rate of various fuel arrays likely to be present in buildings where smoke and heat venting is a potential fire safety provision. It primarily addresses the estimation of fuel concentrations found in storage and manufacturing locations. NFPA 92 addresses the types of fuel arrays more common to the types of building situations covered by that document. The methods provided in Chapter 8 for predicting the rate of heat release are based on "free burning" conditions, in which no ceiling or smoke layer effects are involved.

A.8.2.2 The minimum aisle width to prevent lateral spread by radiation, W_{min} in Equation 8.2.3, is based on Alpert and Ward [1984]. The values produced by Equation 8.2.3 can be produced from the following equation if χ_r is assumed to be 0.5:

$$\dot{q}''_i = \frac{\chi_r}{4\pi r^2} \quad \textbf{[A.8.2.2]}$$

A.8.2.6 The heat release rate is taken as the heat release rate per unit area times the floor area of the fuel concentration. The maximum foreseeable storage height (above the fire base) and associated heat release rate should be considered.

The heat release rate per unit area might be available from listings for a given storage height, such as Table A.8.2.6. To establish estimates for other than specified heights, it can be assumed that the heat release rate per unit area is proportional to the storage height, based on tests (Yu and Stavrianidis, 1991) and the data in Table A.8.2.6 for wood pallets. For fuel configurations that have not been tested, other procedures should be used. See Annex E for estimating heat release rates of other fuel arrays.

There is a distinct possibility that a combustible storage array could collapse before the end of the design interval of the venting system. The design interval might end, for example, when manual fire fighting is expected to begin. The fire diameter increases, contributing to increased smoke production (via a lower flame height and virtual origin). However, the heat release rate and fire growth rate after collapse are likely to be smaller than with no collapse. Consequently, it is reasonable to assume that the net effect of collapse is not significant for the calculation procedure.

Table A.8.2.6 Unit Heat Release Rates for Commodities

Commodity	Heat Release Rate (kW per m² of floor area)*
Wood pallets, stacked 0.46 m high (6%–12% moisture)	1,420
Wood pallets, stacked 1.52 m high (6%–12% moisture)	4,000
Wood pallets, stacked 3.05 m high (6%–12% moisture)	6,800
Wood pallets, stacked 4.88 m high (6%–12% moisture)	10,200
Mail bags, filled, stored 1.52 m high	400
Cartons, compartmented, stacked 4.5 m high	1,700
PE letter trays, filled, stacked 1.5 m high on cart	8,500
PE trash barrels in cartons, stacked 4.5 m high	2,000
FRP shower stalls in cartons, stacked 4.6 m high	1,400
PE bottles packed in compartmented cartons, stacked 4.5 m high	6,200
PE bottles in cartons, stacked 4.5 m high	2,000
PU insulation board, rigid foam, stacked 4.6 m high	1,900
PS jars packed in compartmented cartons, stacked 4.5 m high	14,200
PS tubs nested in cartons, stacked 4.2 m high	5,400
PS toy parts in cartons, stacked 4.5 m high	2,000
PS insulation board, rigid foam, stacked 4.2 m high	3,300
PVC bottles packed in compartmented cartons, stacked 4.5 m high	3,400
PP tubs packed in compartmented cartons, stacked 4.5 m high	4,400
PP and PE film in rolls, stacked 4.1 m high	6,200
Methyl alcohol	740
Gasoline	2,500
Kerosene	1,700
Fuel oil, no. 2	1,700

PE: polyethylene. PP: polypropylene. PS: polystyrene. PU: polyurethane. PVC: polyvinyl chloride. FRP: fiberglass-reinforced polyester.

*Heat release rate per unit floor area of fully involved combustibles, based on negligible radiative feedback from the surroundings and 100 percent combustion efficiency.

A.8.3.1 The growth time, t_g, is a measure of the fire growth rate — the smaller the growth time, the faster the fire grows.

A.8.3.2 By comparing Equations 8.3.1 and 8.3.2, the following relation exists:

$$\alpha_g = \frac{1000}{t_g^2} \quad \textbf{[A.8.3.2]}$$

A.8.3.4 Design objectives and the design interval time, t_r, should take into consideration all of the following critical events:

(1) Arrival and deployment of the emergency response team
(2) Arrival and deployment of fire fighters from the public fire department
(3) Completion of evacuation
(4) Other critical events

A.9.1 The procedures in Chapter 9 are based on the automatic activation of vents by a heat-responsive device with an established response time index (RTI) and known activation temperature. These assumptions do not preclude other means of vent activation, as long as the activation time of the alternative means is known or can be calculated using the procedures contained herein or can be established as acceptable by a specific listing, specific test data, or engineering analysis. Activation by heat detectors, smoke detectors, thermoplastic drop-out vent panels, or other approved means is acceptable as long as the design objectives are met.

The equations and procedures for hand calculations in Section 9.2 and the models in Section 9.3 address the venting of limited-growth fires and continuously growing fires.

A.9.1.1 The vent area in a curtained area should not be required to exceed the vent area calculated for the largest limited-growth fire predicted for the combustibles beneath any curtained area. Using sufficiently small concentrations of combustibles and aisles of sufficient width to prevent spread according to Equation 8.2.3, it might be possible to satisfy venting requirements by using vent areas smaller than those required for a vent design and a continuous-growth fire.

A.9.1.4 Many large facilities have buildings or areas subject to differing fire hazards.

A.9.2.2.1 In Figure 9.2.2.1, z_s is the height of the smoke layer boundary above the base of the fire; H is the distance between the base of the fire and the ceiling; d_c is the depth of the draft curtains; d is the depth of the smoke layer; $\dot{m}_p$ is the mass flow rate of hot gas from the fire plume into the smoke layer; $\dot{m}_v$ is the mass flow rate of hot gas out of the vent (or vents) in the curtained area; and A_v is the vent area in the curtained area (total vent area in the curtained area if more than one vent is provided).

The vent area calculated for equilibrium conditions corresponds to the area needed for a long-term steady fire or to the area needed at the end of a design interval for a slow-growing fire. For shorter-term steady fires and for faster-growing fires, the calculated equilibrium vent area will prevent the smoke layer boundary from descending completely to the bottom of the draft curtains. Therefore, equilibrium calculations represent a safety factor in the design.

A.9.2.3.1 The mass flow rate in the plume depends on whether locations above or below the mean flame height are considered (i.e., whether the flames are below the smoke layer boundary or reach into the smoke layer).

A.9.2.4 The calculations in this section assume that the vent is exhausting only smoke from the smoke layer. When the smoke layer is at its design depth, the provisions for avoidance of plugholing in Section 5.4 will ensure that this is so.

However, during part of the time period when the smoke layer is descending to its design height, the vents will extract a mixture of smoke from the smoke layer and the ambient air from below the smoke layer. They will therefore extract less smoke than the calculations indicate, causing the smoke layer to descend at a faster rate.

Existing research has provided formulae to assess at what point a vent starts plugholing, but not to assess the smoke extract rate while a vent is plugholing.

There is therefore no experimentally validated method of assessing the effect of plugholing on the rate of descent of a smoke layer. A method has been published in BS 7346-5, *Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems employing time-dependent design fires.*

A.9.2.4.1 The mass flow rate through the vent is the product of gas density, velocity, and cross-sectional area of the flow in the vent. The velocity follows from equating the buoyancy head across the vent to the dynamic head in the vent, with consideration of the pressure drop across the air inlets. The factor $[(T_o\Delta T)/T^2]^{1/2}$ is quite insensitive to temperature as long as the smoke layer temperature rise, ΔT, is not small. For example, assuming T_o = 294 K, the factor varies through 0.47, 0.50, and 0.47 as the smoke layer temperature rise varies through 150 K, 320 K, and 570 K. At a temperature rise of 60 K, the factor is 0.38, and at a temperature rise of 20 K, it is 0.24, or about one-half its maximum value. Consequently, roof venting by natural ventilation becomes increasingly less effective as the smoke layer temperature decreases. For low smoke layer temperatures, powered ventilation as covered in NFPA 92 should be considered.

Where high upper-layer temperatures of 400 K above ambient are anticipated, 80 percent of the predicted vent flow is expected to be achieved with an inlet area/vent area ratio of 1, whereas it is expected that 90 percent of the vent flow will result from a ratio of 2. Where relatively low upper-layer temperatures, such as 200 K above ambient, are expected, a ratio of inlet air/vent area of 1 would result in about 70 percent of the predicted vent flow, whereas a ratio of 2 would be expected to produce about 90 percent of the predicted vent flow.

A.9.2.4.2 The aerodynamic vent area is always smaller than the geometric vent area, A_v. A discharge coefficient of 0.6 should be reasonable for most vents and for doors and windows that open at least 45 degrees. However, the discharge coefficient can be different for other types of openings. For example, an opening with a louver can have a coefficient ranging between 0.1 and 0.4.

A.9.2.5.4.1 For continuous-growth fires, the earlier the fire is detected and vents actuated, the smaller the fire size at the end of the design interval and the smaller the required vent area. In the case of limited-growth fires, the earlier the fire is detected and the vents actuated, the less likely to occur are an initial underspill of smoke at the draft curtains and smoke layer descent to low heights.

If a design objective is to confine smoke to the curtained area of origin, the time the last required vent opens, t_{vo}, should not exceed the time the smoke layer boundary drops below draft curtains, which can be determined in accordance with Equation A.9.2.5.4.1a for steady fires and Equation A.9.2.5.4.1b for unsteady fires.

$$\frac{z_{si}}{H} = 0.67 - 0.28 \ln\left[\frac{\left(tQ^{1/3}/H^{4/3}\right)}{\left(A_c/H^2\right)}\right] \quad \textbf{[A.9.2.5.4.1a]}$$

$$\frac{z_{si}}{H} = 0.23\left[\frac{t}{t_g^{\,2/5}\left(H^{4/5}\right)\left(A_c/H^2\right)^{3/5}}\right]^{-1.45} \quad \textbf{[A.9.2.5.4.1b]}$$

where:

z_{si} = height of smoke layer interface above the base of the fire
t = time (s)
Q = total heat release rate
H = ceiling height above base of fire
A_c = curtained area being filled with smoke (m^2)

A.9.2.5.4.2.1 The response data in *NFPA 72* assume extensive, flat, horizontal ceilings.

This assumption might appear optimistic for installations involving beamed ceilings. However, any delay in operation due to beams is at least partially offset by the opposite effects of the following:

(1) Heat banking up under the ceiling because of draft curtains or walls
(2) The nearest vent or detector usually being closer to the fire than the assumed, greatest possible distance

Fusible links are commonly used as actuators for mechanically opened heat and smoke vents. Where the response time index (RTI) and fusing temperature of a fusible link are known, and assuming that the link is submerged in the ceiling jet, the relationships described in *NFPA 72* for heat-actuated alarm devices can be used to estimate the opening of a mechanical vent.

A.9.2.5.4.3.1 This requirement does not have a parallel in *NFPA 72*. Temperature rise for activation of smoke detectors depends on the specific detector as well as the material undergoing combustion. Limited data on temperature rise at detection have previously been recorded in the range of 2°C to 42°C, depending on the detector/material combination [Heskestad and Delichatsios, 1977].

A.9.2.5.4.4.1 A computer program known as DETACT-T2 (Detector Actuation — time squared) [Evans and Stroup, 1985] is available for calculating the detection times of heat detectors or fusible links in continuous-growth, *t*-squared fires. DETACT-T2 assumes the detector is located in a large compartment with an unconfined ceiling, where there is no accumulation of hot gases at the ceiling. Thus, heating of the detector is only from the flow of hot gases along the ceiling. Input data consist of ceiling height, time constant or RTI of the detector, operating temperature, distance of the detector from plume centerline, and fire growth rate. The model calculates detection times for smoke detectors *(see 9.2.5.4.3)* based on the predecessor equations. The predecessor equations assume complete combustion of the test fuel used in the experiments used to develop the equations based on the actual heat of combustion:

$$\frac{u}{\left(\Delta T_g/T_o\right)gH^{1/2}} = 0.59\left(\frac{r}{H}\right)^{-0.63} \quad \textbf{[A.9.2.5.4.4.1]}$$

where:

u = gas velocity at detector site
r = radius from fire axis
ΔT_g = gas temperature rise from ambient at detector/sprinkler site
T_o = ambient air temperature
g = acceleration of gravity
H = ceiling height (above combustibles)

However, DETACT-T2 can still be used, provided that the projected fire growth coefficient, α_g, is multiplied by the factor 1.67. In addition, when DETACT-T2 is used, the outputs of heat release rate at detector response from the program calculations must be divided by 1.67 in order to establish heat release rates at detector response.

A.9.2.5.4.4.2 Another program, DETACT-QS (Detector Actuation — quasi-steady) [Evans and Stroup, 1985], is available for calculating detection times of heat detectors, fusible links, and smoke detectors in fires of arbitrary fire growth. DETACT-QS assumes that the detector is located in a large compartment with an unconfined ceiling, where there is no accumulation of hot gases at the ceiling. Thus, heating of the detector is only from the flow of hot gases along the ceiling. Input data consist of ceiling height, time constant or RTI of the detector, operating temperature, distance of the detector from the plume centerline, and fire growth rate. The model calculates detection times for smoke detectors *(see 9.2.5.4.3)* based on the predecessor equations. Quasi-steady temperatures and velocities are assumed (i.e., instantaneously, gas temperatures and velocities under the ceiling are assumed to be related to the heat release rate as in a steady fire). Compared to DETACT-T2, DETACT-QS provides a means of addressing fires that cannot be approximated as *t*-squared fires. However, for *t*-squared fires, DETACT-QS is less accurate than DETACT-T2 (if the projected fire growth coefficient is increased as described in 9.2.5.4.4.1 and A.9.2.5.4.4.1), especially for fast-growing fires.

A.10.1 There is an ISO standard for mechanical smoke extract (ISO DIS 21927-3, *Specification for powered smoke and heat exhaust ventilators*). The ISO standard is technically equivalent to the European (EN) standard for these products. Products that carry the CE mark, which is mandatory for sale of these products within the European Union, are subject to independent testing and ongoing factory production control by Notified Bodies appointed by national governments. The standard is EN 12101-3, *Specification for powered smoke and heat exhaust ventilators.*

A.10.1.1 Where temperature differences of less than 110°C (230°F) are expected, vent flows might be reduced significantly; therefore, consideration should be given to using powered exhaust. NFPA 92 should be consulted for guidance for power venting at these lower temperatures.

A.10.4 The sizing and spacing of exhaust fan intakes should balance the following concerns:

(1) The exhaust intakes need to be sufficiently close to one another to prevent the smoke from cooling to the point that it loses buoyancy as it travels along the underside of the ceiling to an intake and descends from the ceiling. This is particularly important for spaces where the length is greater than the height, such as shopping malls.
(2) The exhaust intakes need to be sized and distributed in the space to minimize the likelihood of air beneath the smoke layer from being drawn through the layer. This phenomenon is called plugholing.

The objective of distributing fan inlets is therefore to establish a gentle and generally uniform rate over the entire smoke layer. To accomplish this, the velocity of the exhaust inlet should not exceed the value determined from Equation A.10.4.

For plugholing calculations, the smoke temperature should be calculated as follows:

$$T = T_o + \frac{KQ_c}{mC_p} \qquad \textbf{[A.10.4]}$$

where:

T = smoke layer temperature (°F)
T_o = ambient temperature (°F)
K = fraction of convective energy contained in the smoke layer gases
Q_c = convective portion of heat release (Btu/sec)
m = mass flow rate of the plume (lb/sec)
C_p = specific heat of plume gases (0.24 Btu/lb-°F)

A value of $K = 0.5$ is suggested unless more detailed information is available.

A.10.4.3 The plugholing equation of this paragraph is consistent with and derived from the scale model studies of Spratt and Heselden [1974]. The equation is also consistent with the recent study of Nii, Nitta, Harada, and Yamaguchi [2003].

A.10.4.4 The γ factor of 1.0 applies to ceiling vents remote from a wall. *Remote* is regarded as a separation greater than two times the depth of the smoke layer below the lower point of the exhaust opening.

A.10.4.5 The γ factor of 0.5 is based upon potential flow considerations for a ceiling vent adjacent to a wall. While γ should vary smoothly from 0.5 for a vent directly adjacent to a wall to 1.0 for a ceiling vent remote from a wall, the available data do not support this level of detail in the requirements of the standard.

A.10.4.6 The γ factor of 0.5 is used for all wall vents. Because no data exist for wall exhausts, a value of γ greater than 0.5 could not be justified.

A.10.4.7 Noise due to exhaust fan operation or due to velocity at the exhaust inlet should be limited to allow the fire alarm signal to be heard.

A.11.1 Chapters 4 through 10 represent the state of technology of vent and draft curtain board design in the absence of sprinklers. A broadly accepted equivalent design basis for using sprinklers, vents, and curtain boards together for hazard control (e.g., life safety, property protection, water usage, obscuration) is currently not available. Designers are cautioned that the use of venting with automatic sprinklers is an area of ongoing research to determine its benefit and effect in conjunction with automatic suppression. See Section F.3 for more information.

A.11.2 Smoke and heat vents should be designed not to adversely impact the performance of the automatic sprinkler system. See 12.1.1 of NFPA 13. Testing and computer model studies conducted to date that have addressed the interaction of smoke and heat vents have been limited to control mode sprinklers. Because ESFR sprinklers have not been considered in any such studies, use of the guidance in this document is not applicable to ESFR sprinklers. The RTI is considerably lower than, and the required water discharge per sprinkler is considerably higher than, those of control mode sprinklers. There is concern that early operation of a smoke and heat venting system could adversely affect the performance of the fire suppression provided by ESFR sprinklers.

A.11.3 Figure A.11.3 shows the recommended spacing of sprinklers with respect to the draft curtain locations.

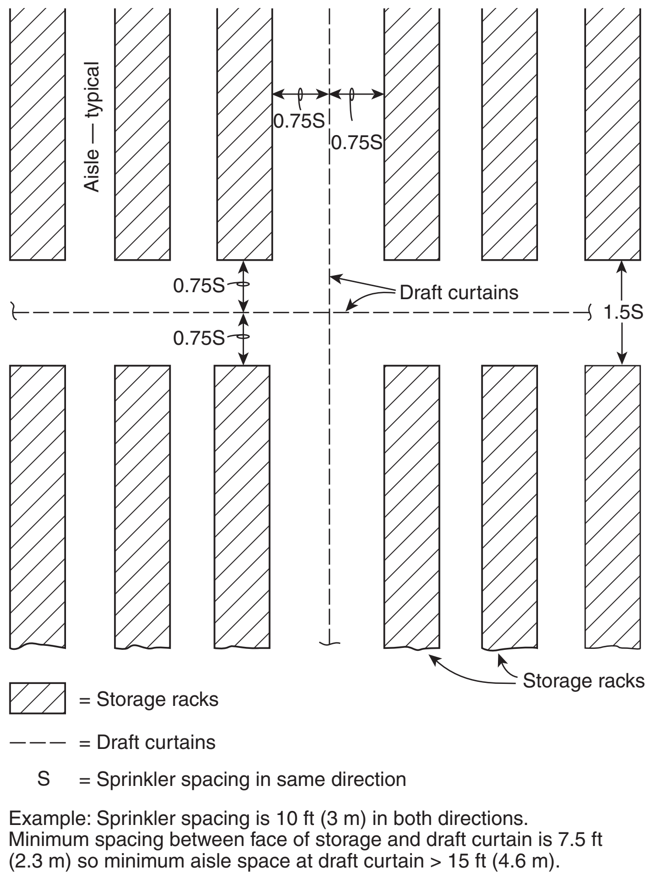

FIGURE A.11.3 Recommended Sprinkler Spacing with Respect to Draft Curtain Locations.

A.12.1 Regular inspection and maintenance is essential for emergency equipment and systems that are not subjected to their intended use for many years.

A.12.2 Various types of approved automatic thermal smoke and heat vents are available commercially. These vents fall into the following two general categories:

(1) Mechanically opened vents, which include spring-lift, pneumatic-lift, or electric motor-driven vents
(2) Thermoplastic drop-out vents, which include polyvinyl chloride (PVC) or acrylic drop-out panels

Thermoplastic drop-out vents do not allow nondestructive operation.

A.12.3.1.4 Vents designed for multiple functions (e.g., the entrance of daylight, roof access, comfort ventilation) need maintenance of the fire protection function that might be impaired by the other uses. These impairments can include loss of spring tension; racking or wear of moving parts; adverse exterior cooling effects on the fire protection release mechanism; adverse changes in performance sequence, such as premature heat actuation leading to opening of the vent; or reduced sensitivity to heat.

A.12.3.2.2 Inspection schedules should include provisions for testing all units at 12-month intervals or on a schedule based on a percentage of the total units to be tested every month or every two months. Such procedures improve reliability. A change in occupancy, or in neighboring occupancies, and in materials being used could introduce a significant change in the nature or severity of corrosive atmosphere exposure, debris accumulation, or physical encumbrance and could necessitate a change in the inspection schedule.

A.12.3.2.3 Recording and logging of all pertinent characteristics of performance allows results to be compared with those of previous inspections or acceptance tests and thus provides a basis for determining the need for maintenance or for modifying the frequency of the inspection schedule to fit the experience.

A.12.3.3.1 The same general considerations for inspection that apply to mechanically opened vents also pertain to thermoplastic drop-out vents. The thermoplastic panels of these vents are designed to soften and drop out from the vent opening in response to the heat of a fire. This makes an operational test after installation impracticable. Recognized fire protection testing laboratories have developed standards and procedures for evaluating thermoplastic drop-out vents, including factory and field inspection schedules. It is suggested that laboratory recommendations be followed for the field inspection of such units.

A.12.3.3.2 Thermoplastic drop-out vents utilize various types of plastics such as PVC and acrylic. Without the presence of ultraviolet (UV) stabilizers, exposure to UV rays can cause degradation and failure of the thermoplastic component (dome). Indication of UV degradation includes yellowing, browning, or blackening of the dome, as well as cracking or a brittle texture of the dome. (This condition can prevent proper operation of the thermoplastic material; i.e., it will not operate at its design activation temperature.) Corrective action requires replacing the thermoplastic dome with a dome having an equivalent thermal response.

A.12.4.1.3 The whipping action of the cable on release presents a possibility of injury to anyone in the area. For this reason, the person conducting the test should ensure that all personnel are well clear of the area where whipping of the cable might occur.

A.13.1 Design documentation is critical to the proper installation, operation, and maintenance of the smoke and heat vent systems. It forms the basis for evaluating the system's adequacy to perform as intended if the building or its use is modified.

Annex B The Theoretical Basis of LAVENT

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Overview. This annex develops the physical basis and an associated mathematical model for estimating the fire-generated environment and the response of sprinkler links in well-ventilated compartment fires with curtain boards and ceiling vents actuated by heat-responsive elements such as fusible links or thermoplastic drop-out panels. Complete equations and assumptions are presented. Phenomena taken into account include the following:

(1) Flow dynamics of the upward-driven, buoyant fire plume
(2) Growth of the elevated-temperature smoke layer in the curtained compartment
(3) Flow of smoke from the layer to the outside through open ceiling vents
(4) Flow of smoke below curtain partitions to building spaces adjacent to the curtained space of fire origin
(5) Continuation of the fire plume in the upper layer
(6) Heat transfer to the ceiling surface and the thermal response of the ceiling as a function of radial distance from the point of plume–ceiling impingement
(7) Velocity and temperature distribution of plume-driven near-ceiling flows and the response of near-ceiling–deployed fusible links as functions of distance below the ceiling
(8) Distance from plume–ceiling impingement

The theory presented here is the basis of the LAVENT computer program that is supported by a user guide, which is presented in Annex C, and that can be used to study parametrically a wide range of relevant fire scenarios [1–3].

B.2 Introduction. The space under consideration is a space of a plan area, A, defined by ceiling-mounted curtain boards with a fire of time-dependent energy release rate, $\dot{Q}(t)$, and with open ceiling vents of total time-dependent area, $A_V(t)$. The curtained area can be considered as one of several such spaces in a large building compartment. Also, by specifying that the curtains be deep enough, they can be thought of as simulating the walls of a single, uncurtained compartment. This annex presents the physical basis and associated mathematical model for estimating the fire-generated environment and the response of sprinkler links in curtained compartment fires with ceiling vents actuated by heat-responsive elements such as fusible links or thermoplastic drop-out panels.

The overall building compartment is assumed to have near-floor wall vents that are large enough to maintain the inside environment, below any near-ceiling smoke layers that could form, at assumed initial outside-ambient conditions. Figure F.2(a) depicts the generic fire scenario for the space under consideration. The assumption of large near-floor wall vents necessitates that the modeling be restricted to conditions where y, the elevation of the smoke layer interface, is above the floor elevation (i.e., $y > 0$). The assumption also has important implications with regard to the cross-ceiling vent pressure differential. This is the pressure differential that drives elevated-temperature upper-layer smoke through the ceiling vents to the outside. Therefore, below the smoke layer (i.e., from the floor of the facility to the elevation of the smoke layer interface), the inside-to-outside hydrostatic pressure differential exists at all elevations in the reduced-density smoke layer itself (higher pressure inside the curtained area, lower pressure in the outside environment), the maximum differential occurring at the ceiling and across the open ceiling vents.

B.3 The Basic Equations. A two-layer, zone-type compartment fire model is used to describe the phenomena under investigation. As is typical in such models, the upper smoke layer of total mass, m_U, is assumed to be uniform in density, ρ_U, and absolute temperature, T_U.

The following time-dependent equations describe conservation of energy, mass, and the perfect gas law in the upper smoke layer.

Conservation of energy,

$$\frac{d\left[\left(y_{ceil}-y\right)\rho_U T_U A C_V\right]}{dt} = \dot{q}_U + \left(\rho A \frac{dy}{dt}\right) \quad \textbf{[B.3a]}$$

Conservation of mass,

$$\frac{dm_U}{dt} = \dot{m}_U \quad \textbf{[B.3b]}$$

$$m_U = \left(y_{ceil}-y\right)\rho_U A \quad \textbf{[B.3c]}$$

Perfect gas law,

$$\frac{\rho_U}{R} \propto \frac{\rho}{R} = constant = \rho_U T_U = \rho_{amb} T_{amb} \quad \textbf{[B.3d]}$$

That is,

$$T_U = \frac{T_{amb}\rho_{amb}}{\rho_U} \quad \textbf{[B.3e]}$$

In the preceding equations, y_{ceil} is the elevation of the ceiling above the floor, $R = C_p\text{-}C_V$ is the gas constant, C_p and C_V are the specific heats at a constant pressure and volume, respectively, and p is a constant characteristic pressure (e.g., p_{atm}) at the floor elevation. In Equation B.3a, $\dot{q}_U$ is the net rate of enthalpy flow plus heat transfer to the upper layer and is made up of flow components as follows: $\dot{q}_{curt}$, from below the curtain; $\dot{q}_{plume}$, from the plume; $\dot{q}_{vent}$, from the ceiling vent; and the component $\dot{q}_{HT}$, the total heat transfer rate.

$$\dot{q}_U = \dot{q}_{curt} + \dot{q}_{plume} + \dot{q}_{vent} + \dot{q}_{HT} \quad \textbf{[B.3f]}$$

In Equation B.3b, $\dot{m}_U$ is the net rate of mass flow to the upper layer with flow components; $\dot{m}_{curt}$, from below the curtain; $\dot{m}_{plume}$, from the plume; and $\dot{m}_{vent}$, from the ceiling vent.

$$\dot{m}_U = \dot{m}_{curt} + \dot{m}_{plume} + \dot{m}_{vent} \quad \textbf{[B.3g]}$$

Using Equation B.3c in Equation B.3a leads to

$$\frac{dy}{dt} = \frac{\dot{q}_U}{AC_\rho p_{amb} T_{amb}} \quad \textbf{[B.3h]}$$

if

$$y = y_{ceil} \text{ and } \dot{q}_U \geq 0$$

or

$$0 < y > y_{ceil} \text{ and } \dot{q}_U \text{ is arbitrary}$$

Because both of these conditions are satisfied, Equation B.3h is always applicable.

The basic problem of mathematically simulating the growth and properties of the upper layer for the generic Figure F.2(a) scenario necessitates the solution of the system of Equation B.3b and Equation B.3h for m_U and y. When $m_U > 0$,

ρ_U can be computed from Equation B.3c according to the following:

$$\rho_U = \frac{(y_{ceil} - y)A}{m_U};\ \text{if } m_U > 0 \qquad \textbf{[B.3i]}$$

and T_U can be determined from Equation B.3e.

B.4 Mass Flow and Enthalpy Flow Plus Heat Transfer.

B.4.1 Flow to the Upper Layer from the Vents. Conservation of momentum across all open ceiling vents as expressed by Bernoulli's equation leads to the following:

$$V = C\left(\frac{2\Delta\rho_{ceil}}{\rho_U}\right)^{1/2} \qquad \textbf{[B.4.1a]}$$

$$\dot{m}_{vent} = -\rho_U A_V V = -A_V C\left(2\rho_U \Delta\rho_{ceil}\right)^{1/2} \qquad \textbf{[B.4.1b]}$$

where:
V = the average velocity through all open vents
C = the vent flow coefficient (0.68) [4]
$\Delta\rho_{ceil}$ = the cross-vent pressure difference

From hydrostatics,

$$\begin{aligned}\Delta\rho_{ceil} &= \rho_U(y = y_{ceil}) - \rho_{amb}(y = y_{ceil}) \\ &= (\rho_{amb} - \rho_U)g(y_{ceil} - y)\end{aligned} \qquad \textbf{[B.4.1c]}$$

where:
g = the acceleration of gravity

Substituting Equation B.4.1c into Equation B.4.1b leads to the desired $\dot{m}_{vent}$ result, as follows:

$$\dot{m}_{vent} = -A_V C\left[2\rho_U(\rho_{amb} - \rho_U)g(y_{ceil} - y)\right]^{1/2} \qquad \textbf{[B.4.1d]}$$

which is equivalent to the equations used to estimate ceiling vent flow rates *(see Equation 9.2.4.1 and references [5] and [6])*. Using Equation B.4.1d, the desired $\dot{q}_{vent}$ result is as follows:

$$\dot{q}_{vent} = \dot{m}_{vent} C_P T_U \qquad \textbf{[B.4.1e]}$$

B.4.2 Flow to the Layer from the Plume and Radiation from the Fire. It is assumed that the mass generation rate of the fire is small compared to $\dot{m}_{ent}$, the rate of mass of air entrained into the plume between the fire elevation, y_{fire}, and the layer interface, or compared to other mass flow rate components of $\dot{m}_U$. It is also assumed that all of the $\dot{m}_{ent}$ penetrates the layer interface and enters the upper layer. Therefore,

$$\dot{m}_{plume} = \dot{m}_{ent} \qquad \textbf{[B.4.2a]}$$

$$\dot{q}_{plume} = \dot{m}_{ent} C_P T_{amb} + (1 - \lambda_r)\dot{Q} \qquad \textbf{[B.4.2b]}$$

The first term on the right side of Equation B.4.2b is the enthalpy associated with $\dot{m}_{ent}$, and λ_r, in the second term in Equation B.4.2b, is the effective fraction of $\dot{Q}$ assumed to be radiated isotropically from the fire's combustion zone.

It is assumed that the smoke layer is relatively transparent and that it does not participate in any significant radiation heat transfer exchanges. In particular, all of the $\lambda_r Q$ radiation is assumed to be incident on the bounding surfaces of the compartment. Therefore, the last term of Equation B.4.2b is the net amount of enthalpy added to the upper layer from the combustion zone and its buoyancy-driven plume. Flaming fires exhibit values for λ_r of $0 < \lambda_r < 0.6$ (e.g., smallest values for small methane fires and highest values for large polystyrene fires). However, for a hazardous fire involving a wide range of common groupings of combustibles, it is reasonable to approximate flame radiation by choosing $\lambda \propto 0.35$ [7].

A specific plume entrainment model is necessary to complete Equations B.4.1e and B.4.2a for $\dot{m}_{plume}$ and $\dot{q}_{plume}$. The following estimate for $\dot{m}_{ent}$ [8, 9] is adopted as follows:

$$\dot{m}_{ent} = \left|\begin{array}{l} 0;\ \text{if } y - y_{fire} \le 0; \\ 0.0054\left[(1-\lambda_r)\dot{Q}\right]\dfrac{y - y_{fire}}{L_{flame}};\ \text{if } 0 < \dfrac{y - y_{fire}}{L_{flame}} < 1 \\ 0.071\left[(1-\lambda_r)\dot{Q}\right]^{1/3} \\ \times\left\{(y - y_{fire} - L_{flame}) + 0.166\left[(1-\lambda_r)\dot{Q}\right]^{2/5}\right\}^{5/3} \\ \times\left[\begin{array}{l} 1 + \in\left[(1-\lambda_r)\dot{Q}\right]^{2/3} \\ \times\left\{(y - y_{fire} - L_{flame}) + 0.166\left[(1-\lambda_r)\dot{Q}\right]^{2/5}\right\}^{-5/3} \end{array}\right]; \\ \quad \text{if } \dfrac{y - y_{fire}}{L_{flame}} \ge 1 \end{array}\right. \qquad \textbf{[B.4.2c]}$$

where $\dot{m}_{ent}$ is in kg/s, $\dot{Q}$ is in kW, and y, y_{fire}, L_{flame} are in m and where

$$\frac{L_{flame}}{D_{fire}} = \left|\begin{array}{l} 0;\quad \text{if } \dfrac{0.249\left[(1-\lambda_r)\dot{Q}\right]^{2/5}}{D_{fire}} - 1.02 < 0 \\ \dfrac{0.249\left[(1-\lambda_r)\dot{Q}\right]^{2/5}}{D_{fire}} - 1.02; \\ \quad \text{if } \dfrac{0.249\left[(1-\lambda_r)\dot{Q}\right]^{2/5}}{D_{fire}} - 1.02 \ge 0 \end{array}\right. \qquad \textbf{[B.4.2d]}$$

where $\dot{Q}$ is in kW, D_{fire} is in m, and

$$\in = \left(\frac{0.0054}{0.071}\right) - (0.166)^{5/3} = 0.02591682\ldots \approx 0.026 \qquad \textbf{[B.4.2e]}$$

In Equations B.4.2c through B.4.2e,
L_{flame} is the fire's flame length.
D_{fire} is the effective diameter of the fire source ($\pi D^2_{fire}/4$ = area of the fire source).
$\in$ is chosen so that, analytically, the value of $\dot{m}_{ent}$ is exactly continuous at the elevation $y = y_{fire} + L_{flame}$.

B.4.3 Flow to the Layer from Below the Curtains. If the upper layer interface, y, drops below the elevation of the bottom of the curtains, y_{curt}, mass and enthalpy flows occur from the upper layer of the curtained area where the fire is located to adjacent curtained areas of the overall building compartment. The mass flow rate is the result of hydrostatic cross-curtain pressure differentials. Provided adjacent curtained areas are not yet filled with smoke, this pressure difference increases linearly from zero at the layer interface to Δp_{curt} at $y = y_{curt}$.

From hydrostatics,

$$\begin{aligned}\Delta\rho_{curt} &= \rho_U(y = y_{curt}) - \rho_{amb}(y = y_{curt}) \\ &= (\rho_{amb} - \rho_U)g(y_{curt} - y)\end{aligned} \qquad \textbf{[B.4.3a]}$$

Using Equation B.4.3a together with well-known vent flow relations (e.g., Equation 32 of reference [4]), $\dot{m}_{curt}$ and $\dot{q}_{curt}$ can be estimated from the following:

$$\dot{m}_{curt} = \begin{cases} 0; & \text{if } y \geq y_{curt} \\ -\dfrac{L_{curt}}{3}\left[8\left(y_{curt}-y\right)^3 \rho_U \left(\rho_{amb}-\rho_U\right) g\right]^{1/2}; & \text{if } y \leq y_{curt} \end{cases} \quad \textbf{[B.4.3b]}$$

$$\dot{q}_{curt} = \dot{m}_{curt} C_P T_U \quad \textbf{[B.4.3c]}$$

where L_{curt} is that length of the perimeter of the curtained areas of the fire origin that is connected to other curtained areas of the overall building compartment. For example, if the curtained area is in one corner of the building compartment, then the length of its two sides coincident with the walls of the compartment are not included in L_{curt}. Because the generic vent flow configuration under consideration in this case is long and deep, a flow coefficient for the vent flow incorporated into Equation B.4.3b is taken to be 1.

B.4.4 Heat Transfer to the Upper Layer. As discussed in B.4.3, where the fire is below the layer interface, the buoyant fire plume rises toward the ceiling, and all of its mass and enthalpy flow, $\dot{m}_{plume}$ and $\dot{q}_{plume}$, are assumed to be deposited into the upper layer. Having penetrated the interface, the plume continues to rise toward the ceiling of the curtained compartment. As it impinges on the ceiling surface, the plume flow turns and forms a relatively high-temperature, high-velocity, turbulent ceiling jet that flows radially outward along the ceiling and transfers heat to the relatively cool ceiling surface. The ceiling jet is cooled by convection, and the ceiling material is heated by conduction. The convective heat transfer rate is a strong function of the radial distance from the point of plume–ceiling impingement and reduces rapidly with increasing radius. It is dependent also on the characteristics of the plume immediately upstream of ceiling impingement.

The ceiling jet is blocked eventually by the curtains, wall surfaces, or both. It then turns downward and forms vertical surface flows. In the case of wall surfaces and very deep curtains, the descent of these flows is stopped eventually by upward buoyant forces, and they finally mix with the upper layer. In this case, it is assumed that the plume–ceiling impingement point is relatively far from the closest curtain or wall surface (e.g., greater than a few fire-to-ceiling lengths). Under such circumstances, the ceiling jet–wall flow interactions are relatively weak, and compared to the net rate of heat transfer from the ceiling and near the plume–ceiling impingement point, the heat transfer to the upper layer from all vertical surfaces is relatively small.

Define λ_{conv} as the fraction of $\dot{Q}$ that is transferred by convection from the upper-layer gas ceiling jet to the ceiling and to the vertical wall and curtain surfaces as follows:

$$\dot{q}_{HT} = -\lambda_{conv}\dot{Q} \quad \textbf{[B.4.4]}$$

Once the values of $\lambda_{conv}\dot{Q}$ and $\dot{q}_{HT}$ are determined from a time-dependent solution to the coupled, ceiling jet–ceiling material, convection-conduction problem, the task of determining an estimate for each component of $\dot{q}_U$ and $\dot{m}_U$ in Equations B.3f and B.3g, respectively, is complete.

B.4.4.1 Properties of the Plume in the Upper Layer When y_{fire} < y. Those instances of the fire elevation being below the interface (i.e., when $y_{fire} < y$) are considered here.

As the plume flow moves to the center of the upper layer, the forces of buoyancy that act to drive the plume toward the ceiling (i.e., as a result of relatively high-temperature, low-density plume gases being submerged in a relatively cool, high-density ambient environment) are reduced immediately because of the temperature increase of the upper-layer environment over that of the lower ambient. As a result, the continued ascent of the plume gases is less vigorous (i.e., ascent is at reduced velocity) and of higher temperature than it would be in the absence of the layer. Indeed, some of the penetrating plume flow will be at a lower temperature than T_U. The upper-layer buoyant forces on this latter portion of the flow actually retard and can possibly stop its subsequent rise to the ceiling.

A simple point-source plume model [10] is used to simulate the plume flow, first immediately below or upstream of the interface and then throughout the depth of the upper layer itself.

A plume above a point source of buoyancy [10], where the source is below the interface, will be considered to be equivalent to the plume of a fire (in the sense of having identical mass and enthalpy flow rates at the interface) if the point-source strength is $(1 - \lambda_r)\dot{Q}$ and the elevation of the equivalent source, y_{eq}, satisfies the following:

$$\dot{m}_{plume} = 0.21\rho_{amb} g^{1/2} \left(y - y_{eq}\right)^{5/2} \dot{Q}_{eq}^{*1/3} \quad \textbf{[B.4.4.1a]}$$

In Equation B.4.4.1a, $\dot{Q}_{eq}^*$, a dimensionless measure of the strength of the fire plume at the interface, is defined as follows:

$$\dot{Q}_{eq}^* = \frac{\left(1-\lambda_r\right)\dot{Q}}{\rho_{amb} C_P T_{amb} g^{1/2} \left(y - y_{eq}\right)^{5/2}} \quad \textbf{[B.4.4.1b]}$$

It should be noted that at an arbitrary moment of time on the simulation of a fire scenario, $\dot{m}_{plume}$ in Equation B.4.4.1a, is a known value that is determined previously from Equations B.4.2a and B.4.2c.

Using Equations B.4.4.1a and B.4.4.1b to solve for y_{eq} and $\dot{Q}_{eq}^*$,

$$y_{eq} = y - \left[\frac{\left(1-\lambda_r\right)\dot{Q}}{\dot{Q}_{eq}^* \rho_{amb} C_P T_{amb} g^{1/2}}\right]^{2/5} \quad \textbf{[B.4.4.1c]}$$

$$\dot{Q}_{eq}^* = \left[\frac{0.21\left(1-\lambda_r\right)\dot{Q}}{C_P T_{amb} \dot{m}_{plume}}\right]^{3/2} \quad \textbf{[B.4.4.1d]}$$

As the plume crosses the interface, the fraction, $\dot{m}^*$, of $\dot{m}_{plume}$, that is still buoyant relative to the upper-layer environment and presumably continues to rise to the ceiling, entraining upper-layer gases along the way, is predicted [11] to be as follows:

$$\dot{m}^* = \begin{cases} 0; & \text{if } -1 < \sigma \leq 0 \\ \dfrac{1.04599\sigma + 0.360391\sigma^2}{1.0 + 1.37748\sigma + 0.360391\sigma^2}; & \text{if } \sigma > 0 \end{cases} \quad \textbf{[B.4.4.1e]}$$

where the dimensionless parameter, σ, is defined as follows:

$$\sigma = \frac{1 - \alpha + C_T \dot{Q}_{eq}^{*2/3}}{\alpha - 1} \quad \textbf{[B.4.4.1f]}$$

$$\alpha = \frac{T_U}{T_{amb}} \quad \textbf{[B.4.4.1g]}$$

where C_T = 9.115 and where $\dot{Q}_{eq}^*$ is the value computed in Equation B.4.4.1d.

The parameters necessary to describe plume flow continuation in the upper layer (i.e., between y and y_{ceil}) are further identified [11] according to a point-source plume [10]. It has been determined that this plume can be modeled as being driven by a nonradiating buoyant source of strength, $\dot{Q}'$, located a distance

$$H = y_{ceil} - y'_{source} > y_{ceil} - y_{fire} \qquad \textbf{[B.4.4.1h]}$$

below the ceiling in a downward-extended upper-layer environment of temperature, T_U, and density, ρ_U. The relevant parameters predicted [11] are as follows:

$$\dot{Q}' = \frac{(1-\lambda_r)\dot{Q}\sigma\dot{m}^*}{1+\sigma} \qquad \textbf{[B.4.4.1i]}$$

$$y'_{source} = y - (y - y_{eq})\alpha^{3/5}\dot{m}^{*2/5}\left(\frac{1+\sigma}{\sigma}\right)^{1/5} \qquad \textbf{[B.4.4.1j]}$$

The fire and the equivalent source in the lower layer and the continuation source in the upper layer are depicted in Figure B.4.4.1, parts (a) through (c). Those times during a fire simulation when Equation B.4.4. 1f predicts $\sigma > 1$ are related to states of the fire environment in which the temperature distribution above T_{amb} of the plume flow, at the elevation of interface penetration, is predicted to be mostly much larger than $T_U - T_{amb}$. Under such circumstances, the penetrating plume flow is still very strongly buoyant as it enters the upper layer. The plume continues to rise to the ceiling and to drive ceiling jet convective heat transfer at rates that differ only slightly (due to the elevated temperature upper-layer environment) from the heat transfer rates that could occur in the absence of an upper layer.

Conditions where Equation B.4.4.1f predicts $\sigma < 0$ are related to times during a fire scenario when the temperature of the plume at the elevation of interface penetration is predicted to be uniformly less than T_U. Under such circumstances, the penetration plume flow is not positively (i.e., upward) buoyant at any point as it enters the upper layer. Therefore, while all of this flow is assumed to enter and mix with the upper layer, it is predicted that none of it rises to the ceiling in a coherent plume (i.e., $\dot{Q}' = 0$). For this reason, where $\sigma < 0$, the existence of any significant ceiling jet flow is precluded, along with significant convective heat transfer to the ceiling surface or to near-ceiling–deployed fusible links.

The preceding analysis assumes that $y_{fire} < y$. However, at the onset of the fire scenario, $y_{fire} < y = y_{ceil}$ and α, σ, and $\dot{m}^*$ of Equation B.4.4.1e through Equation B.4.4.1h, which depend on the indeterminate initial value of T_U, are themselves undefined. The situation at $t = 0$ is properly taken into account if $Q = (1\text{-}\lambda_r)\dot{Q}$ and

$$y'_{source} = y_{eq} \quad \text{at } t = 0 \qquad \textbf{[B.4.4.1j]}$$

B.4.4.2 General Properties of the Plume in the Upper Layer. When the fire is below the interface, the results of Equations B.4.4.1i and B.4.4.1j allow the fire-driven plume dynamics in the upper layer to be described according to the point-source plume model [10]. If the fire is at or above the interface (i.e., $y_{fire} \geq y$), then $\dot{m}_{plume} = 0$, $\dot{q}_{plume} = (1 - \lambda_r)\dot{Q}$, and the point-source model is used once again to simulate the upper-layer plume flow. All cases can be treated using the following modified versions of original Equations B.4.4.1i and B.4.4.1j:

$$\dot{Q}' = \left|\begin{array}{ll} \dfrac{(1-\lambda_r)Q\sigma\dot{m}^*}{(1+\sigma)}; & \text{if } y_{fire} < y < y_{ceil} \\ (1-\lambda_r)\dot{Q}; & \text{if } y_{fire} \geq y \quad \text{or} \quad \text{if } y = y_{ceil} \end{array}\right. \qquad \textbf{[B.4.4.2a]}$$

[B.4.4.2b]

$$y'_{source} = \left|\begin{array}{ll} y_{fire;} \quad \text{if } y \leq y_{fire} < y_{ceil} & \\ y - (y - y_{eq})\alpha^{3/5}\dot{m}^{*2/5}\left(\dfrac{1+\sigma}{\sigma}\right)^{1/5}; & \text{if } y_{fire} < y < y_{ceil} \\ y_{eq}; \quad \text{if } y = y_{ceil} & \end{array}\right.$$

where y_{eq}, $\dot{m}^*$, σ, and α are calculated from Equations B.4.4.1c through B.4.4.1g.

B.4.5 Computing $\dot{q}HT$ and the Thermal Response of the Ceiling. Where the fire is below the interface and the interface is below the ceiling, the method used for calculating the heat transfer from the plume-driven ceiling jet to the ceiling and the thermal response of the ceiling is from reference [12]. This method was developed to treat generic, confined-ceiling, room fire scenarios. As outlined in this method [12], the confined ceiling problem is solved by applying the unconfined ceiling heat transfer solution [13–15] to the problem of an upper-layer source in an extended upper-layer environment equivalent to Equations B.4.4.2a and B.4.4.2b. When the fire is about the interface, the unconfined ceiling methodology applies directly.

To use the methods in references [12–15], an arbitrary moment of time during the course of the fire development is considered. It is assumed that the temperature distribution of

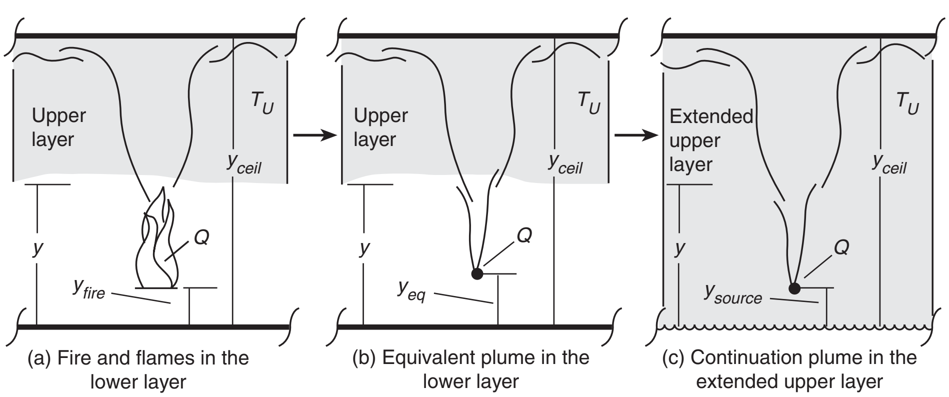

FIGURE B.4.4.1 Fire and Equivalent Source.

the ceiling material, T, has been computed up to this moment and is known as a function of distance, Z, measured upward from the bottom surface of the ceiling, and radial distance, r, measured from the constant point of plume–ceiling impingement. The equivalent, extended upper-layer, unconfined ceiling flow and heat transfer problem is depicted in Figure B.4.4.1. It involves the equivalent $\dot{Q}'$ heat source from Equation B.4.4.2a located a distance, H, below the ceiling surface in an extended ambient environment of density, ρ_U, and absolute temperature, T_U, where H is determined from Equations B.4.4.1h and B.4.4.1j.

The objective is to estimate the instantaneous convective heat transfer flux from the upper-layer gas to the lower-ceiling surface, $\dot{q}''_{conv,L}(r,t)$, and the net heat transfer fluxes to the upper and lower ceiling surface of the ceiling, $\dot{q}''_u(r,t)$ and $\dot{q}''_L(r,t)$, respectively. With this information, the time-dependent solution for the in-depth thermal response of the ceiling material can be advanced to subsequent times. Also, $\dot{q}''_{conv,L}$ can be integrated over the lower-ceiling surface to obtain the desired instantaneous value for $\dot{q}_{HT}$.

In view of the assumptions of the relatively large distance of the fire from walls or curtains and on the relatively small contribution of heat transfer to these vertical surfaces, it is reasonable to carry out a somewhat simplified calculation for $\dot{q}_{HT}$. Therefore, $\dot{q}_{HT}$ is approximated by the integral of $\dot{q}''_{conv,L}$ over an effective circular ceiling area, A_{eff}, with a diameter, D_{eff}, centered at the point of impingement as follows:

$$\begin{aligned}\dot{q}_{HT} &= \lambda_{conv}\dot{Q}(t)\\ &= -\int_A \dot{q}''_{conv,L}(r,t)\,dA\\ &\approx -2\pi\int_0^{D_{eff}/2} \dot{q}''_{conv,L}(r,t)\,r\,dr\end{aligned} \quad \textbf{[B.4.5a]}$$

The value $A_{eff} = \pi D^2_{eff}/4$ is taken to be the actual area of the curtained space, A, plus the portion of the vertical curtain and wall surfaces estimated to be covered by ceiling jet–driven wall flows. An estimate for this extended, effective ceiling surface area is obtained [16], where it is concluded with some generality that ceiling jet–driven wall flows penetrate for a distance of approximately $0.8H$ from the ceiling in a downward direction. Therefore,

$$\begin{aligned}A_{eff} &= \frac{\pi D^2_{eff}}{4}\\ &= A + 0.8H\left(P - L_{curt}\right) + L_{curt}\min\left[0.8H,\left(y_{ceil} - y_{curt}\right)\right]\end{aligned} \quad \textbf{[B.4.5b]}$$

where P = the total length of the perimeter of the curtained area.

B.4.5.1 Net Heat Transfer Flux to the Ceiling's Lower Surface. The net heat transfer flux to the ceiling's lower surface, $\dot{q}''_L$, is made by means of up to three components — incident radiation, $\dot{q}''_{rad-fire}$; convection, $\dot{q}''_{conv,L}$; and reradiation, $\dot{q}''_{rerad,L}$ — as follows:

$$\dot{q}''_L = \dot{q}''_{rad-fire} + \dot{q}''_{conv,L} + \dot{q}''_{rerad,L} \quad \textbf{[B.4.5.1a]}$$

As discussed in B.4.4, the radiant energy from the fire, $\lambda_r\dot{Q}$, is assumed to be radiated isotropically from the fire with negligible radiation absorption and emission from the compartment gases.

$$\dot{q}''_{rad-fire} = \left[\frac{\lambda_r\dot{Q}}{4\pi\left(y_{ceil} - y_{fire}\right)^2}\right]\left[1 + \left(\frac{r}{y_{ceil} - y_{fire}}\right)^2\right]^{-3/2} \quad \textbf{[B.4.5.1b]}$$

The convective heat transfer flux from the upper-layer gas to the ceiling's lower surface can be calculated [13, 14] as follows:

$$\dot{q}''_{conv,L} = h_L\left(T_{AD} - T_{S,L}\right) \quad \textbf{[B.4.5.1c]}$$

where:

$\dot{q}''_{conv,L}$ = convective heat transfer flux from the upper-layer gas to the ceiling's lower surface

h_L = a heat transfer coefficient

T_{AD} = the temperature that is measured adjacent to an adiabatic lower-ceiling surface

$T_{S,L}$ = the absolute temperature of the ceiling's lower surface

Equations B.4.5.1d and B.4.5.1e determine h_L and T_{AD} as follows:

$$\frac{h_L}{\tilde{h}} = \begin{cases} 8.82Re_H^{-1/2}Pr^{-2/3}\left[1 - \left(5.0 - 0.284Re_H^{0.2}\right)\left(\dfrac{r}{H}\right)\right]; & \text{if } 0 \le \dfrac{r}{H} < 0.2 \\ 0.283Re_H^{-0.3}Pr^{-2/3}\left(\dfrac{r}{H}\right)^{-1/2}\left(\dfrac{\dfrac{r}{H} - 0.0771}{\dfrac{r}{H} + 0.279}\right); & \text{if } 0.2 \le \dfrac{r}{H} \end{cases} \quad \textbf{[B.4.5.1d]}$$

$$\frac{T_{AD} - T_U}{T_U\dot{Q}_H^{*2/3}} = \begin{cases} 10.22 - \dfrac{14.9r}{H}; & \text{if } 0 \le \dfrac{r}{H} < 0.2 \\ 8.39f\left(\dfrac{r}{H}\right); & \text{if } 0.2 \le \dfrac{r}{H} \end{cases} \quad \textbf{[B.4.5.1e]}$$

where:

[B.4.5.1f]

$$f\left(\frac{r}{H}\right) = \frac{1 - 1.10\left(\dfrac{r}{H}\right)^{0.8} + 0.808\left(\dfrac{r}{H}\right)^{1.6}}{1 - 1.10\left(\dfrac{r}{H}\right)^{0.8} + 2.20\left(\dfrac{r}{H}\right)^{1.6} + 0.690\left(\dfrac{r}{H}\right)^{2.4}}$$

$$\tilde{h} = \rho_U C_p g^{1/2} H^{1/2} \dot{Q}_H^{*1/3}$$

$$Re_H = \frac{g^{1/2}H^{3/2}\dot{Q}_H^{*1/3}}{\nu_U} \quad \textbf{[B.4.5.1g]}$$

$$\dot{Q}_H^* = \frac{\dot{Q}'}{\rho_U C_p T_U (gH)^{1/2} H^2}$$

In Equation B.4.5.1d, Pr is the Prandtl number (taken to be 0.7), and in Equation B.4.5.1g, ν_U is the kinematic viscosity of the upper-layer gas, which is assumed to have the properties of air. Also, $\dot{Q}_H^*$, a dimensionless number, is a measure of the strength of the plume, and Re_H is a characteristic Reynolds number of the plume at the elevation of the ceiling.

The following estimate for ν_U [17] is used when computing Re_H from Equation B.4.5.1g:

$$\nu_U = \frac{0.04128\left(10^{-7}\right)T_U^{5/2}}{T_U + 110.4} \quad \textbf{[B.4.5.1h]}$$

where ν_U is in m^2/s and T_U is in K.

Equations B.4.5.1c through B.4.5.1h use a value for T_U. At $t = 0$, where it is undefined, T_U should be set equal to T_{amb}. This yields the correct limiting result for the convective heat transfer to the ceiling, specifically, convective heat transfer to the initially ambient temperature ceiling from an unconfined ceiling jet in an ambient environment.

As the fire simulation proceeds, the ceiling's lower surface temperature, $T_{S,L}$, initially at T_{amb}, begins to increase. At all times, the lower-ceiling surface is assumed to radiate diffusely to the initially ambient temperature floor surface and to exposed surfaces of the building contents. In response to this radiation and to the direct radiation from the fire's combustion zone, the temperatures of these surfaces also increase with time. However, for times of interest here, it is assumed that their effective temperature increases are relatively small compared to the characteristic increases of $T_{S,L}$. Accordingly, at a given radial position of the ceiling's lower surface, the net radiation exchange between the ceiling and floor-contents surfaces can be approximated by the following:

$$\dot{q}''_{rerad,L} = \frac{\sigma\left(T_{amb}^4 - T_{S,L}^4\right)}{\dfrac{1}{\epsilon_L} + \dfrac{1}{\epsilon_{floor}} - 1} \quad \textbf{[B.4.5.1i]}$$

where σ is the Stefan–Boltzmann constant and ϵ_L and ϵ_{floor} are the effective emittance-absorptance of the ceiling's lower surface and the floor and contents surfaces (assumed to be gray), respectively, both of which are taken to be 1.

B.4.5.2 Net Heat Transfer Flux to Ceiling's Upper Surface. It is assumed that the ceiling's upper surface is exposed to a relatively constant-temperature far-field environment at T_{amb}. Therefore, the net heat transfer flux to this surface, $\dot{q}_U$, is made up of two components, convection, $\dot{q}''_{conv,U}$, and reradiation, $\dot{q}''_{rerad,U}$, as follows:

$$q''_U = \dot{q}''_{conv,U} + \dot{q}''_{rerad,U} \quad \textbf{[B.4.5.2a]}$$

These can be estimated from the following:

$$\dot{q}''_{conv,U} = h_U\left(T_{amb} - T_{S,U}\right) \quad \textbf{[B.4.5.2b]}$$

$$\dot{q}''_{rerad,U} = \frac{\sigma\left(T_{amb}^4 - T_{S,U}^4\right)}{\dfrac{1}{\epsilon_U} + \dfrac{1}{\epsilon_{far}} - 1} \quad \textbf{[B.4.5.2c]}$$

where $T_{S,U}$ is the absolute temperature of the upper surface of the ceiling, h_U is a heat transfer coefficient, and ϵ_{far} and ϵ_U are the effective emittance-absorptance of the far-field and ceiling's upper surface (assumed to be gray), respectively, both of which are taken to be 1.

The value for h_U to be used [18] is as follows:

$$h_U = 1.65\left(T_{amb} - T_{S,U}\right)^{1/3} \quad \textbf{[B.4.5.2d]}$$

where h_U is in W/m^2, and T_{amb} and $T_{S,U}$ are in K.

B.4.5.3 Solving for the Thermal Response of the Ceiling for $\dot{q}_{HT}$. The temperature of the ceiling material is assumed to be governed by the Fourier heat conduction equation. By way of the lower-ceiling-surface boundary condition, the boundary value problem is coupled to, and is to be solved together with, the system of Equations B.3b and B.3h.

Initially, the ceiling is taken to be of uniform temperature, T_{amb}. The upper- and lower-ceiling surfaces are then exposed to the radial- and time-dependent rates of heat transfer, $\dot{q}''_U$ and $\dot{q}''_L$, determined from Equations B.4.5.2a and B.4.5.1a, respectively. For times of interest here, radial gradients of $\dot{q}''_U$ and $\dot{q}''_L$ are assumed to be small enough so that conduction in the ceiling is quasi-one-dimensional in space [i.e., $T = T(Z, t; r)$]. Therefore, the two-dimensional thermal response for the ceiling can be obtained from the solution to a set of one-dimensional conduction problems for the following:

$$T_n(Z,t) = T(Z,t; r = r_n); \quad n = 1 \text{ to } N_{rad} \quad \textbf{[B.4.5.3a]}$$

where N_{rad} is the number of discrete radial positions necessary to obtain a sufficiently smooth representation of the overall ceiling temperature distribution. The r_n radial positions are depicted in Figure B.4.5.3.

Characteristic changes in ceiling temperature will occur over changes in r/H of the order of 1 [15]. Therefore, it is reasonable to expect accurate results for the Equation B.4.5a integral $\dot{q}''_{conv,L}$ by interpolating between values of $\dot{q}''_{conv,L}$ calculated at radial positions separated by r/H intervals of 0.1 to 0.2.

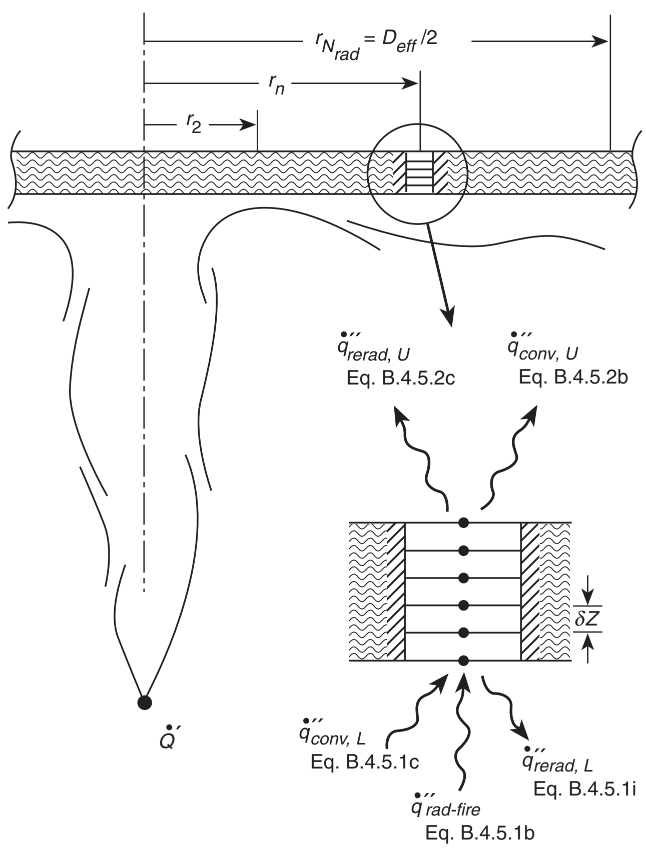

FIGURE B.4.5.3 Illustration of the Geometry for the Boundary Value Problems of the Temperature Distributions, T_n, Through the Ceiling at Radial Positions r_n.

Using the preceding ideas, the following procedure for finding the thermal response of the ceiling and solving for $\dot{q}''_{HT}$ is implemented:

(1) Because $y_{ceil} - y_{fire}$ is a measure of H in the current problem and $D_{eff}/2$ is a measure of the maximum value of r, N_{rad} is chosen as several multiples of the following:

$$\frac{D_{eff}/2}{y_{ceil} - y_{fire}} \qquad \textbf{[B.4.5.3(b)]}$$

In this case, N_{rad} is chosen as the first integer equal to or greater than the following:

$$\frac{5\left(D_{eff}/2\right)}{y_{ceil} - y_{fire}} + 2 \qquad \textbf{[B.4.5.3(c)]}$$

(2) One temperature calculation point is placed at $r = 0$ and the remaining N_{rad} calculation points are distributed with uniform separation at and between $r = 0.2(y_{ceil} - y_{fire})$ and $r = D_{eff}/2$, the latter value being the upper limit of the integral of Equation B.4.5a; that is,

$$\begin{aligned} r_1 &= 0 \\ r_2 &= 0.2\left(y_{ceil} - y_{fire}\right) \\ r_{N_{rad}} &= \frac{D_{eff}}{2} \\ r_n &= r_{n-1} + \Delta r \quad \text{if } 2 < n < N_{rad} \end{aligned} \qquad \textbf{[B.4.5.3(d)]}$$

where

$$\Delta r = \left(r_{N_{rad}} - r_2\right) \big/ \left(N_{rad} - 3\right) \qquad \textbf{[B.4.5.3(e)]}$$

(3) The boundary value problems are solved for the N_{rad} temperature distributions, T_n. At arbitrary radius, r_n, these are indicated in the inset portion of Figure B.4.5.3.

(4) For any moment of time during the calculation, the lower surface values of the T_n are used to compute the corresponding discrete values of

$$\dot{q}''_{conv,L,n}(t) = \dot{q}''_{conv,L}(r = r_n, t) \qquad \textbf{[B.4.5.3(f)]}$$

from Equation B.4.5.1c.

(5) The $\dot{q}''_{conv,L}$ distribution in r is approximated by interpolating linearly between the $\dot{q}''_{conv,L,n}$. The integration indicated in Equation B.4.5a is carried out.

The procedure for solving for the T_n is the same as that used in reference [15]. It requires the thickness, thermal conductivity, and thermal diffusivity of the ceiling material. The solution to the one-dimensional heat conduction equation involves an explicit finite difference scheme that uses an algorithm taken from references [19, 20]. For a given set of calculations, $N \leq 20$ equal-spaced nodes are positioned at the surfaces and through the thickness of the ceiling at every radius position, r_n. The spacing, δZ *(see Figure B.4.5.3)*, of these is selected to be large enough (based on a maximum time step) to ensure stability of the calculation.

B.5 Actuation of Vents and Sprinklers. It is an objective of this standard to simulate conditions in building spaces where ceiling vents and sprinkler links can be actuated by the responses of near-ceiling–deployed fusible links. The concept is that, during the course of a compartment fire, a deployed link is engulfed by the near-ceiling convective flow of the elevated-temperature products of combustion and entrained air of the fire-generated plume. As the fire continues, convective heating of the link leads to an increase in its temperature. If and when its fuse temperature is reached, any devices being operated by the link are actuated.

The near-ceiling flow engulfing the link is the plume-driven ceiling jet referred to previously, which transfers heat to the lower-ceiling surface and is cooled as it traverses under the ceiling from the point of plume–ceiling impingement. In the case of relatively smooth ceiling configurations, assumed to be representative of the facilities studied in this standard, the ceiling jet flows outward radially from the point of impingement, and its gas velocity and temperature distributions, V_{CJ} and T_{CJ}, respectively, are a function of radius from the impingement point, r, distance below the ceiling, z, and time, t.

Vents actuated by alternate means, such as thermoplastic drop-out panels with equivalent performance characteristics, can also be modeled using LAVENT. Refer to A.9.1.

B.5.1 Predicting the Thermal Response of the Fusible Links. The thermal response of deployed fusible links is calculated up to their fuse temperature, T_F, by the convective heating flow model of reference [21]. It is assumed that the specific link is positioned at a specified radius from the impingement point, $r = r_L$, and distance below the lower-ceiling surface, $z = z_L$. T_L is defined as the link's assumed, nearly uniform temperature. Instantaneous changes in T_L are determined by the following:

$$\frac{dT_L}{dt} = \frac{\left(T_{CJ,L} - T_L\right)V_{CJ,L}^{1/2}}{RTI} \qquad \textbf{[B.5.1]}$$

where $T_{CJ,L}$ and $V_{CJ,L}$ are the values of V_{CJ} and T_{CJ}, respectively, evaluated near the link position, and where *RTI* (response time index), a property of the link and relative flow orientation, can be measured in the "plunge test" [21, 22]. The *RTI* for ordinary sprinkler links ranges from low values of 22 $(\text{m}\cdot\text{s})^{1/2}$ for quick-operating residential sprinklers, to 375 $(\text{m}\cdot\text{s})^{1/2}$ for slower standard sprinklers [23]. The utility of Equation B.5.1, which has been shown in reference [24] to be valid typically through the link-fusing processes, is discussed further in reference [23], where it was used to predict link response in a parametric study involving two-layer compartment fire scenarios. Also, in the latter work, the link response prediction methodology was shown to demonstrate favorable comparisons between predicted and measured link responses in a full-scale, one-room, open-doorway compartment fire experiment.

Computing T_L from Equation B.5.1 for a different link location necessitates estimates of $V_{CJ,L}$ and $T_{CJ,L}$ for arbitrary link positions, r_L and z_L.

B.5.2 The Velocity Distributions of the Ceiling Jet. Outside of the plume–ceiling impingement stagnation zone, defined approximately by $r/H \leq 0.2$, and at a given r, V_{CJ} rises rapidly from zero at the ceiling's lower surface, $z = 0$, to a maximum, V_{max}, at a distance $z = 0.23\delta$, $\delta(r)$ being the distance below the ceiling where $V/V_{max} = 1/2$ [16]. In this region outside the stagnation zone, V_{CJ} can be estimated [16] as follows:

$$\text{if } \frac{r}{H} \geq 0.2; \qquad \textbf{[B.5.2a]}$$

$$\frac{V_{CJ}}{V_{max}} = \begin{cases} \left(\dfrac{8}{7}\right)\left(\dfrac{z}{0.23\delta}\right)^{1/7}\left[1 - \dfrac{z/(0.23\delta)}{8}\right]; & \text{if } 0 \leq \dfrac{z}{0.23\delta} \leq 1 \\ \cosh^{-2}\left\{\left(\dfrac{0.23}{0.77}\right)\operatorname{arccosh}\left(2^{1/2}\right) \times \left[\dfrac{z}{0.23\delta} - 1\right]\right\}; & \text{if } 1 \leq \dfrac{z}{0.23\delta} \end{cases}$$

$$\frac{V_{max}}{V} = 0.85\left(\frac{r}{H}\right)^{-1.1}$$
$$\frac{\delta}{H} = 0.10\left(\frac{r}{H}\right)^{0.9} \quad \textbf{[B.5.2b]}$$
$$V = g^{1/2}H^{1/2}\dot{Q}_H^{*1/3}$$

where $\dot{Q}_H^*$ is defined in Equation B.4.5.1g. V_{CJ}/V_{max} per Equation B.5.2a is plotted in Figure B.5.2.

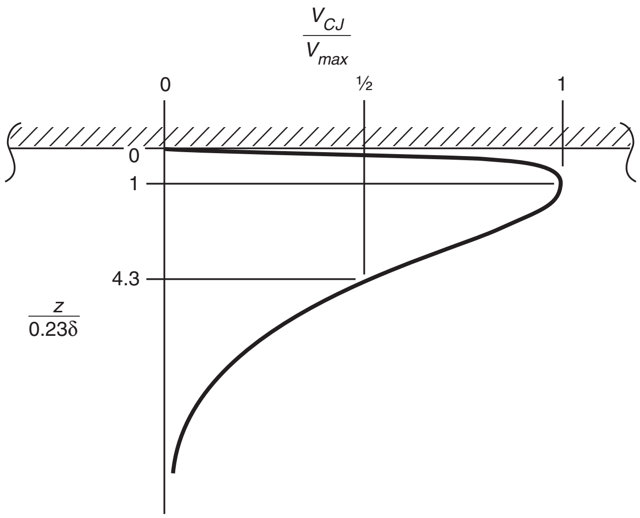

FIGURE B.5.2 A Plot of Dimensionless Ceiling Jet Velocity Distribution, V_{CJ}/V_{max}, as a Function of $z/0.23\delta$ per Equation B.5.2a.

In the vicinity of near-ceiling–deployed links located inside the stagnation zone, the fire-driven flow is changing directions from an upward-directed plume flow to an outward-directed ceiling jet–type flow. There the flow velocity local to the link, the velocity that drives the link's connective heat transfer, involves generally a significant vertical as well as radial component of velocity. Nevertheless, at such link locations, it is reasonable to continue to approximate the link response using Equation B.5.1 with V_{CJ} estimated using Equations B.5.2a and B.5.2b and with r/H set equal to 0.2; that is,

$$V_{CJ} = V_{CJ}\left(\frac{r}{H} = 0.2\right); \quad \text{if } 0 \le \frac{r}{H} < 0.2 \qquad \textbf{[B.5.2c]}$$

B.5.3 The Temperature Distribution of the Ceiling Jet. Outside of the plume–ceiling impingement stagnation zone (i.e., where $r/H \ge 0.2$) and at a given value of r, T_{CJ} rises very rapidly from the temperature of the ceiling's lower surface, $T_{S,L}$, at $z = 0$, to a maximum, T_{max}, somewhat below the ceiling surface. It is assumed that this maximum value of T_{CJ} occurs at the identical distance below the ceiling as does the maximum of V_{CJ} (i.e., at $z = 0.23\delta$). Below this elevation, T_{CJ} drops with increasing distance from the ceiling until it reaches the upper-layer temperature, T_U. In this latter, outer region of the ceiling jet, the shape of the normalized T_{CJ} distribution, $(T_{CJ} - T_U)/(T_{max} - T_U)$, has the same characteristics as that of V_{CJ}/V_{max}. Also, because the boundary flow is turbulent, it is reasonable to estimate the characteristic thicknesses of the outer region of both the velocity and temperature distributions as being identical, both dictated by the distribution of the turbulent eddies there.

For these reasons, the dimensionless velocity and temperature distribution are approximated as being identical in the outer region of the ceiling jet flow, $0.23\delta \le z$. In the inner region of the flow, between $z = 0$ and 0.23δ, the normalized temperature distribution is approximated by a quadratic function of $z/(0.23\delta)$, with $T_{CJ} = T_{S,L}$ at $z = 0$ and $T_{CJ} = T_{max}$, $dT_{CJ}/dz = 0$ at $z = 0.23\delta$. Therefore, where $r/H \ge 0.2$,

[B.5.3a]

$$\Theta \equiv \frac{T_{CJ} - T_U}{T_{max} - T_U} = \begin{cases} \Theta_S + 2\left[(1-\Theta_S)\left(\dfrac{z}{0.23\delta}\right)\right] - \left[(1-\Theta_S)\left(\dfrac{z}{0.23\delta}\right)^2\right]; \\ \quad \text{if } 0 \le \dfrac{z}{0.23\delta} \le 1 \\ \dfrac{V_{CJ}}{V_{max}}; \ \text{if } 1 \le \dfrac{z}{0.23\delta} \end{cases}$$

$$\Theta_S \equiv \Theta\left(T_{CJ} = T_{S,L}\right) = \frac{T_{S,L} - T_U}{T_{max} - T_U} \qquad \textbf{[B.5.3b]}$$

It should be noted that Θ_S is negative when the ceiling surface temperature is less than the upper-layer temperature (e.g., relatively early in a fire, when the original ambient-temperature ceiling surface has not yet reached the average temperature of the growing upper layer). Also, Θ_S is greater than 1 when the ceiling surface temperature is greater than T_{max}. This is possible, for example, during times of reduced fire size when the fire's near-ceiling plume temperature is reduced significantly, perhaps temporarily, from previous values, but the ceiling surface, heated previously to relatively high temperatures, has not cooled substantially. Plots of Θ per Equation B.5.3a are shown in Figure B.5.3 for cases where Θ is < 0, between 0 and 1, and > 0.

In a manner similar to the treatment of V_{CJ}/V_{max}, for the purpose of calculating T_L, from Equation B.5.1, Θ_S is approximated

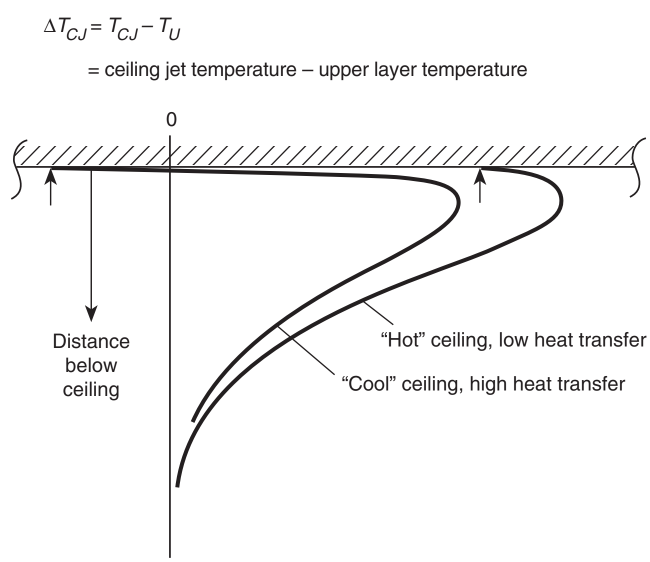

FIGURE B.5.3 Plots of Dimensionless Ceiling Jet Temperature Distribution, Θ, as a Function of $z/0.23\delta$ per Equation B.5.3a for Cases Where Θ_S is <0, Between 0 and 1, and >0.

inside the stagnation zone by the description of Equations B.5.3a and B.5.3b, with r/H set equal to 0.2 as follows:

$$\Theta_S = \Theta_S\left(\frac{r}{H} = 0.2\right); \quad \text{if } 0 \le \frac{r}{H} \le 0.2 \qquad \textbf{[B.5.3c]}$$

With the radial distribution for $T_{S,L}$ and T_U already calculated up to a specific time, only T_{max} is needed to complete the derived estimate from Equations B.5.3a through B.5.3c for the ceiling jet temperature distribution. This estimate is obtained by invoking conservation of energy. Therefore, at an arbitrary r outside the stagnation zone, the total rate of radial outflow of enthalpy (relative to the upper-layer temperature) of the ceiling jet is equal to the uniform rate of enthalpy flow in the upper-layer portion of the plume, $\dot{Q}'$, less the integral (from the plume–ceiling impingement prior to r) of the flux of convective heat transfer from the ceiling jet to the ceiling surface as follows:

$$2\pi\int_0^\infty \rho_U C_P \left(T_{CJ} - T_U\right) V_{CJ} r \, dz = \dot{Q}' - 2\pi\int_0^r \dot{q}''_{conv,L}(r,t)\, r\, dr \qquad \textbf{[B.5.3d]}$$
$$\equiv \left(1 - \lambda'_{conv}\right) \dot{Q}'; \quad \text{if } 0.2 \le \frac{r}{H}$$

λ'_{conv} is the fraction of $\dot{Q}'$ transferred by convection to the ceiling from the point of ceiling impingement to r as follows:

$$\lambda'_{conv}(r) = \frac{2\pi\int_0^r \dot{q}''_{conv,L}(r,t)\, r\, dr}{\dot{Q}'} \qquad \textbf{[B.5.3e]}$$

In Equations B.5.3d and B.5.3e, $\dot{Q}'$ has been calculated previously in Equation B.4.4.2a. Also, the integral on the right-hand sides of Equations B.5.3d and B.5.3e can be calculated by approximating $\dot{q}''_{conv,L}(r,t)$, as shown in Equation B.5.3e, as a linear function of r between previously calculated values of $\dot{q}_{conv,L}\left(r = r_n, t\right)$.

The integral on the left-hand side of Equation B.5.3d is calculated using V_{CJ} of Equations B.5.2a and B.5.3b and T_{CJ} of Equations B.5.3a and B.5.3b. From this, the desired distribution for T_{max} is determined as follows:

[B.5.3f]

$$\left(T_{max} - T_U\right) = 2.6\left(1 - \lambda'_{conv}\right)\left(\frac{r}{H}\right)^{-0.8} \dot{Q}_H^{*2/3} T_U - 0.090\left(T_{S,L} - T_U\right);$$
$$\text{if } 0.2 \le \frac{r}{H}$$

The result of Equation B.5.3f, together with Equations B.5.3a and B.5.3b, represents the desired estimate for T_{CJ}. This and the estimate derived from Equations B.5.2a through B.5.2c for T_{CJ} are used to calculate T_L from Equation B.5.1.

B.5.4 Dependence of Open Vent Area on Fusible-Link–Actuated Vents. As discussed, the influence of ceiling vent action on the fire-generated equipment is dependent on the active area of the open ceiling vents, A_V. A variety of basic vent opening design strategies is possible, and a major application of the current model equations is to evaluate these strategies within the context of the developing fire environment. For example, one of the simplest strategies [9] assumes that all vents deployed in the specified curtained area are opened by whatever means at the onset of the fire. In general, A_V will be time-dependent. To the extent that a strategy of vent opening is dependent directly on the fusing of any one or several deployed fusible links, the location of these links and their characteristics (i.e., likely spacings from plume–ceiling impingement, distance below the ceiling, and the RTI) and the functional relationship between link fusing and A_V need to be specified. These matters can be examined in the context of different solutions to the overall problem by exercising parametrically the LAVENT computer program [2], which implements all the model equations provided in this annex.

B.5.5 Concluding Remarks — A Summary of Guidelines, Assumptions, and Limitations. The theory presented here is the basis of LAVENT, a user-friendly computer program [2] that is supported by a user guide [3] and that can be used to study parametrically a wide range of relevant fire scenarios.

The assumptions made in the development of the set of model equations limit fire scenarios or aspects of fire scenarios that can be simulated and studied with confidence. A summary of guidelines and assumptions that characterize what are perhaps the most critical of these limitations follows. These are the result of explicit or implicit assumptions necessary for valid application of the variety of submodels introduced throughout this work.

L and W are the length and width, respectively, of the plan area of the curtained space. Simulated configurations should be limited to those with aspect ratios, L/W, that are not much different from 1 (e.g., $0.5 \le L/W < 2$). Also, in such configurations, the fire should not be too close to or too far from the walls [e.g., the fire should be no closer to a wall than $(y_{ceil} - y_{fire})/2$ and no farther than $3(y_{ceil} - y_{fire})$].

The curtain boards should be deep enough to satisfy $(y_{ceil} - y_{curt}) \le 0.2\ (y_{ceil} - y_{fire})$, unless the equations and the standard are used to simulate an unconfined ceiling scenario where $(y_{ceil} - y_{curt}) = 0$.

The ceiling of the curtained space should be relatively smooth, with protuberances having depths significantly less than $0.1(y_{ceil} - y_{fire})$. Except at the locations of the curtain boards, below-ceiling–mounted barriers to flow, such as solid beams, should be avoided. Ceiling surface protuberances near to and upstream of fusible links (i.e., between the links and the fire) should be significantly smaller than link-to-ceiling distances.

W_V is the width, that is, the smaller dimension of a single ceiling vent (or vent cluster). If vents are open, the prediction of smoke layer thickness, $y_{ceil} - y$, is reliable only after the time that $(y_{ceil} - y)/W_V$ is greater than 1. (For smaller layer depths, "plugholing" flow through the vents could occur, leading to possible significant inaccuracies in vent flow estimates.) Note that this places an additional limitation on the minimum depth of the curtain boards [i.e., $(y_{ceil} - y_{curt})/W_V$ should exceed 1].

At all times during a simulated fire scenario, the overall building space should be vented to the outside (e.g., through open doorways).

In this regard, compared to the open ceiling vents in the curtained compartment, the area of the outside vents must be large enough such that the pressure drop across the outside vents is small compared to the pressure drop across ceiling vents. For example, under near-steady-state conditions, when the rate of mass flow into the outside vents is approximately equal to the rate of mass outflow from the ceiling vents, the outside vent area must satisfy $(A_{Vout}/A_V)^2(T_U/T_{amb})^2 >> 1$, or, more conservatively and independent of T_U, $(A_{Vout}/A_V)^2 >> 1$. The latter criterion will always be reasonably satisfied if $A_{Vout}/A_V > 2$. Under flashover-level conditions — say, when $T_U / T_{amb} = 3$ — the former criterion will be satisfied if $(3A_{Vout}/A_V)^2 >> 1$ — say, if $A_{Vout} = A_V$, or even if A_{Vout} is somewhat smaller than A_V.

The simulation assumes a relatively quiescent outside environment (i.e., without any wind) and a relatively quiescent inside environment (i.e., remote from vent flows, undercurtain flows, ceiling jets, and the fire plume). In real fire scenarios, such an assumption should be valid where the characteristic velocities of actual flows in these quiescent environments are much less than the velocity of the fire plume near its ceiling impingement point (i.e., where the characteristic velocities are much less than V_{max} of Equation B.5.2b). It should be noted that, for a given fire strength, Q, this latter assumption places a restriction on the maximum size of $(y_{ceil} - y_{fire})$, which is a measure of H, since V_{max} is approximately proportional to $(y_{ceil} - y_{fire})^{-1/3}$.

In configurations where smoke flows below curtain partitions to adjacent curtained spaces, the simulation is valid only up to the time that it takes for any one of the adjacent spaces to fill with smoke to the level of the bottom of the curtain. While it is beyond the scope of this standard to provide any general guidelines for this limiting time, the following rule can be useful where all curtained spaces of a building are similar and where the fire is not growing too rapidly: The time to fill an adjacent space is of the order of the time to fill the original space.

The reliability of the simulation begins to degrade subsequent to the time that the top of the flame penetrates the layer elevation, and especially if Equation B.4.3a predicts a flame height that reaches the ceiling.

It is assumed that the smoke is relatively transparent and that the rate of radiation absorbed by or emitted from the smoke layer is small compared to the rate of radiation transfer from the fire's combustion zone. The assumption is typically true, and a simulation is valid at least up to those times that the physical features of the ceiling can be discerned visually from the floor elevation.

It should be emphasized that the preceding limitations are intended only as guidelines. Therefore, even when the characteristics of a particular fire scenario satisfy these limitations, the results should be regarded with caution until solutions to the overall model equations have been validated by a substantial body of experimental data. Also, where a fire scenario does not satisfy the preceding limitations but is close to doing so, it is possible that the model equations can still provide useful quantitative descriptions of the simulated phenomena.

B.6 References for Annex B.

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B.7 Nomenclature for Annex B.

A = plan area of single curtain space

A_{eff} = effective area for heat transfer to the extended lower-ceiling surface, $\pi D_{eff}^2 / 4$

A_V = total area of open ceiling vents in curtained space

A_{Vout} = total area of open vents to outside exclusive of A_V

C = vent flow coefficient (0.68)

C_P = specific heat at constant pressure

C_T = 9.115, dimensionless constant in plume model

C_V = specific heat at constant volume

D_{eff} = effective diameter of A_{eff}

D_{fire} = effective diameter of fire source ($\pi D_{fire}^2/4$ = area of fire source)

g = acceleration of gravity

H = distance below ceiling of equivalent source

$\tilde{h}$ = characteristic heat transfer coefficient

h_L, h_U = lower-, upper-ceiling surface heat transfer coefficient

L = characteristic length of the plan area of curtained space

L_{curt} = length of the perimeter of A connected to other curtained areas of the building

L_{flame} = flame length

$\dot{m}_{curt}$ = mass flow rate from below curtain to upper layer

$\dot{m}_{ent}$ = rate of plume mass entrainment between the fire and the layer interface

$\dot{m}_{plume}$ = mass flow rate of plume at interface

m_U = total mass of the upper layer

$\dot{m}_U$ = net mass flow rate to upper layer

$\dot{m}_{vent}$ = mass flow rate through ceiling vents to upper layer

N = number of equal-spaced nodes through the ceiling

N_{rad} = number of values of r_n

P = length of perimeter of single curtained area

Pr = Prandtl number, taken to be 0.7

p = pressure

p_U, p_{amb} = pressure in upper-layer, outside ambient

$\dot{Q}$ = energy release rate of fire

$\dot{Q}'$ = strength of continuation source in extended upper layer

$\dot{Q}_H^*$ = dimensionless strength of plume at ceiling

$\dot{Q}_{eq}^*$ = dimensionless strength of plume at interface

$\dot{q}''_{conv,L}, \dot{q}''_{conv,U}$ = convective heat transfer flux to lower-, upper-ceiling surface

$$\dot{q}''_{conv,L,_N} = \dot{q}''_{conv,L}(r = r_n, t)$$

$\dot{q}_{curt}$ = enthalpy flow rate from below curtain to upper layer

$\dot{q}_{HT}$ = heat transfer rate to upper layer

$\dot{q}_{plume}$ = enthalpy flow rate of plume at interface

$\dot{q}_{rad\text{-}fire}$ = radiation flux incident on lower surface of ceiling

$\dot{q}''_{rerad,L}, \dot{q}''_{rerad,U}$ = reradiation flux to lower, upper surface of ceiling

$\dot{q}_U$ = net enthalpy flow rate plus heat transfer rate to upper layer

$\dot{q}'_L, \dot{q}''_U$ = net heat transfer fluxes to upper-, lower-ceiling surface

$\dot{q}_{vent}$ = enthalpy flow rate through ceiling vent to upper layer

R = gas constant, $C_P - C_V$

Re_H = Reynolds number of plume at ceiling elevation

RTI = response time index

r = radial distance from plume–ceiling impingement

r_L = r at link

r_n = discrete values of r

T = absolute temperature of ceiling material

T_{AD} = adiabatic lower-ceiling surface temperature

T_{CJ} = temperature distribution of ceiling jet gas

$T_{CJ,L}$ = T_{CJ} at link

$T_{max}(t) = T_{S,L}(r = 0, t) = T(Z = 0, t, r = 0)$

$T_{S,L}$, $T_{S,U}$ = absolute temperature of lower-, upper-ceiling surface

$T_{S,L,n}(t) = T_{S,L}(r = r_n, t) = T_n(Z = 0, t, r = r_n)$

T_U, T_{amb} = absolute temperature of upper-layer, outside ambient

$T_n = T(Z, t\ r = r_n)$

t = time

V = average flow velocity through all open vents

V = characteristic value of V_{CJ}

V_{CJ} = velocity distribution of ceiling jet gas

$V_{CJ,L}$ = V_{CJ} at link

V_{max} = maximum value of V_{CJ} at a given r

W = characteristic width of plan area of curtained space

W_V = width of a single ceiling vent (or vent cluster)

y, y_{ceil}, y_{curt}, y_{eq}, y_{fire} = elevation of smoke layer interface, ceiling, bottom of curtain, equivalent source fire above floor

y'_{source} = elevation of plume continuation point source in extended upper layer above floor

Z = distance into the ceiling, measured from bottom surface

z, z_L = distance below lower-ceiling surface, z, at link

$\alpha = T_U/T_{amb}$

τ = ratio of specific heat, C_P/C_V

Δp_{ceil} = cross-vent pressure difference

Δp_{curt} = cross-curtain pressure difference

δ = value of z where $V_{CJ} = V_{max}/2$

δZ = distance between nodes through the ceiling thickness

$\in$ = constant, Equations B.4.2c and B.4.2e

$\in_L$, $\in_U$, $\in_{floor}$, $\in_{far}$ = emittance-absorptance of lower, upper, floor, and far-field gray surfaces, all taken to be 1

Θ = normalized, dimensionless ceiling jet temperature distribution, $(T_{CJ} - T_U)/(T_{max} - T_U)$

Θ_S = Θ at lower-ceiling surface, $(T_{S,L} - T_U)/(T_{max} - T_U)$

λ_r = fraction of $\dot{Q}$ radiated from combustion zone

λ_{conv} = fraction of $\dot{Q}$ transferred by convection from upper layer

λ'_{conv} = fraction of $\dot{Q}'$ transferred to the ceiling in a circle of radius, r, and centered at $r = 0$, Equation B.5.3e

ν_U = kinematic viscosity of upper-layer gas

ρ_U, ρ_{amb} = density of upper-layer, outside ambient

σ = dimensionless variable, Equation B.4.4.1e

Annex C User Guide for the LAVENT Computer Code

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

C.1 Overview. This annex is a user guide for the LAVENT computer code (Link-Actuated VENTs), Version 1.1, and an associated graphics code called GRAPH. As discussed in Section 9.3 and in Annex B, LAVENT has been developed to simulate the environment and the response of sprinkler links in compartment fires with curtain boards and fusible-link–actuated ceiling vents. Vents actuated by alternative means such as thermoplastic drop-out panels with equivalent performance characteristics can also be modeled using LAVENT. Refer to A.1.1.1.

A fire scenario simulated by LAVENT is defined by the following input parameters:

(1) Area and height of the curtained space
(2) Separation distance from the floor to the bottom of the curtain
(3) Length of the curtain (A portion of the perimeter of the curtained space can include floor-to-ceiling walls.)
(4) Thickness and properties of the ceiling material (density, thermal conductivity, and heat capacity)
(5) Constants that define a specified time-dependent energy release rate of the fire
(6) Fire elevation
(7) Area or characteristic energy release rate per unit area of the fire
(8) Total area of ceiling vents whose openings are actuated by a single fusible link (Multiple vent area/link system combinations may be permitted in any particular simulation.)
(9) Identifying numbers of fusible links used to actuate single sprinkler heads or groups of sprinkler heads (Multiple sprinkler links are permitted in any particular simulation.)

The characteristics of the simulated fusible links are defined by the following input parameters:

(1) Radial distance of the link from the fire–ceiling impingement point
(2) Ceiling–link separation distance
(3) Link fuse temperature
(4) The response time index (RTI) of the link

For any particular run of LAVENT, the code outputs a summary of the input information and simulation results of the calculation, in tabular form, at uniform simulation time intervals requested by the user. The output results include the following:

(1) Temperature of the upper smoke layer
(2) Height of the smoke layer interface
(3) Total mass in the layer
(4) Fire energy release rate
(5) Radial distributions of the lower-ceiling surface temperature
(6) Radial distribution of heat transfer rates to the lower- and upper-ceiling surfaces
(7) The temperature for each link and the local velocity and temperature of the ceiling jet

This annex explains LAVENT using a series of exercises in which the reader reviews and modifies a default input data file that describes vent and sprinkler actuation during fire growth in an array of wood pallets located in a warehouse-type occupancy. Results of the default simulation are discussed.

LAVENT is written in Fortran 77. The executable code operates on IBM PC-compatible computers and needs a minimum of 300 kilobytes of memory.

C.2 Introduction — The Phenomena Simulated by LAVENT. Figure C.2 depicts the generic fire scenario simulated by LAVENT. This scenario involves a fire in a building space with ceiling-mounted curtain boards and near-ceiling, fusible-link–actuated ceiling vents and sprinklers. The curtained area can be considered as one of several such spaces in a single large building compartment. By specifying that the curtains be deep enough, they can be thought of as simulating the walls of a single uncurtained compartment that is well-ventilated near the floor.

The fire generates a mixture of gaseous and solid-soot combustion products. Because of high temperature, buoyancy forces drive the products upward toward the ceiling, forming a plume of upward-moving hot gases and particulates. Cool gases are laterally entrained and mixed with the plume flow, reducing its temperature as it continues its ascent to the ceiling.

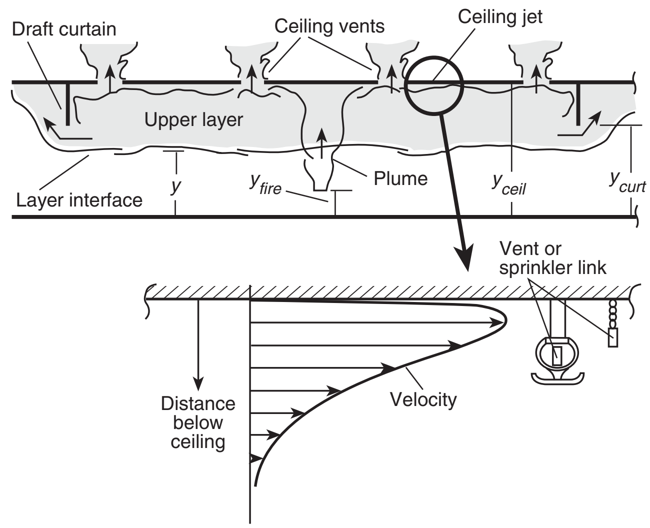

FIGURE C.2 Fire in a Building Space with Curtain Boards, Ceiling Vents, and Fusible Links.

When the hot plume flow impinges on the ceiling, it spreads under it, forming a relatively thin, high-temperature ceiling jet. Near-ceiling–deployed fusible links engulfed by the ceiling jet are depicted in Figure C.2. There is reciprocal convective cooling and heating of the ceiling jet and of the cooler lower-ceiling surface, respectively. The lower-ceiling surface is also heated due to radiative transfer from the combustion zone and cooled due to reradiation to the floor of the compartment. The compartment floor is assumed to be at ambient temperature. The upper-ceiling surface is cooled as a result of convection and radiation to a far-field, ambient temperature environment.

When the ceiling jet reaches a bounding vertical curtain board or wall surface, its flow is redistributed across the entire curtained area and begins to form a relatively quiescent smoke layer (now somewhat reduced in temperature) that submerges the continuing ceiling jet flow activity. The upper smoke layer grows in thickness. Away from bounding surfaces, the time-dependent layer temperature is assumed to be relatively uniform throughout its thickness. It should be noted that the thickness and temperature of the smoke layer affect the upper-plume characteristics, the ceiling jet characteristics, and the heat-transfer exchanges to the ceiling.

If the height of the bottom of the smoke layer drops to the bottom of the curtain board and continues downward, the smoke begins to flow below the curtain into the adjacent curtained spaces. The growth of the upper layer is retarded.

Fusible links that are designed to actuate the opening of ceiling vents and the onset of waterflow through sprinklers are deployed at specified distances below the ceiling and at specified radial distances from the plume–ceiling impingement point. These links are submerged within the relatively high-temperature, high-velocity ceiling jet flow. Because the velocity and temperature of the ceiling jet vary with location and time, the heat transfer to, and time of fusing of, any particular link design also vary.

The fusing of a ceiling vent link leads to the opening of all vents “ganged” to that link. Once a ceiling vent is open, smoke flows out of the curtained space. Again, as when smoke flows below the curtains, growth of the upper-layer thickness is retarded.

The fusing of a sprinkler link initiates the flow of water through the sprinkler. All of the described phenomena, up to the time that waterflow through a sprinkler is initiated, are simulated by LAVENT. Results cannot be used after water begins to flow through a sprinkler.

C.3 The Default Simulation. The use of LAVENT is discussed and is illustrated in the following paragraphs where exercises in reviewing and modifying the LAVENT default-simulation input file are provided. To appreciate the process more fully, a brief description of the default simulation is presented at the outset.

Note that, as explained in Section C.4, Getting Started, the user can choose to run LAVENT using either English or metric units. The default simulation uses U.S. customary units. The example in Annex D uses metric units.

The default scenario involves an 84 ft × 84 ft (25.6 m × 25.6 m) curtained compartment [7056 ft^2 (655 m^2) in area] with the ceiling located 30 ft (9.1 m) above the floor. A curtain board 15 ft (4.6 m) in depth completely surrounds and defines the compartment, which is one of several such compartments in a larger building space. The ceiling is constructed of a relatively thin sheet-steel lower surface that is well insulated from above. *[See Figure C.3(a).]*

The curtained compartment has four uniformly spaced 48 ft^2 (4.5 m^2) ceiling vents with a total area of 192 ft^2 (18 m^2), or 2.7 percent of the compartment area. Opening of the ceiling vents is actuated by quick-response fusible links with RTIs of 50 (ft·sec)$^{1/2}$ and fuse temperatures of 165°F (74°C). The links are located at the centers of the vents and 0.3 ft (0.09 m) below the ceiling surface.

Fusible-link–actuated sprinklers are deployed on a square grid with 12 ft (3.7 m) spacing between sprinklers. The links have RTIs of 400 (ft·s)$^{1/2}$ and fuse temperatures of 165°F (74°C). The sprinklers and links are mounted 1 ft (30.1 cm) below the ceiling surface.

The simulation fire involves four abutting 5 ft (1.5 m) high stacks of 5 ft × 5 ft (1.5 m × 1.5 m) wood pallets. The combined grouping of pallets makes up a combustible array 10 ft × 10 ft (3.1 m × 3.1 m) [100 ft^2 (9.3 m^2) in area] on the floor and 5 ft (1.5 m) in height. It is assumed that other combustibles in the curtained compartment are far enough away from this array that they cannot be ignited in the time interval to be simulated.

The total energy release rate of the simulation fire, $\dot{Q}$, assumed to grow from ignition, at time $t = 0$, in proportion to t^2. According to the guidance in Table F.1(a), in the growth phase of the fire, $\dot{Q}$ is taken specifically as follows:

$$\dot{Q} = 1000\left(\frac{t}{130\text{ sec}}\right)^2 \text{Btu/sec} \qquad \textbf{[C.3]}$$

The fire grows according to the preceding estimate until the combustibles are fully involved. It is then assumed that $\dot{Q}$ levels off to a relatively constant value. Following the guidance of Table 4.1 of reference [1] and Table A.8.2.6, it is estimated that, at the fully developed stage of the fire, the total energy release rate for the 5 ft (1.5 m) high stack of wood pallets will be 330 Btu/s · ft^2, or 33,000 Btu/sec for the entire 100 ft^2 array. The preceding equation leads to the result that the fully developed stage of the fire will be initiated at t_{fd} = 747 seconds.

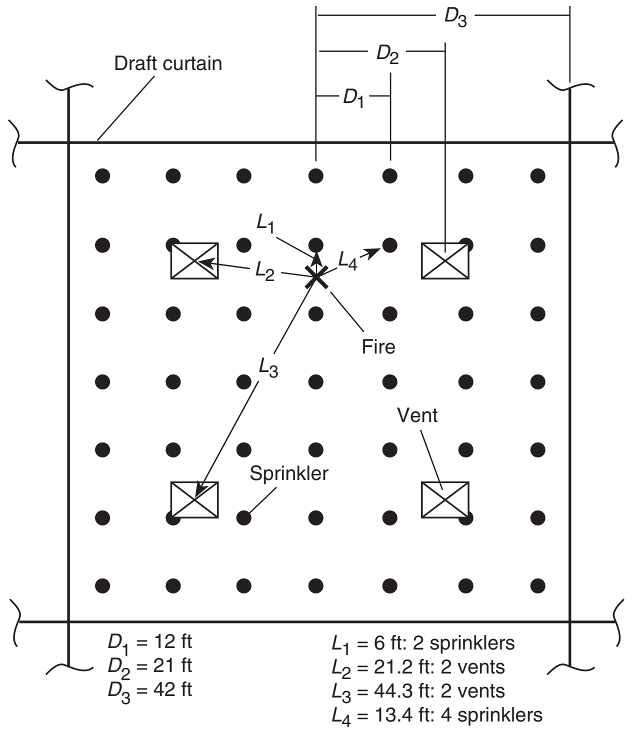

FIGURE C.3(a) Vent and Sprinkler Spacing and Fire Location for the Default Simulation.

A plot of the fire growth according to the preceding description is shown in Figure C.3(b). In the actual calculation, the fire's instantaneous energy release rate is estimated by interpolating linearly between a series of N input data points at times t_n, $n = 1$ to N, on the fire-growth curve. These points are defined by user-specified values of $\left[t_n, \dot{Q}(t_n)\right]$. For times larger than t_N, the fire's energy release rate is assumed to stay constant at $\dot{Q}(t_N)$. The calculation fire-growth curve involves six input data points (i.e., $N = 6$). These points are plotted in Figure C.3(b).

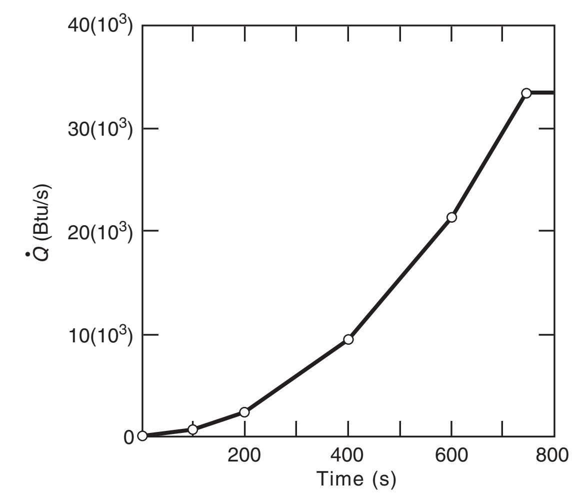

FIGURE C.3(b) Energy Release Rate vs. Time for the Fire of the Default Simulation.

The position of the fire's center is identified in Figure C.3(a). In terms of this plan view, the fire is assumed to be located at the midpoint of a 12 ft (3.7 m) line between two sprinkler links, at a distance of 21.2 ft (6.5 m) from each of the two closest equidistant vents [a total area of 96 ft^2 (8.9 m^2)] and at a distance of 44.3 ft (13.5 m) from the remaining two equidistant vents [a total area of 96 ft^2) (8.9 m^2)]. Of the sprinklers and associated links, two are closest and equidistant to the fire–plume axis at radial distances of 6 ft (1.8 m). Figure C.3(a) shows that the second and third closest groups of sprinklers and links are at radial distances of 13.4 ft (4.1 m) (four sprinklers and links) and 18 ft (5.5 m) (two sprinklers and links). In the default calculation, the opening of each of the four vents occurs, and the flow out of the vents is initiated at the simulated time of fusing of their associated links. Also simulated in the default calculation is the thermal response, including time of fusing, of the pair of sprinkler links closest to the fire.

As a final specification of the fire, it is assumed that the characteristic elevation of the fire remains at a fixed value, 2.5 ft (0.8 m) above the floor, at the initial mid-elevation of the array of combustibles. For the purpose of the default calculation, the simulation is carried out to $t = 400$ seconds, with data output every 30 seconds.

Having described the default simulation, the procedure for getting started and using LAVENT follows.

C.4 Getting Started. The executable code, LAVENT.EXE, is found on the floppy disk. Before using it, backup copies should be made. If the user has a hard drive, a separate directory should be created and the executable code should be copied into that directory. The code operates on an IBM PC or compatible computer containing a math coprocessor. It is written in Fortran 77 and needs a minimum of 300 kilobytes of memory.

To execute LAVENT, change to the proper directory or insert a floppy disk containing a copy of the executable code and enter LAVENT <ret>. In this case, <ret> refers to the ENTER or RETURN key. The first prompt provides an option for English or metric units:

1 FOR ENGLISH UNITS
2 FOR METRIC UNITS

The program has a unit conversion function and transforms files that are in one set of units to another set. The code executes in SI units; therefore, conversion is done only on input and output in order to avoid rounding errors.

For the purposes of getting started, choose Option 1, ENGLISH UNITS. Enter 1 <ret>. The following menu will be displayed on the screen:

1 READ AND RUN A DATA FILE
2 READ AND MODIFY A DATA FILE
3 MODIFY THE DEFAULT CASE TO CREATE A NEW FILE
4 RUN THE DEFAULT CASE

If Option 1 or 2 is chosen, the program will ask for the name of the data file to be used. If the chosen file resides on the hard disk, this question should be answered by typing the path of the file name, for example, C:\subdirectory\filename. If the file is on a floppy disk, type A:filename or B:filename, depending on whether the A or B drive is being used. It is recommended that all data files use a common extender such as ".dat" to facilitate identification of these files.

A first-time user should select Option 4, RUN THE DEFAULT CASE, by entering 4 <ret>. This selection will ensure that the code has been transferred intact. The default-case output is provided in Figure C.4 and is discussed in Section C.8. As a point of information, the times needed to carry out the default simulation on IBM PC-compatible 486/33 MHZ and Pentium/90 MHZ computers were 40 seconds and 8 seconds, respectively.

Now restart the code and, at this point, choose Option 3, MODIFY THE DEFAULT CASE, to review and modify the default input data. Enter 3 <ret>.

C.5 The Base Menu.

C.5.1 Modifying the Default Case — General. When Option 3, MODIFY THE DEFAULT CASE, is chosen, the following menu is displayed:

1 ROOM PROPERTIES
2 PHYSICAL PROPERTIES
3 OUTPUT PARAMETERS
4 FUSIBLE LINK PROPERTIES
5 FIRE PROPERTIES
6 SOLVER PARAMETERS
0 NO CHANGES

This menu will be referred to as the *base menu*.

Entering the appropriate option number of the base menu and then <ret> will always transfer the user to the indicated item on the menu. Entering a zero will transfer the user to the file status portion of the input section discussed in Section C.6.

The next subsections discuss data entry under Options 1 through 6 of the base menu.

Now choose Option 1, ROOM PROPERTIES, of the base menu to review and modify the default room-property input data. Enter 1 <ret>.

C.5.2 Room Properties. When Option 1, ROOM PROPERTIES, of the base menu is chosen, the following room properties menu is displayed:

1	30.00000	CEILING HEIGHT (FT)
2	84.00000	ROOM LENGTH (FT)
3	84.00000	ROOM WIDTH (FT)
4	2	NUMBER OF VENTS, ETC.
5	336.00000	CURTAIN LENGTH (FT)
6	15.00000	HEIGHT TO BOTTOM OF CURTAIN (FT)
0		TO CHANGE NOTHING

All input values are expressed in either S.I. or U.S. customary units, and the units are prompted on the input menus.

Note that the default number of vents is 2, not 4, because the symmetry of the default scenario, as indicated in Figure C.3(a), leads to "ganged" operation of each of two pairs of the four vents involved.

To change an input value in the preceding room properties menu — for example, to change the ceiling height from 30 ft to 20 ft — the user would enter 1 <ret> and 20. <ret>. The screen would show revisions using the new value of 20 ft for the ceiling height. This value or other values on this screen can be changed by repeating the process.

WARNING: *The user is warned that it is critical to end each entry number with a decimal point when a noninteger number is indicated (i.e., when the screen display shows a decimal point for that entry). The user is warned further that the code will attempt to run with any specified input file and that it will not distinguish between realistic and unrealistic input values.*

```
CEILING HEIGHT =           30.0 FT
ROOM LENGTH =              84.0 FT
ROOM WIDTH =               84.0 FT
CURTAIN LENGTH =           336.0 FT
CURTAIN HEIGHT =           15.0 FT
MATERIAL =                 INSULATED DECK (SOLID POLYSTYRENE)
CEILING CONDUCTIVITY =     .240E-04 BTU/FT F S
CEILING DENSITY =          .655E+02 LB/FT3
CEILING HEAT CAPACITY =    .277E+00 BTU/LB F
CEILING THICKNESS =        .500E+00 FT
FIRE HEIGHT =              2.5 FT
FIRE POWER/AREA =          0.3300E+03 BTU/S FT2

LINK NO =  1 RADIUS =     6.0 FT    DIST CEILING =    1.00 FT
         RTI=  400.00 SQRT FUSION TEMPERATURE FOR LINK =   165.00 K
LINK NO =  2 RADIUS =    21.2 FT    DIST CEILING =    0.30 FT
         RTI=   50.00 SQRT FUSION TEMPERATURE FOR LINK =   165.00 K
LINK NO =  3 RADIUS =    44.3 FT    DIST CEILING =    0.30 FT
         RTI=   50.00 SQRT FUSION TEMPERATURE FOR LINK =   165.00 K
VENT =   1   VENT AREA =     96.0 FT2           LINK CONTROLLING VENT =   2
VENT =   2   VENT AREA =     96.0 FT2           LINK CONTROLLING VENT =   3

TIME (S)=    0.000 LYR TEMP (F)=    80.0 LYR HT (FT)=   30.00 LYR MASS (LB)= 0.000E+00
FIRE OUTPUT (BTU/S)=  0.0000E+00 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=   80.00 JET VELOCITY (FT/S)=     0.000 JET TEMP (F) =     80.0
LINK =  2 LINK TEMP (F)=   80.00 JET VELOCITY (FT/S)=     0.000 JET TEMP (F) =     80.0
LINK =  3 LINK TEMP (F)=   80.00 JET VELOCITY (FT/S)=     0.000 JET TEMP (F) =     80.0
R (FT)=    0.00 TSL (F)=    80.0 QB (BTU/FT2 S)= 0.000E+00 QT (BTU/FT2 S)= 0.000E+00
R (FT)=   12.41 TSL (F)=    80.0 QB (BTU/FT2 S)= 0.000E+00 QT (BTU/FT2 S)= 0.000E+00
R (FT)=   24.82 TSL (F)=    80.0 QB (BTU/FT2 S)= 0.000E+00 QT (BTU/FT2 S)= 0.000E+00
R (FT)=   37.23 TSL (F)=    80.0 QB (BTU/FT2 S)= 0.000E+00 QT (BTU/FT2 S)= 0.000E+00
R (FT)=   49.64 TSL (F)=    80.0 QB (BTU/FT2 S)= 0.000E+00 QT (BTU/FT2 S)= 0.000E+00
R (FT)=   62.05 TSL (F)=    80.0 QB (BTU/FT2 S)= 0.000E+00 QT (BTU/FT2 S)= 0.000E+00

TIME (S)=   30.000 LYR TEMP (F)=    89.6 LYR HT (FT)=   28.90 LYR MASS (LB)= 0.562E+03
FIRE OUTPUT (BTU/S)=  0.1776E+03 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=   80.78 JET VELOCITY (FT/S)=     1.866 JET TEMP (F) =     94.9
LINK =  2 LINK TEMP (F)=   85.37 JET VELOCITY (FT/S)=     2.077 JET TEMP (F) =     95.3
LINK =  3 LINK TEMP (F)=   81.83 JET VELOCITY (FT/S)=     0.873 JET TEMP (F) =     87.4
R (FT)=    0.00 TSL (F)=    84.5 QB (BTU/FT2 S)= 0.312E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=    81.7 QB (BTU/FT2 S)= 0.122E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=    80.8 QB (BTU/FT2 S)= 0.570E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=    80.4 QB (BTU/FT2 S)= 0.325E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    80.3 QB (BTU/FT2 S)= 0.212E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    80.2 QB (BTU/FT2 S)= 0.152E-02 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=   60.000 LYR TEMP (F)=    96.5 LYR HT (FT)=   27.34 LYR MASS (LB)= 0.134E+04
FIRE OUTPUT (BTU/S)=  0.3552E+03 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=   82.80 JET VELOCITY (FT/S)=     2.395 JET TEMP (F) =    105.0
LINK =  2 LINK TEMP (F)=   95.13 JET VELOCITY (FT/S)=     2.657 JET TEMP (F) =    105.8
LINK =  3 LINK TEMP (F)=   85.76 JET VELOCITY (FT/S)=     1.117 JET TEMP (F) =     92.9
R (FT)=    0.00 TSL (F)=    92.7 QB (BTU/FT2 S)= 0.517E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=    85.2 QB (BTU/FT2 S)= 0.223E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=    82.5 QB (BTU/FT2 S)= 0.107E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=    81.4 QB (BTU/FT2 S)= 0.619E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    80.9 QB (BTU/FT2 S)= 0.405E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    80.6 QB (BTU/FT2 S)= 0.292E-02 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=   90.000 LYR TEMP (F)=   103.2 LYR HT (FT)=   25.65 LYR MASS (LB)= 0.216E+04
FIRE OUTPUT (BTU/S)=  0.5328E+03 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=   85.90 JET VELOCITY (FT/S)=     2.809 JET TEMP (F) =    114.5
LINK =  2 LINK TEMP (F)=  105.74 JET VELOCITY (FT/S)=     3.104 JET TEMP (F) =    115.8
LINK =  3 LINK TEMP (F)=   90.66 JET VELOCITY (FT/S)=     1.305 JET TEMP (F) =     98.2
```

FIGURE C.4 Printout of the Default-Case Output.

```
R (FT)=    0.00 TSL (F)=   102.4 QB (BTU/FT2 S)= 0.687E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=    89.7 QB (BTU/FT2 S)= 0.317E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=    84.7 QB (BTU/FT2 S)= 0.156E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=    82.7 QB (BTU/FT2 S)= 0.908E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    81.8 QB (BTU/FT2 S)= 0.598E-02 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    81.1 QB (BTU/FT2 S)= 0.987E-03 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  120.000 LYR TEMP (F)=   111.5 LYR HT (FT)=   23.85 LYR MASS (LB)= 0.301E+04
FIRE OUTPUT (BTU/S)=  0.9470E+03 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=   90.30 JET VELOCITY (FT/S)=     3.614 JET TEMP (F) =    129.3
LINK =  2 LINK TEMP (F)=  118.43 JET VELOCITY (FT/S)=     3.966 JET TEMP (F) =    132.1
LINK =  3 LINK TEMP (F)=   96.66 JET VELOCITY (FT/S)=     1.667 JET TEMP (F) =    106.2
R (FT)=    0.00 TSL (F)=   115.6 QB (BTU/FT2 S)= 0.113E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=    96.2 QB (BTU/FT2 S)= 0.543E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=    87.9 QB (BTU/FT2 S)= 0.266E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=    84.6 QB (BTU/FT2 S)= 0.154E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    83.0 QB (BTU/FT2 S)= 0.101E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    82.0 QB (BTU/FT2 S)= 0.728E-02 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  150.000 LYR TEMP (F)=   124.4 LYR HT (FT)=   21.85 LYR MASS (LB)= 0.390E+04
FIRE OUTPUT (BTU/S)=  0.1479E+04 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=   97.16 JET VELOCITY (FT/S)=     4.364 JET TEMP (F) =    149.2
LINK =  2 LINK TEMP (F)=  137.37 JET VELOCITY (FT/S)=     4.754 JET TEMP (F) =    153.4
LINK =  3 LINK TEMP (F)=  105.49 JET VELOCITY (FT/S)=     1.998 JET TEMP (F) =    117.4
R (FT)=    0.00 TSL (F)=   136.5 QB (BTU/FT2 S)= 0.158E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   107.0 QB (BTU/FT2 S)= 0.810E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=    93.3 QB (BTU/FT2 S)= 0.405E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=    87.7 QB (BTU/FT2 S)= 0.236E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    85.1 QB (BTU/FT2 S)= 0.155E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    83.5 QB (BTU/FT2 S)= 0.112E-01 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  180.000 LYR TEMP (F)=   140.2 LYR HT (FT)=   19.77 LYR MASS (LB)= 0.477E+04
FIRE OUTPUT (BTU/S)=  0.2012E+04 VENT AREA (FT2)=      0.00
LINK =  1 LINK TEMP (F)=  106.66 JET VELOCITY (FT/S)=     5.008 JET TEMP (F) =    171.4
LINK =  2 LINK TEMP (F)=  159.68 JET VELOCITY (FT/S)=     5.414 JET TEMP (F) =    176.5
LINK =  3 LINK TEMP (F)=  116.69 JET VELOCITY (FT/S)=     2.275 JET TEMP (F) =    130.2
R (FT)=    0.00 TSL (F)=   160.3 QB (BTU/FT2 S)= 0.195E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   120.4 QB (BTU/FT2 S)= 0.106E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   100.2 QB (BTU/FT2 S)= 0.545E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=    91.8 QB (BTU/FT2 S)= 0.322E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    87.8 QB (BTU/FT2 S)= 0.213E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    85.3 QB (BTU/FT2 S)= 0.332E-02 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  210.000 LYR TEMP (F)=   158.7 LYR HT (FT)=   19.59 LYR MASS (LB)= 0.471E+04
FIRE OUTPUT (BTU/S)=  0.2722E+04 VENT AREA (FT2)=     96.00
LINK =  1 LINK TEMP (F)=  118.85 JET VELOCITY (FT/S)=     5.605 JET TEMP (F) =    196.8
LINK =  2 LINK TEMP (F)=  184.03 JET VELOCITY (FT/S)=     6.021 JET TEMP (F) =    202.7
LINK =  3 LINK TEMP (F)=  129.71 JET VELOCITY (FT/S)=     2.530 JET TEMP (F) =    144.9
TIME LINK    2  OPENS EQUALS     186.7478 (S)
R (FT)=    0.00 TSL (F)=   185.7 QB (BTU/FT2 S)= 0.239E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   135.8 QB (BTU/FT2 S)= 0.137E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   108.5 QB (BTU/FT2 S)= 0.718E-01 QT (BTU/FT2 S)= 0.847E-18

R (FT)=   37.23 TSL (F)=    96.8 QB (BTU/FT2 S)= 0.427E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    91.1 QB (BTU/FT2 S)= 0.285E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    87.2 QB (BTU/FT2 S)= 0.210E-01 QT (BTU/FT2 S)= 0.847E-18

 TIME (S)=  240.000 LYR TEMP (F)=   184.9 LYR HT (FT)=   19.77 LYR MASS (LB)= 0.444E+04
FIRE OUTPUT (BTU/S)=  0.3787E+04 VENT AREA (FT2)=     96.00
LINK =  1 LINK TEMP (F)=  134.89 JET VELOCITY (FT/S)=     6.327 JET TEMP (F) =    231.8
LINK =  2 LINK TEMP (F)=  215.69 JET VELOCITY (FT/S)=     6.741 JET TEMP (F) =    238.2
LINK =  3 LINK TEMP (F)=  146.44 JET VELOCITY (FT/S)=     2.832 JET TEMP (F) =    165.1
TIME LINK    2  OPENS EQUALS     186.7478 (S)
```

FIGURE C.4 ***Continued***

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R (FT)=    0.00 TSL (F)=   218.6 QB (BTU/FT2 S)= 0.299E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   156.6 QB (BTU/FT2 S)= 0.180E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   119.9 QB (BTU/FT2 S)= 0.971E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=   103.7 QB (BTU/FT2 S)= 0.582E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=    95.7 QB (BTU/FT2 S)= 0.389E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    90.3 QB (BTU/FT2 S)= 0.288E-01 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  270.000 LYR TEMP (F)=   217.5 LYR HT (FT)=   20.17 LYR MASS (LB)= 0.407E+04
FIRE OUTPUT (BTU/S)=  0.4852E+04 VENT AREA (FT2)=    192.00
LINK =  1 LINK TEMP (F)=  155.49 JET VELOCITY (FT/S)=     6.854 JET TEMP (F) =    271.3
LINK =  2 LINK TEMP (F)=  253.19 JET VELOCITY (FT/S)=     7.244 JET TEMP (F) =    277.0
LINK =  3 LINK TEMP (F)=  167.24 JET VELOCITY (FT/S)=     3.043 JET TEMP (F) =    188.5
TIME LINK    2  OPENS EQUALS     186.7478 (S)
TIME LINK    3  OPENS EQUALS     266.9820 (S)
R (FT)=    0.00 TSL (F)=   254.4 QB (BTU/FT2 S)= 0.339E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   181.1 QB (BTU/FT2 S)= 0.217E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   133.9 QB (BTU/FT2 S)= 0.121E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=   112.2 QB (BTU/FT2 S)= 0.735E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=   101.5 QB (BTU/FT2 S)= 0.494E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    93.7 QB (BTU/FT2 S)= 0.371E-01 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  300.000 LYR TEMP (F)=   253.4 LYR HT (FT)=   22.84 LYR MASS (LB)= 0.281E+04
FIRE OUTPUT (BTU/S)=  0.5918E+04 VENT AREA (FT2)=    192.00
LINK =  1 LINK TEMP (F)=  179.59 JET VELOCITY (FT/S)=     6.901 JET TEMP (F) =    308.7
LINK =  2 LINK TEMP (F)=  289.67 JET VELOCITY (FT/S)=     7.195 JET TEMP (F) =    311.3
LINK =  3 LINK TEMP (F)=  189.77 JET VELOCITY (FT/S)=     3.023 JET TEMP (F) =    211.4
TIME LINK    1  OPENS EQUALS     282.8710 (S)
TIME LINK    2  OPENS EQUALS     186.7478 (S)
TIME LINK    3  OPENS EQUALS     266.9820 (S)
R (FT)=    0.00 TSL (F)=   287.1 QB (BTU/FT2 S)= 0.352E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   205.5 QB (BTU/FT2 S)= 0.238E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   148.7 QB (BTU/FT2 S)= 0.138E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=   121.5 QB (BTU/FT2 S)= 0.851E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=   107.8 QB (BTU/FT2 S)= 0.574E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=    98.8 QB (BTU/FT2 S)= 0.428E-01 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  330.000 LYR TEMP (F)=   284.4 LYR HT (FT)=   24.25 LYR MASS (LB)= 0.216E+04
FIRE OUTPUT (BTU/S)=  0.6983E+04 VENT AREA (FT2)=    192.00
LINK =  1 LINK TEMP (F)=  206.05 JET VELOCITY (FT/S)=     7.109 JET TEMP (F) =    342.3
LINK =  2 LINK TEMP (F)=  322.58 JET VELOCITY (FT/S)=     7.227 JET TEMP (F) =    341.6
LINK =  3 LINK TEMP (F)=  211.77 JET VELOCITY (FT/S)=     3.036 JET TEMP (F) =    231.8
TIME LINK    1  OPENS EQUALS     282.8710 (S)
TIME LINK    2  OPENS EQUALS     186.7478 (S)
TIME LINK    3  OPENS EQUALS     266.9820 (S)
R (FT)=    0.00 TSL (F)=   316.3 QB (BTU/FT2 S)= 0.366E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   229.1 QB (BTU/FT2 S)= 0.257E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   163.7 QB (BTU/FT2 S)= 0.153E+00 QT (BTU/FT2 S)= 0.847E-18

R (FT)=   37.23 TSL (F)=   130.9 QB (BTU/FT2 S)= 0.952E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=   114.2 QB (BTU/FT2 S)= 0.644E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=   103.0 QB (BTU/FT2 S)= 0.481E-01 QT (BTU/FT2 S)= 0.847E-18

 TIME (S)=  360.000 LYR TEMP (F)=   307.3 LYR HT (FT)=   24.77 LYR MASS (LB)= 0.191E+04
FIRE OUTPUT (BTU/S)=  0.8048E+04 VENT AREA (FT2)=    192.00
LINK =  1 LINK TEMP (F)=  233.80 JET VELOCITY (FT/S)=     7.559 JET TEMP (F) =    370.4
LINK =  2 LINK TEMP (F)=  351.11 JET VELOCITY (FT/S)=     7.461 JET TEMP (F) =    367.4
LINK =  3 LINK TEMP (F)=  231.51 JET VELOCITY (FT/S)=     3.134 JET TEMP (F) =    248.9
TIME LINK    1  OPENS EQUALS     282.8710 (S)
TIME LINK    2  OPENS EQUALS     186.7478 (S)
TIME LINK    3  OPENS EQUALS     266.9820 (S)
R (FT)=    0.00 TSL (F)=   344.3 QB (BTU/FT2 S)= 0.380E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   252.3 QB (BTU/FT2 S)= 0.275E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   178.8 QB (BTU/FT2 S)= 0.167E+00 QT (BTU/FT2 S)= 0.847E-18
```

FIGURE C.4 ***Continued***

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R (FT)=   37.23 TSL (F)=   140.5 QB (BTU/FT2 S)= 0.105E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=   120.8 QB (BTU/FT2 S)= 0.709E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=   107.5 QB (BTU/FT2 S)= 0.530E-01 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  390.000 LYR TEMP (F)=   327.0 LYR HT (FT)=   24.81 LYR MASS (LB)= 0.185E+04
FIRE OUTPUT (BTU/S)=  0.9113E+04 VENT AREA (FT2)=    192.00
LINK =  1 LINK TEMP (F)=  262.32 JET VELOCITY (FT/S)=     8.168 JET TEMP (F) =    397.0
LINK =  2 LINK TEMP (F)=  376.92 JET VELOCITY (FT/S)=     7.811 JET TEMP (F) =    392.0
LINK =  3 LINK TEMP (F)=  249.19 JET VELOCITY (FT/S)=     3.281 JET TEMP (F) =    264.9
TIME LINK    1  OPENS EQUALS     282.8710 (S)
TIME LINK    2  OPENS EQUALS     186.7478 (S)
TIME LINK    3  OPENS EQUALS     266.9820 (S)
R (FT)=    0.00 TSL (F)=   372.0 QB (BTU/FT2 S)= 0.398E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   275.6 QB (BTU/FT2 S)= 0.294E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   194.1 QB (BTU/FT2 S)= 0.181E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=   150.3 QB (BTU/FT2 S)= 0.114E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=   127.5 QB (BTU/FT2 S)= 0.773E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=   113.2 QB (BTU/FT2 S)= 0.574E-01 QT (BTU/FT2 S)= 0.847E-18

TIME (S)=  400.000 LYR TEMP (F)=   333.5 LYR HT (FT)=   24.77 LYR MASS (LB)= 0.185E+04
FIRE OUTPUT (BTU/S)=  0.9468E+04 VENT AREA (FT2)=    192.00
LINK =  1 LINK TEMP (F)=  271.98 JET VELOCITY (FT/S)=     8.387 JET TEMP (F) =    406.0
LINK =  2 LINK TEMP (F)=  385.32 JET VELOCITY (FT/S)=     7.936 JET TEMP (F) =    400.2
LINK =  3 LINK TEMP (F)=  254.85 JET VELOCITY (FT/S)=     3.333 JET TEMP (F) =    270.2
TIME LINK    1  OPENS EQUALS     282.8710 (S)
TIME LINK    2  OPENS EQUALS     186.7478 (S)
TIME LINK    3  OPENS EQUALS     266.9820 (S)
R (FT)=    0.00 TSL (F)=   381.3 QB (BTU/FT2 S)= 0.403E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   12.41 TSL (F)=   283.5 QB (BTU/FT2 S)= 0.300E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   24.82 TSL (F)=   199.2 QB (BTU/FT2 S)= 0.186E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   37.23 TSL (F)=   153.6 QB (BTU/FT2 S)= 0.117E+00 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   49.64 TSL (F)=   129.7 QB (BTU/FT2 S)= 0.794E-01 QT (BTU/FT2 S)= 0.847E-18
R (FT)=   62.05 TSL (F)=   115.0 QB (BTU/FT2 S)= 0.589E-01 QT (BTU/FT2 S)= 0.847E-18
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FIGURE C.4 ***Continued***

Option 6, HEIGHT TO BOTTOM OF CURTAIN, of the room properties menu is used to define the height above the floor of the bottom of the curtain. As can be seen, in the default data, this is 15 ft. Where this height is chosen to be identical to the ceiling height, the user should always define the very special idealized simulation associated with an extensive, unconfined ceiling fire scenario (i.e., by whatever means, it is assumed that the flow of the ceiling jet is extracted from the compartment at the extremities of the ceiling). Under such a simulation, an upper layer never develops in the compartment. The lower-ceiling surface and fusible links are submerged in and respond to an unconfined ceiling jet environment, which is unaffected by layer growth. This idealized fire scenario, involving the unconfined ceiling, is used, for example, in reference [1] to simulate ceiling response and in references [2] and [3] to simulate sprinkler response.

The choice of some options on a menu, such as Option 4, NUMBER OF VENTS, ETC., of the room properties menu, leads to a subsequent display/requirement of additional associated input data. Menu options that necessitate multiple entries are indicated by the use of "ETC." In the case of Option 4, NUMBER OF VENTS, ETC., three values are involved for each vent or group of vents actuated by a fusible link. As indicated under Option 4, NUMBER OF VENTS, ETC., the default data describe a scenario with two vents or groups of vents.

Now choose Option 4, NUMBER OF VENTS, ETC., to review and modify the default input data associated with these two vents or groups of vents. Enter 4 <ret>. The following is displayed on the screen:

VENT NO. = 1 FUSIBLE LINK = 2 VENT AREA = 96.00000 FT2

VENT NO. = 2 FUSIBLE LINK = 3 VENT AREA = 96.00000 FT2

ENTER 6 TO REMOVE A VENT

ENTER VENT NO., LINK NO., AND VENT AREA (FT2) TO ADD OR MODIFY A VENT

MAXIMUM NO. OF VENTS IS 5

ENTER 0 TO RETURN TO THE MENU

This display indicates that the two simulated vents or groups of vents are numbered 1 (VENT NO. = 1) and 2 (VENT NO. = 2), that they are actuated by fusible links numbered 2 (FUSIBLE LINK = 2) and 3 (FUSIBLE LINK = 3), respectively, and that each of the two vents or groups of vents has a total area of 96 ft^2 (VENT AREA = 96.00000 FT2).

In the default fire scenario, it would be of interest to study the effect of "ganging" the operation of all four vents (total area of 192 ft^2) to fusing of the closest vent link. To do so, it would be necessary to first remove vent number 2, as identified in the preceding menu, and then to modify the area of vent number 1.

To remove vent number 2, enter 6 <ret>. The following is now displayed on the screen:

ENTER NUMBER OF VENT TO BE ELIMINATED
ENTER 0 TO RETURN TO MENU

Now enter 2 <ret>. This completes removal of vent 2, with the following revision displayed on the screen:

VENT NO. = 1 FUSIBLE LINK = 2 VENT AREA = 96.00000 FT2
ENTER 6 TO REMOVE A VENT
ENTER VENT NO., LINK NO., AND VENT AREA (FT2) TO ADD OR MODIFY A VENT
MAXIMUM NO. OF VENTS IS 5
ENTER 0 TO RETURN TO THE MENU

Now modify the characteristics of vent number 1. To do so, enter 1 <ret>, 2 <ret>, 192. <ret>. The screen will now display the following:

VENT NO. = 1 FUSIBLE LINK = 2 VENT AREA = 192.00000 FT2
ENTER 6 TO REMOVE A VENT
ENTER VENT NO., LINK NO., AND VENT AREA (FT2) TO ADD OR MODIFY A VENT
MAXIMUM NO. OF VENTS IS 5
ENTER 0 TO RETURN TO THE MENU

To add or reimplement vent number 2, actuated by link number 3 and of area 96 ft^2, enter 2 <ret>, 3 <ret>, 96. <ret>. Now return to the original default scenario by bringing the area of vent number 1 back to its original 96 ft^2 value; enter 1<ret>, 2 <ret>, and 96. <ret>.

The user can now continue to modify or add additional ceiling vents or return to the room properties menu by entering 0 <ret>. If the user tries to associate a vent with a link not yet entered in the program, the code will warn the user, give the maximum number of links available in the present data set, and request a new link value. If the user deletes a link that is assigned to a vent, the code will assign the link with the next smallest number to that vent. The best method for assigning vents to links is to first use Option 4, FUSIBLE LINK PROPERTIES, of the base menu (to be discussed in C.5.5) to assign the link parameters and then to use Option 1, ROOM PROPERTIES, followed by the option NUMBER OF VENTS, ETC. to assign vent properties.

Now return to the room properties menu by entering 0 <ret>, then to the base menu by entering 0 <ret> again.

With the base menu back on the screen, choose Option 2, PHYSICAL PROPERTIES, to review and/or modify the default room property input data. Enter 2 <ret>.

C.5.3 Physical Properties. When Option 2, PHYSICAL PROPERTIES, of the base menu is chosen, the following physical properties menu is displayed:

MATERIAL = INSULATED DECK (SOLID POLYSTYRENE)
HEAT CONDUCTIVITY = 2.400E-05 (BTU/S LB F)
HEAT CAPACITY = 2.770E-01 (BTU/LB F)
DENSITY = 6.550E+01 (LB/FT3)

1	80.00000	AMBIENT TEMPERATURE (F)
2	0.50000	MATERIAL THICKNESS (FT)
3	MATERIAL =	INSULATED DECK (SOLID POLYSTYRENE)
0		CHANGE NOTHING

The values in Options 1 and 2 are modified by entering the option number and then the new value.

Now choose Option 3 by coding 3 <ret>. The following menu is displayed:

1 CONCRETE
2 BARE METAL DECK
3 INSULATED DECK (SOLID POLYSTYRENE)
4 WOOD
5 OTHER

By choosing one of Options 1 through 4 of this menu, the user specifies the material properties of the ceiling according to the table of standard material properties in reference [4]. When the option number of one of these materials is chosen, the material name, thermal conductivity, heat capacity, and density are displayed on the screen as part of an updated physical properties menu.

Now choose Option 5, OTHER, by entering 5 <ret>. The following screen is displayed:

ENTER MATERIAL NAME
THERMAL CONDUCTIVITY (BTU/S FT F)
HEAT CAPACITY (BTU/LB F)
DENSITY (LB/FT3)

The four indicated inputs are required. After they are entered, the screen returns to an updated physical properties menu.

Now return to the default material, INSULATED DECK (SOLID POLYSTYRENE). To do so, enter any arbitrary material name with any three property values (enter MATERIAL<ret>, 1. <ret>, 1. <ret>, 1. <ret>); then choose Option 3, MATERIAL, from the menu displayed (enter 3 <ret>); and, from the final menu displayed, choose Option 3, INSULATED DECK (SOLID POLYSTYRENE) by entering 3 <ret>.

Now return to the base menu. Enter 0 <ret>. Choose Option 3, OUTPUT PARAMETERS, of the base menu to review or modify the default output-parameter data. Enter 3 <ret>.

C.5.4 Output Parameters. When Option 3, OUTPUT PARAMETERS, of the base menu is chosen, the following output-parameters menu is displayed:

1	400.000000	FINAL TIME (S)
2	30.000000	OUTPUT INTERVAL (S)
0		CHANGE NOTHING

FINAL TIME represents the ending time of the calculation. OUTPUT INTERVAL controls the time interval between successive outputs of the calculation results. All times are in seconds. For example, assume that it is desired to run a fire scenario for 500 seconds with an output of results every 10 seconds. First choose Option 1 with a value of 500 (enter 1 <ret>, 500. <ret>), then Option 2 with a value of 10 (enter 2 <ret>, 10. <ret>). The following revised output-parameters menu is displayed:

1	500.000000	FINAL TIME (S)
2	10.000000	OUTPUT INTERVAL (S)
0		CHANGE NOTHING

Return to the original default output parameters menu by entering 1 <ret>, 400. <ret>, followed by 2 <ret>, 30. <ret>.

Now return to the base menu from the output parameters menu by entering 0 <ret>.

With the base menu back on the screen, choose Option 4, FUSIBLE LINK PROPERTIES, to review or modify the default fusible link properties data. Enter 4 <ret>.

C.5.5 Fusible Link Properties. When Option 4, FUSIBLE LINK PROPERTIES, of the base menu is chosen, the following fusible link properties menu is displayed:

TO ADD OR CHANGE A LINK, ENTER LINK NO., RADIUS (FT), DISTANCE BELOW CEILING (FT), RTI (SQRT[FT S]), AND FUSE TEMPERATURE (F).
MAXIMUM NUMBER OF LINKS EQUALS 10.
ENTER 11 TO REMOVE A LINK.
ENTER 0 TO RETURN TO THE MENU.

LINK #	RADIUS (FT)	DISTANCE (FT) BELOW CEILING	RTI SQRT (FT S)	FUSE TEMP (F)
1	6.000	1.000	400.000	165.000
2	21.200	0.300	50.000	165.000
3	44.300	0.300	50.000	165.000

Each fusible link must be assigned a link number (e.g., LINK # = 1), radial position from the plume–ceiling impingement point (e.g., RADIUS = 6.00 FT), ceiling-to-link separation distance (e.g., DISTANCE BELOW CEILING = 1.00 FT), response time index (e.g., RTI = 400.00 SQRT[FT S]), and fuse temperature (e.g., FUSE TEMPERATURE = 165.00 F).

Suppose that in the default fire scenario it was desired to simulate the thermal response of the group of (four) sprinkler links second closest to the fire. According to the description in Section C.3 and in Figure C.3(a), this would be done by adding a fourth link, link number 4, at a radial distance of 13.4 ft, 1 ft below the ceiling, with an RTI of 400 $(ft/sec)^{1/2}$ and a fusion temperature of 165°F. To do this, enter 4 <ret>, 13.4 <ret>, 1. <ret>, 400. <ret>, 165.<ret>. Then the following screen is displayed:

TO ADD OR CHANGE A LINK, ENTER LINK NO., RADIUS (FT), DISTANCE BELOW CEILING (FT), RTI (SQRT[FT S]), AND FUSE TEMPERATURE (F).
MAXIMUM NUMBER OF LINKS EQUALS 10.
ENTER 11 TO REMOVE A LINK.
ENTER 0 TO RETURN TO THE MENU.

LINK #	RADIUS (FT)	DISTANCE (FT) BELOW CEILING	RTI SQRT (FT S)	FUSE TEMP (F)
1	6.000	1.000	400.000	165.000
2	13.400	1.000	400.000	165.000
3	21.200	0.300	50.000	165.000
4	44.300	0.300	50.000	165.000

Note that the new link, which was entered as link number 4, was sorted automatically into the list of the original three links and that all four links were renumbered according to radial distance from the fire. The original link-vent assignments are preserved in this operation. Hence, the user need not return to Option 4, NUMBER OF VENTS, ETC., unless it is desired to reassign link-vent combinations.

A maximum of 10 link responses can be simulated in any one simulation.

Now remove link number 2 to return to the original default array of links. To do so, enter 11 <ret>. The following screen is displayed:

ENTER THE NUMBER OF THE LINK TO BE REMOVED

Enter 2 <ret> to remove link 2.

Now return to the base menu from the fusible link properties menu by entering 0 <ret>.

With the base menu back on the screen, choose Option 5, FIRE PROPERTIES, to review or modify the default fire properties data. Enter 5 <ret>.

C.5.6 Fire Properties. When Option 5, FIRE PROPERTIES, from the base menu is chosen, the following fire properties menu is displayed:

1	2.5	FIRE HEIGHT (FT)
2	330.0	FIRE POWER/AREA (BTU/S FT2), ETC.
3		FIRE OUTPUT AS A FUNCTION OF TIME
0		CHANGE NOTHING

The value associated with Option 1 is the height of the base of the fire above the floor. Change this to 3 ft, for example, by entering 1 <ret> and 3. <ret>. Then return to the default data by entering 1 <ret> and 2.5 <ret>.

The value associated with Option 2 is the fire energy release rate per fire area. It is also possible to consider simulations where the fire area is fixed by specifying a fixed fire diameter. The fire energy release rate per fire area can be changed, or the fixed fire area type of specification can be made by choosing Option 2 by entering 2 <ret>. This leads to a display of the following menu:

1	WOOD PALLETS, STACK, 5 FT HIGH	330 (BTU/S FT2)
2	CARTONS, COMPARTMENTED, STACKED 15 FT HIGH	200 (BTU/S FT2)
3	PE BOTTLES IN COMPARTMENTED CARTONS 15 FT HIGH	540 (BTU/S FT2)
4	PS JARS IN COMPARTMENTED CARTONS 15 FT HIGH	1300 (BTU/S FT2)
5	GASOLINE	200 (BTU/S FT2)
6	INPUT YOUR OWN VALUE IN (BTU/S FT2)	
7	SPECIFY A CONSTANT DIAMETER FIRE IN FT	
0	CHANGE NOTHING	

Options 1 through 5 of the preceding menu are for variable area fires. The Option 1 to 5 constants displayed on the right are the fire energy release rate per unit fire area. They are taken from Table 4.1 of reference [1]. If one of these options is chosen, an appropriately updated fire properties menu is then displayed on the screen. Option 0 would lead to the return of the original fire properties menu.

Option 6 allows any other fire energy release rate per unit fire area of the user's choice. Option 7 allows the user to specify the diameter of a constant area fire instead of an energy release rate per unit area fire. Choice of Option 6 or 7 must be followed by entry of the appropriate value. Then an appropriately updated fire properties menu appears on the screen.

To try Option 7, SPECIFY A CONSTANT DIAMETER FIRE IN FEET, enter 7 <ret>. The following screen is displayed:

ENTER YOUR VALUE FOR FIRE DIAMETER IN FT

Assume the fire diameter is fixed at 5 ft. Enter 5. <ret>. Then the following screen is displayed:

1	2.50000	FIRE HEIGHT (FT)
2	5.00000	FIRE DIAMETER (FT), ETC.
3		FIRE OUTPUT AS A FUNCTION OF TIME
0		CHANGE NOTHING

Now return to the original default fire properties menu by entering 2 <ret>. The previous menu will be displayed. In this, choose Option 1, WOOD PALLETS, STACK, 5 ft high, by entering 1 <ret>.

Option 3, FIRE OUTPUT AS A FUNCTION OF TIME, of the fire properties menu allows the user to prescribe the fire as a function of time. The prescription involves: (1) linear interpolation between adjacent pairs of user-specified points with coordinates (time in seconds, fire energy release rate in BTU/sec); and (2) continuation of the fire to an arbitrarily large time at the fire energy release rate of the last data point.

Now choose Option 3 by entering 3 <ret>. The following screen associated with the default fire output data is displayed:

1	TIME(s) = 0.00000	POWER(BTU/S) = 0.00000E+0
2	TIME(s) = 100.0000	POWER(BTU/S) = 0.59200E+03
3	TIME(s) = 200.0000	POWER(BTU/S) = 0.23670E+04
4	TIME(s) = 400.0000	POWER(BTU/S) = 0.94680E+04
5	TIME(s) = 600.0000	POWER(BTU/S) = 0.21302E+05
6	TIME(s) = 747.0000	POWER(BTU/S) = 0.33000E+05

ENTER DATA POINT NO., TIME (S), AND POWER (BTU/S)

ENTER 11 TO REMOVE A POINT

ENTER 0 TO RETURN TO MENU

As discussed in Section C.3, with use of the six preceding data points, the default simulation will estimate the fire's energy release rate according to the plot of Figure C.3(b).

Additional data points can be added to the fire growth simulation by entering the new data point number, <ret>, the time in seconds, <ret>, the energy release rate in BTU/sec, and <ret>.

The maximum number of data points permitted is 10. The points can be entered in any order. A sorting routine will order the points by time. One point must correspond to zero time.

As an example of adding an additional data point to the preceding six, assume that a closer match to the "*t*-squared" default fire growth curve was desired between 200 seconds and 400 seconds. From Section C.3 it can be verified that the fire energy release rate will be 5325 BTU/sec at $t = 300$. To add this point to the data, thereby forcing the fire growth curve to pass exactly through the "*t*-squared" curve at 300 seconds, enter 7 <ret>, 300. <ret>, and 5325. <ret>. The following revised screen will be displayed:

1	TIME(s) = 0.0000	POWER(BTU/S) = 0.00000E+00
2	TIME(s) = 100.0000	POWER(BTU/S) =0.59200E+03
3	TIME(s) = 200.0000	POWER(BTU/S) = 0.23670E+04
4	TIME(s) = 300.0000	POWER(BTU/S) = 0.53250E+04
5	TIME(s) = 400.0000	POWER(BTU/S) =0.94680E+04
6	TIME(s) = 600.0000	POWER(BTU/S) = 0.21302E+05
7	TIME(s) = 747.0000	POWER(BTU/S) = 0.33000E+05

ENTER DATA PT. NO., TIME (S), AND POWER (BTU/S)

ENTER 11 TO REMOVE A POINT

ENTER 0 TO RETURN TO MENU

Note that the revised point, which was entered as point number 7, has been resorted into the original array of data points and that all points have been renumbered appropriately.

Now remove the point just added (which is now point number 4). First enter 11 <ret>. Then the following screen is displayed:

ENTER THE NUMBER OF THE DATA POINT TO BE REMOVED

Now enter 4 <ret>. This brings the fire growth simulation data back to the original default set of values.

Now return to the fire properties menu. Enter 0 <ret>. Then return to the base menu by entering again 0 <ret>.

With the base menu back on the screen, it is assumed that the inputing of all data required to define the desired fire simulation is complete. Now choose Option 0, NO CHANGES, to proceed to the file status menu. Enter 0 <ret>.

C.5.7 Solver Parameters. Users of the code will generally have no need to refer to this section (i.e., especially when learning to use the LAVENT code, a user should now skip to Section C.6), since they are rarely, if ever, expected to run into a situation where the code is not able to obtain a solution for a particular application or is taking an inordinate amount of time to produce the solution. However, if this does happen, there are a number of variations of the default solver parameter inputs that can resolve the problem.

Start the input part of the program to get to the base menu. Then choose Option 6, SOLVER PARAMETERS, by entering 6 <ret>. The following input options menu will be displayed:

1	0.6500E+00	GAUSS-SEIDEL RELAXATION
2	0.1000E-04	DIFF EQ SOLVER TOLERANCE
3	0.1000E-04	GAUSS-SEIDEL TOLERANCE
4	2.000000	FLUX UPDATE INTERVAL (S)
5	6	NUMBER OF CEILING GRID POINTS, MIN=2, MAX=50
6	0.1000E-07	SMALLEST MEANINGFUL VALUE
7		CHANGE NOTHING

The solvers used in this code consist of a differential equation solver DDRIVE2, used to solve the set of differential equations associated with the layer and the fusible links, and a Gauss–Seidel/tridiagonal solver using the Crank–Nicolson formalism to solve the set of partial differential equations associated with the heat conduction calculation for the ceiling. Because two different solvers are being used in the code, there is potential for the solvers to become incompatible with each other, particularly if the upper layer has nearly reached a steady-state temperature but the ceiling is still increasing its temperature. When this occurs, the differential equation solver will try to take time steps that are too large for the Gauss–Seidel solver to handle, and a growing oscillation in the ceiling temperature variable might occur. By reducing the FLUX UPDATE INTERVAL, the growing oscillation can be suppressed. The smaller the FLUX UPDATE INTERVAL, the slower the code will run.

The GAUSS–SEIDEL RELAXATION coefficient can be changed to produce a faster running code or to handle a case that will not run with a different coefficient. Typical values of this coefficient should range between 0.2 and 1.0.

The DIFF EQ SOLVER TOLERANCE and the GAUSS–SEIDEL TOLERANCE can also be changed. Decreasing or increasing these values can provide a faster running code for a given case, and by decreasing the value of the tolerances, the accuracy of the calculations can be increased. If the tolerance values are made too small, the code will either run very slowly or not run at all. Suggested tolerances would be in the range of 0.00001 to 0.000001.

Consistent with the model assumptions, accuracy in the radial ceiling temperature distribution around the plume–ceiling impingement point is dependent on the NUMBER OF CEILING GRID POINTS. Relatively greater or lesser accuracy is achieved by using relatively more or fewer grid points. This leads, in turn, to a relatively slower or faster computer run.

C.6 File Status — Running the Code. When Option 0, NO CHANGES, of the base menu is chosen, the following file status menu is displayed:

1 SAVE THE FILE AND RUN THE CODE
2 SAVE THE FILE BUT DON'T RUN THE CODE
3 DON'T SAVE THE FILE BUT RUN THE CODE
4 ABORT THE CALCULATION

If one of the save options is selected, the user will be asked to supply a file name to designate the file where the newly generated input data are to be saved. The program will automatically create the new file. File names may be as long as eight characters and should have a common extender such as .DAT (for example MYFILE.DAT). The maximum length that can be used for the total length of input or output files is 25 characters. For example, C:\SUBDIRECT\FILENAME.DAT would allow a file named FILENAME.DAT to be read from the subdirectory SUBDIRECT on the C drive. To read a file from a floppy disk in the A drive, use A:FILENAME.DAT. If Option 4 is chosen, the program will end without any file being saved.

A request for an output file name can appear on the screen. File names can be as long as eight characters and should have an extender such as ".OUT" so that the output files can easily be recognized. To output a file to a floppy disk in the A drive, name the file A:FILENAME.OUT. To output a file to a subdirectory other than the one that is resident to the program, use C:\SUBDIRECT\FILENAME.OUT for the subdirectory SUBDIRECT.

Once the output file has been designated, the program will begin to execute. The statement PROGRAM RUNNING will appear on the screen. Each time the program writes to the output file, a statement such as T = 3.0000E01 S will appear on the screen to provide the user with the present output time.

C.7 The Output Variables and the Output Options. The program generates two separate output files. An example of the first output file is appended at the end of this document. This file is named by the user and consists of a listing of the input data plus all the relevant output variables in a format where the output units are specified and the meanings of all but three of the output variables are clearly specified. These latter variables are *TSL, QB,* and *QT*, the temperature of the ceiling inside the enclosure, the net heat transfer flux to the bottom surface of the ceiling, and the net heat transfer flux to the top surface of the ceiling, respectively. The variables are output as a function of radius, with $R = 0$ being the center of the fire plume projected on the ceiling. Other abbreviations include LYR TEMP, LYR HT, LYR MASS, JET VELOCITY, and JET TEMP — the upper-layer (layer adjacent to the ceiling) temperature, height of the upper-layer interface above the floor, mass of gas in the layer, ceiling jet velocity, and ceiling jet temperature at the position of each fusible link, respectively. The VENT AREA is the total area of roof vents open at the time of output.

The second output file, GRAPH.OUT, is used by the graphics program GRAPH. GRAPH is a Fortran program that makes use of a graphics software package to produce graphical output of selected output variables [5, 6]. To use the graphics program, the file GRAPH.OUT must be in the same directory as the program GRAPH. GRAPH is a menu-driven program that provides the user with the ability to plot two sets of variables on the PC screen. An option exists that permits the user to print the plots from the screen to a printer. If using an attached EPSON-compatible printer, enter <ret> to produce a plot using the printer. To generate a PostScript file for use on a laser printer, enter <ret> and provide a file name when the file name prompt appears in the upper left hand corner of the graph. To exit to screen mode from the graphics mode, enter <ret>. The file GRAPH.OUT will be destroyed each time the code LAVENT is run. If the user wishes to save the graphics file, it must be copied using the DOS copy command into another file with a different file name.

To demonstrate the use of GRAPH, start the program by entering graph <ret>. GRAPH will read in the graphics output file GRAPH.OUT, and the following screen will be displayed:

ENTER 0 TO PLOT POINTS, ENTER 1 TO PLOT AND CONNECT POINTS

The graphics presented in Figure C.7(a) through Figure C.7(e) were done with GRAPH using option 0. Enter 0 <ret> and the following graphics menu is displayed:

ENTER THE X AND Y VARIABLES FOR THE DESIRED TWO GRAPHS

1 TIME
2 LAYER TEMPERATURE
3 LAYER HEIGHT
4 LAYER MASS
5 FIRE OUTPUT
6 CEILING VENT AREA
7 PLUME FLOW
8 LINK TEMPERATURE
9 JET VELOCITY AT LINK
10 JET TEMPERATURE AT LINK

Two plots can be studied on a single screen. For example, from the default simulation, assume that displays of the plots of Figure C.7(a) and Figure C.7(b), LAYER HEIGHT vs. TIME and LAYER TEMPERATURE vs. TIME, respectively, are desired. Then enter 1 <ret>, 3 <ret>, 1 <ret>, and 2 <ret>. The program will respond with the following prompt:

ENTER THE TITLES FOR THE TWO GRAPHS, 16 CHARACTERS MAX.

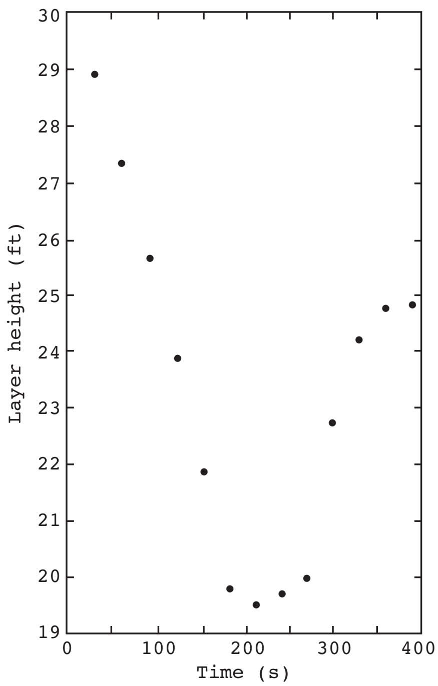

FIGURE C.7(a) Plot of the Height of the Smoke Layer Interface vs. Time for the Default Simulation.

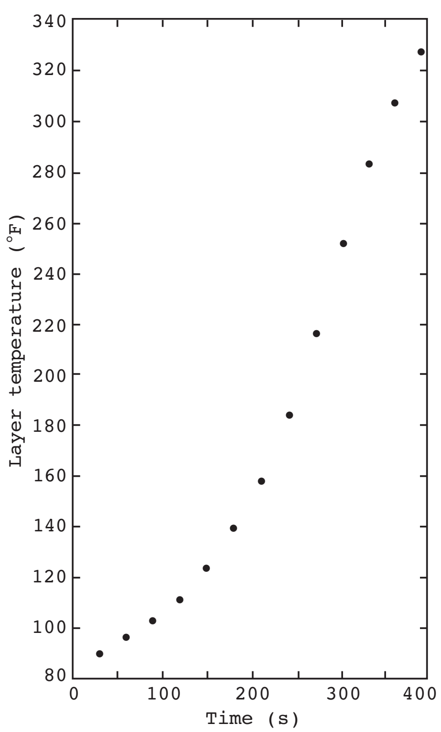

FIGURE C.7(b) Plot of the Temperature of the Smoke Layer vs. Time for the Default Simulation.

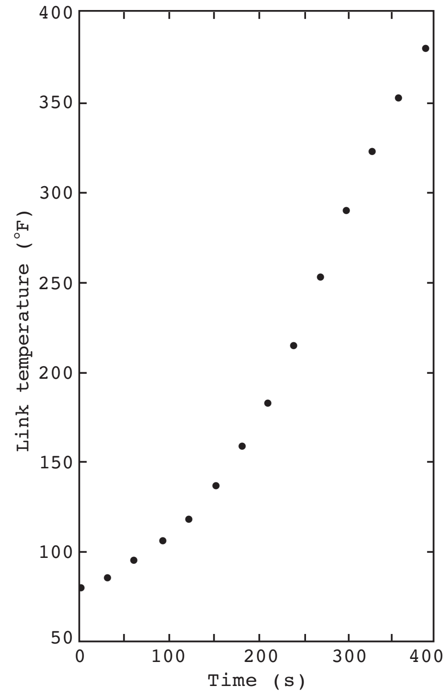

FIGURE C.7(c) Plot of the Closest (*R* = 21.2 ft) Vent-Link Temperature vs. Time for the Default Simulation.

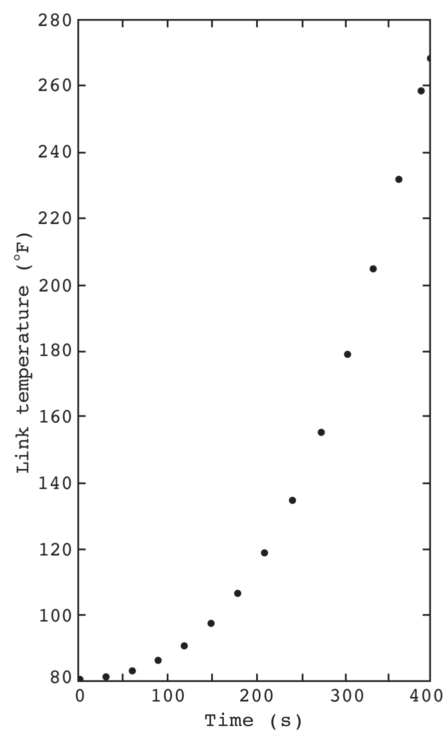

FIGURE C.7(d) Plot of the Far (*R* = 44.3 ft) Pair of Vent-Link Temperatures vs. Time for the Default Simulation.

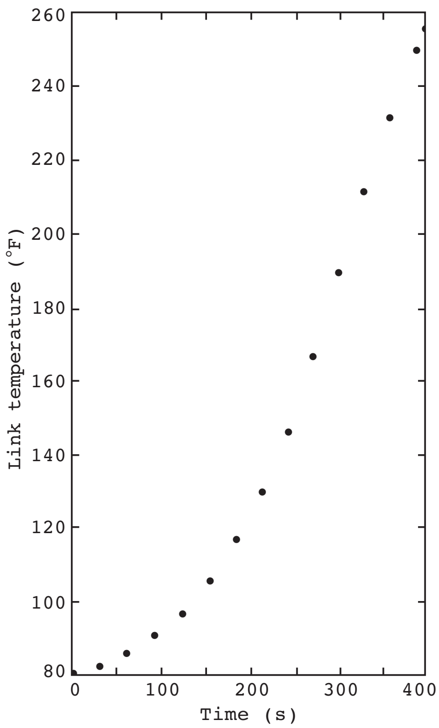

FIGURE C.7(e) Plot of the Closest (*R* = 6 ft) Sprinkler-Link Temperatures vs. Time for the Default Simulation.

The user might choose titles that would identify particular cases such as LY HT RUN 100 <ret> and LY TEMP RUN 100 <ret>. If a title longer than 16 characters is chosen, it will be truncated to 16 characters. After the titles have been entered, the program will respond with the following prompt:

ENTER 1 FOR DEFAULT SCALING, 2 FOR USER SCALING.

If the user chooses option 1, the desired plots will appear on the screen with an internal scaling for the *x*- and *y*-axis of each graph. If the user chooses option 2, the program will respond with the following prompt:

ENTER THE MINIMUM AND MAXIMUM VALUES FOR THE X AND Y AXIS OF EACH GRAPH.

ENTER 0 FOR THE MINIMUM AND MAXIMUM VALUES OF EACH AXIS WHERE DEFAULT SCALING IS DESIRED. FOR EXAMPLE, VALUES SHOULD BE ENTERED AS 0.,100.,0.,200.,10.,50.,20.,100.<ret> FOR X1(0-100), Y1(0-200), X2(10-50), Y2(20-100).

Use of this option allows a number of different cases to be compared using similar values for the *x*- and *y*-axis of each graph. All eight numbers must be entered and separated with commas before entering <ret>. Once the entry is made, the plots will appear on the screen. Note that this option permits a mixture of default scaling and user-specified scaling.

Once a pair of plots are displayed on the screen, the user would have the choice of entering <ret> to obtain a hard-copy plot of the graphs or of entering <ret> to exit the graphics mode.

To plot a second pair of graphs, the user would exit the graphics mode by entering <ret> and then repeat the preceding process by entering graph <ret>, and so forth.

If the user selects plots that involve variables defined by Option 8, 9, or 10, then, following the entry 8 <ret>, 9 <ret>, or 10 <ret>, the following prompt for identifying the desired link number (in the default simulation with three simulated links) will be displayed immediately:

ENTER LINK NUMBER, MAXIMUM NUMBER = 3

The user would then enter the desired link number followed by <ret> and continue entering the remaining input data that define the desired plots.

As an example of generating link-related plots, consider displaying the pair of plots LINK TEMPERATURE vs. TIME and JET VELOCITY AT LINK vs. TIME for link number 3 in the default simulation. First enter 1 <ret> (for TIME on the *x*-axis) and 8 <ret> (for LINK TEMPERATURE on the *y*-axis). At this point, "ENTER LINK NUMBER . . ." would be displayed on the screen. Continue by entering 3 <ret> (for link number 3). This would complete the data entry for the first of the two plots. For the second plot, enter 1 <ret> (for TIME on the *x*-axis) and 9 <ret> (for LINK TEMPERATURE on the *y*-axis). At this point, "ENTER LINK NUMBER . . ." would be displayed a second time. Then conclude data input for the pair of plots by entering 3 <ret> (for link number 3). At this point the desired pair of plots would be displayed on the screen.

C.8 An Example Simulation — The Default Case. This section presents and reviews briefly the simulation of the default case.

The tabular output of the default simulation is presented in Figure C.4. Plots of the layer-interface height and of the layer temperature as functions of time are plotted in Figure C.7(a) and Figure C.7(b), respectively. Plots of the thermal response of the two pairs of vent links and the pair of sprinkler links closest to the fire are presented in Figure C.7(c) through Figure C.7(e), respectively.

From Figure C.4 and Figure C.7(c) through Figure C.7(e), it is seen that the sequence of link fusing (at 165°F) is predicted to be the near pair of vents at 187 seconds, the far pair of vents at 267 seconds, and the pair of closest sprinklers at 283 seconds. Although the sprinkler links are closer to the fire than any of the vent links, and although all links have the same fuse temperatures, the simulation predicts that the sprinkler links fuse after all of the vent links. There are two reasons for this. First, the RTIs of the sprinkler links are larger than those of the vent links and, therefore, slower to respond thermally. Second, the two sprinkler links simulated are far enough from the ceiling as to be below the peak temperature of the ceiling jet, which is relatively thin at the 6 ft radial position (see the lower sketch of Figure C.2).

The effect on layer growth of fusing of the two pairs of vent links and opening of their corresponding vents at 187 seconds and 267 seconds can be noted in Figure C.7(a). Note that the opening of the first pair of vents effectively stops the rate-of-increase of layer thickness and the opening of the second pair of vents leads to a relatively rapid rate-of-decrease in the layer thickness. All of this is of course occurring at times when the energy release rate of the fire is growing rapidly.

As can be seen in Figure C.7(a), up until the 400 seconds of simulation time, the smoke is still contained in the original curtained compartment and has not "spilled over" to adjacent spaces. From this figure it appears that with no venting, the layer would have dropped below the bottom of the curtain boards prior to fusing of the first sprinkler links. This could be confirmed with a second simulation run of LAVENT, where all vent action was removed from the default data.

C.9 References for Annex C.

1. Cooper, L. Y., and D. W. Stroup. "Thermal Response of Unconfined Ceilings Above Growing Fires and the Importance of Convective Heat Transfer," *Journal of Heat Transfer* 109:172–178, 1987.

2. Evans, D. D. "Calculating Sprinkler Activation Time in Compartments," *Fire Safety Journal* 9:147–155, 1985.

3. Stroup, D. W., and D. D. Evans. "Use of Computer Fire Models for Analyzing Thermal Detector Spacing," *Fire Safety Journal* 14:33–45, 1988.

4. Gross, D. "Data Sources for Parameters Used in Predictive Modeling of Fire Growth and Smoke Spread," NBSIR 85–3223, National Bureau of Standards, Gaithersburg MD, September 1985.

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6. Kahaner, D., National Institute of Standards and Technology, private communication.

Annex D Sample Problem Using Engineering Equations (Hand Calculations) and LAVENT

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

D.1 Abstract. The following example problem illustrates the use of the information, engineering equations, hand calculations, and computer model described in this document. The impact of a fire on a nonsprinklered retail storage building and its occupants is assessed. The effects of an anticipated fire on the subject building are predicted, and the impact of smoke and heat vents is illustrated.

Design goals and objectives were developed, and a high-challenge fire, likely to occur in the subject building, was identified. The fire impact was assessed using three different methods:

(1) Hand calculations assuming a quasi-steady fire
(2) Hand calculations assuming a continuous-growth (*t*-squared) fire
(3) The computer model LAVENT

Hand calculations are useful for generating quick estimates of the impact of vents on fire effects. However, hand calculations are not able to assess time-varying events. A number of simplifying assumptions have been used to facilitate problem solving via algebraic equations. Hand-calculated results are considered valid, but they produce slightly different estimates of fire effects such as upper-layer temperature. A computer model such as LAVENT generally provides a more complete analysis of the fire-produced effects and, in some instances, is preferable over hand calculations.

D.2 Introduction. The following example problem illustrates the use of engineering equations and a computer model to assess the impact of a fire in a nonsprinklered retail storage building. The problem illustrates the impact of vents and predicts the effect of the anticipated fire on the building.

D.2.1 Goal. Develop a vent design for the subject building that will maintain a tenable environment for a period of time at least equal to the time required to evacuate the building and equal to the time required to maintain the hot upper layer a minimum of 3 m above floor level until the local fire department enters the building.

D.2.2 Objective. Determine the vent area required to maintain the smoke layer at least 3 m above floor level for 300 seconds following detection of the fire by an automatic detection system. Also, limit the heat flux at floor level to a maximum of 2.5 kW/m^2, the threshold irradiance that causes severe pain to exposed skin [1], during the time required for evacuation of the building occupants.

D.2.3 Building Details. The building is 73 m wide, 73 m long, and 9.1 m high. It is not subdivided, nor is it provided with a sprinkler system. The roof is an insulated deck (solid polystyrene). A complete fire alarm system is to be installed using heat detectors spaced 15.2 m on center and 6.1 m from walls. Detectors will have an activation temperature of 74°C and an RTI of 55 $(m{\cdot}s)^{1/2}$ and are to be located 0.3 m below the roof. Sixteen vents are proposed, spaced 18.3 m on center. Vents will be located 9.05 m from walls. The vents will be activated by fusible links with an activation temperature of 74°C and an RTI of 28 $(m{\cdot}s)^{1/2}$ and are to be located 0.3 m below the roof. Inlet air openings will be equal to 1.5 the total vent area. *(See Figure D.2.3.)*

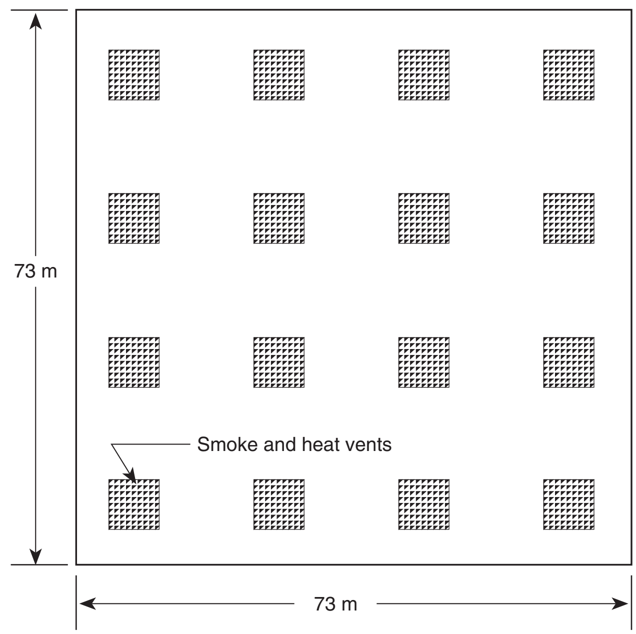

FIGURE D.2.3 Vent Plan View.

D.2.4 Occupancy Details. The building is to be occupied for retail storage. This analysis deals with a fire in rack storage of sofas in the center of the building. The sofas are to be stored in two racks, each 9.75 m long and 1.2 m wide and separated from each other by 2.4 m. Each rack will have four tiers of storage, four sofas per tier, and a total storage height of 7.6 m. Distance to combustibles surrounding the racks will be sufficient to prevent fire spread to those combustibles during the time period covered by this analysis. The sofas are identified as specimen F32 contained within Table E.5.3(d). Data for the same sofas are contained within a database of Hazard I [2], where the sofas are identified as specimen UPS001. Each sofa will contain 51.5 kg of combustible mass and be wrapped in polyethylene.

D.2.5 Ignition. An ignition is assumed to occur in a sofa on the first tier of one of the racks. Ignition of a sofa on the first tier is a probable worst-case scenario and, as a practical matter, is a location where ignition could be expected. Also, placing the fire near floor level results in near-maximum smoke production (entrainment).

D.3 Fire Growth. First, an estimate of the anticipated fire growth must be developed. A t-squared fire will be assumed *(see* 8.3.1 *and* A.8.3.1*)*. In a t-squared fire,

$$Q = \alpha_g t^2 \quad \textbf{[D.3a]}$$

where:
Q = total heat release rate (kW)
α_g = fire growth coefficient
t = time (seconds)

The data base within Hazard I [2] contains data from furniture calorimeter tests of sofas. A sofa (UPS001) was tested and demonstrated a growth time (t_g) to 1 MW of approximately 200 seconds. The fire in the sofa in this example is assumed to have a growth time of 150 seconds to 1 MW as a reasonable, conservative approximation of the anticipated fire in the sofas stored in the example building. If a more precise estimate of the burning characteristics of an individual sofa is necessary, the exact sofa to be stored in the building could be tested in a calorimeter. A fire growth time of 150 seconds results in an α_g for the individual sofa of 0.044 kW/s^2 *(see Equation 8.3.2)*. That is,

$$\alpha_g = \frac{1000}{t_g^2} = \frac{1000}{150^2} = 0.044 \text{ kW/s}^2 \quad \textbf{[D.3b]}$$

Accordingly, fire growth in the first sofa ignited can be approximated by a fast (α_g = 0.044 kW/sec^2) t-squared fire. Further, according to 8.3.1, α_g is directly proportional to the storage height. Therefore, the fire growth constant (α_g) for sofas stacked four high is 4 times 0.044 kW/s^2, or α_g equals 0.18 kW/s^2, and initial fire growth is approximated as

$$Q = \alpha_g t^2 \quad \textbf{[D.3c]}$$

where α_g = 0.18 kW/s^2.

Fire growth in the first rack of sofas results in radiant heat transfer to a second rack of sofas separated from the first rack by 2.4 m. It must be determined when the second rack of sofas ignite. The fire size, when ignition of the second rack of sofas occurs, is determined using Equation 8.2.3 with its terms rearranged:

$$Q = \frac{W}{0.042^2} \quad \textbf{[D.3d]}$$

where:
Q = fire output (kW)
W = aisle width (m)

Next, the time of ignition of the second rack is computed:

$$t = \left(\frac{Q}{\alpha_g}\right)^{1/2} = \left(\frac{3250}{0.18}\right)^{1/2} = 134 \text{ s} \quad \textbf{[D.3e]}$$

where $Q = \alpha_g t^2$.

When the second rack of sofas is ignited at 134 seconds, the fire growth coefficient, α_g, for the two racks burning together is assumed to double the value for the first rack burning alone (α_g = 0.36 kW/s^2). At that time, the fire appears to have originated at effective ignition time, t_{0g}. For t >134 seconds,

$$Q = 0.36\left(t - t_{0g}\right)^2 \text{ kW} \quad \textbf{[D.3f]}$$

Determine t_{0g} as follows:

$$3250 = 0.36\left(134 - t_{0g}\right)^2 \quad \textbf{[D.3g]}$$

where t_{0g} = 39 seconds. Then, for t > 134 seconds,

$$Q = 0.36\left(t - 39\right)^2 \quad \textbf{[D.3h]}$$

The maximum fire size is now estimated. Sofa UPS001 from the Hazard I database [2] [specimen F32 in Table E.5.3(d)] has a peak burning rate of 3120 kW. Maximum fire size, Q_{max}, is based on the assumption that all 32 sofas are burning at their individual peak rates, 3120 kW:

$$Q_{max} = 32(3120) \cong 100 \text{ MW} \quad \textbf{[D.3i]}$$

The time, t_{max}, to reach 100 MW must be determined using the following:

$$Q_{max} = 0.36\left(t - 39\right)^2 \quad \textbf{[D.3j]}$$

When Q = 100,000 kW,

$$100{,}000 = 0.36\left(t_{max} - 39\right)^2 \quad \textbf{[D.3k]}$$

$$t_{max} = \frac{(100{,}000)^{1/2}}{0.36} + 39 = 566 \text{ s} \quad \textbf{[D.3l]}$$

An estimate of fire duration, t_{end}, is now made using data from the Hazard I [2] database for sofa UPS001, where individual sofa combustible mass = 51.5 kg, sofa effective heat of combustion = 18,900 kJ/kg, and maximum fire size = 100,000 kW.

The mass consumed from t = 0 to t = 134 seconds is determined from the total heat release as follows:

$$\int_0^{134} Q\,dt = \frac{0.18}{3} t^3 \Big|_0^{134} = \frac{0.18}{3}(134)^3 = 144{,}366 \text{ kJ} \quad \textbf{[D.3m]}$$

Since $Q = \dot{m}h_c$ (see Equation E.3a), mass loss, Δm, for t = 134 seconds, is determined as follows:

$$\Delta m = \frac{144{,}366 \text{ kJ}}{18{,}900 \text{ kJ/kg}} = 7.6 \text{ kg} \quad \text{or} \cong 8 \text{ kg} \quad \textbf{[D.3n]}$$

The mass consumed from t = 134 seconds to t_{max}, the time the maximum fire size is reached, is similarly determined from the total heat release rate after 134 seconds, as follows:

[D.3o]

$$\int_{134}^{t_{max}} Q\,dt = \int_{134}^{566} 0.36\left(t - 39\right)^2 dt = \int_{134-39}^{566-39} 0.36\beta^2 d\beta = \frac{0.36}{3}(t)^3 \Big|_{95}^{527}$$

Total heat release from t = 134 to t = 566 is then = 0.12[$(527)^3$ - $(95)^3$] = 17,460,697 kJ, and the mass lost, Δm, is Δm = 17,460,697 kJ/18,900 kJ/kg = 923.8 ≅ 924 kg.

Approximately (924 + 8) kg = 932 kg is consumed during the 566 second time interval required to reach Q_{max}. The total combustible mass is 51.5 kg × 32 = 1648 kg. Therefore, around (1648 - 932) kg = 716 kg is available to burn at Q = Q_{max} = 100 MW, after t = 566 seconds, from which the fire duration can be calculated as follows:

[D.3p]

$$Q_{max}\left(t_{end} - 566\right) = 100{,}000\left(t_{end} - 566\right) = 716(18{,}900)$$

$$t_{end} = 566 + \frac{716(18{,}900)}{100{,}000} = 701.3 \text{ seconds} \cong 700 \text{ s} \quad \textbf{[D.3q]}$$

The combustible mass of the sofas alone is able to support the anticipated fire for approximately 700 seconds. In reality, the fire in the sofas would reach a maximum of 100 MW at 550–600 seconds and burn briefly at the 100 MW peak until the combustible mass available began to be consumed, at which time the fire's rate of heat release would begin to decline. Using a t_{end} of 700 seconds is conservative.

In summary, the analysis to this point leads to the following estimate for the anticipated fire:

$$Q = 0.18t^2 \quad \text{for } 0 < t \le 134 \text{ s}$$
$$Q = 0.36(t-39)^2 \quad \text{for } 134 < t \le 566 \text{ s} \qquad \textbf{[D.3r]}$$
$$Q = 100{,}000 \text{ kW} \quad \text{for } t > 566 \text{ s}$$

(See Figure D.3.)

D.4 Fire Detection. The time of fire detection is now calculated given the fire and building as described. The time of detection will be estimated based on the actual composite fire already described. Detection time can be calculated using Equation 9.2.5.4.3. DETACT-QS *(see* A.9.2.5.4.4.2*)* is a readily available computational tool that performs this calculation.

A complete fire alarm system is to be installed using heat detectors that are spaced 15.2 m on center (6.1 m from walls), have an activation temperature of 74°C, and have an RTI of 55 $(\text{m·s})^{1/2}$. Assuming the anticipated fire is as described, the maximum distance from a detector to the fire axis is the diagonal $[2(15.2/2)^2]^{1/2} = 10.7$ m, the ambient temperature is 21°C, and the fire is 0.5 m above floor level, DETACT-QS predicts the activation of a heat detector at 230 seconds. In the event quicker detection is judged to be necessary, smoke detector activation can be predicted by DETACT-QS using the guidance provided in A.9.2.5.4.4.1. Detection time for smoke detectors is based on the gas temperature rise at the detector site. Smoke detector activation can be approximated using DETACT-QS, assuming the smoke detector will respond like a heat detector, which has a small RTI [e.g., $1(\text{m·s})^{1/2}$] and a certain activation temperature above ambient *(see* A.9.2.5.4.4.1*)*. Tests involving burning of the sofa upholstery with the actual detector to be installed have determined that 10°C above ambient is a representative activation condition. Assuming smoke detectors are spaced 9.1 m on center (located a maximum of 6.5 m from the axis of the fire), smoke detector activation is predicted by DETACT-QS at 48 seconds.

Using DETACT-QS, vent operation is predicted using fusible links having an activation temperature of 74°C and an RTI of 28 $(\text{m·s})^{1/2}$. Assuming the anticipated fire is located in the center of the building, the ambient temperature is 21°C, and assuming the fire is 0.5 m above floor level, activation of the first vents (equidistant from the fire) separated $[2(18.3/2)^2]^{1/2} = 12.9$ m from the fire is predicted by DETACT-QS at 228 seconds. The next set of vents (equidistant from the fire at 28.9 m) are predicted to open at 317 seconds. Similarly, the third set of four vents, 38.8 m from the fire axis, open at 356 seconds. All 16 vents are open at 356 seconds. Alternatively, if fusible links having the same RTI as the heat detectors [55 $(\text{m·s})^{1/2}$] are used, all vents are predicted to be open at 384 seconds.

D.5 Vent Design. Of main concern in this example is the temperature of the smoke layer, which governs the heat flux radiated to the floor. Assuming an emissivity of 1 and a configuration factor of 1, the radiant heat flux at the floor is calculated as follows:

$$Flux_{fl} = k\varepsilon\Phi\pi T^4 \qquad \textbf{[D.5]}$$

where:

$Flux_{fl}$ = $(5.67 \times 10^{-11})T^4 \text{kW/m}^2$
k = Stefan–Boltzmann constant = 5.67×10^{-11} $\text{kW/m}^2\,\text{K}^4$
ε = emissivity = 1
Φ = configuration factor = 1
T = temperature of the layer (K)

For a flux limit of 2.5 kW/m^2, as stated in the objective, the temperature of the smoke layer is calculated as 458 K, or 164 K above the ambient temperature of 294 K.

D.6 Steady Fire — Smoke Layer Temperature. First, conditions following attainment of the maximum heat release rate of 100 MW can be examined (i.e., at times greater than 566 seconds) assuming a smoke layer at the lowest acceptable height, 3 m above the floor. (The heat detector installation contemplated was calculated to provide alarm at 230 seconds; 300 seconds following detection places the time of interest at 530 seconds, close to the attainment of the maximum heat release rate.)

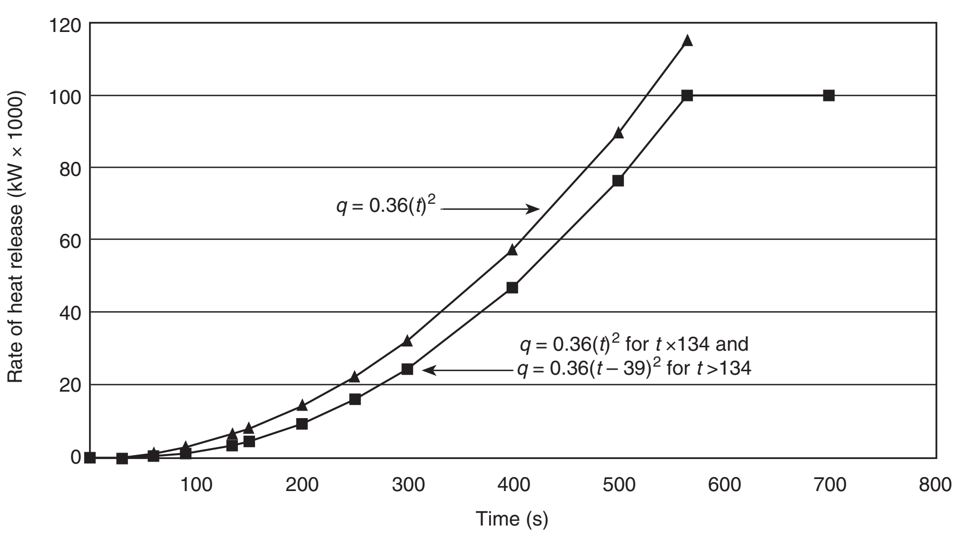

FIGURE D.3 Fire Output.

The effective diameter of the fire is required for the calculations. This diameter can be determined with the aid of Equation 8.3.7, setting Q = 100,000 kW and selecting an appropriate value for the heat release rate per unit floor area, Q''. The two racks facing each other across the 2.4 m wide aisle are 9.75 m long and 1.2 m wide *(see Figure D.6)*. The heat release rate per unit area is taken as the fully involved heat release rate, 100,000 kW, divided by the combined area of the two racks plus the aisle, or (9.75) (1.2) (2.2) + (9.75) (2.4) = 46.8 m^2. Accordingly, the heat release rate per unit area is

$$Q'' = \frac{100{,}000}{46.8} = 2136 \text{ kW/m}^2 \quad \textbf{[D.6a]}$$

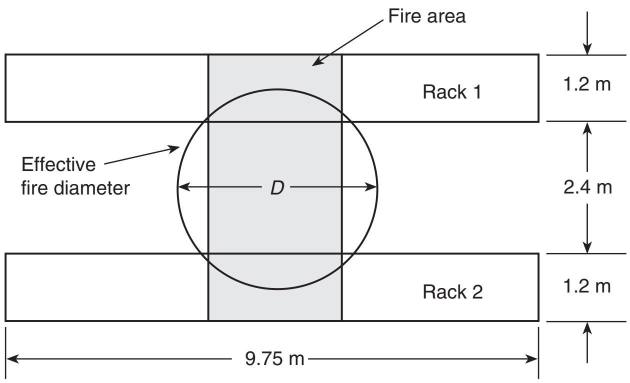

FIGURE D.6 Effective Fire Diameter.

This value can be assumed to be representative of most of the fire history, except for the initial stage. The effective diameter of the fire at 100,000 kW is then, using Equation 8.3.7,

$$D = \left[\frac{4(100{,}000)}{\pi(2136)}\right]^{1/2} = 7.72 \text{ m} \quad \textbf{[D.6b]}$$

Equation 9.2.4.3 is used to estimate the smoke layer temperature rise. The mass flow rate in the plume as it enters the smoke layer, $\dot{m}_p$, is calculated from Equation 9.2.3.6 or 9.2.3.7, depending on whether the flame height is smaller or larger than the height of the smoke layer above the base of the fire, 3-0.5 = 2.5 m. The flame height is calculated from Equation 9.2.3, as follows:

$$L = \left[-1.02(7.72)\right] + \left[0.235(100{,}000)^{2/5}\right] = 15.6 \text{ m} \quad \textbf{[D.6c]}$$

which is greater than the height of the smoke layer. (It is even greater than the ceiling height so that the flames will impinge on the ceiling and flow radially outward.) Therefore, the mass flow rate in the plume as it enters the smoke layer is calculated from Equation 9.2.3.7, as follows (assuming $Q_c = 0.7Q$):

$$\dot{m}_p = 0.0056(0.7 \times 100{,}000)\frac{2.5}{15.6} = 62.8 \text{ kg/s} \quad \textbf{[D.6d]}$$

Now the temperature rise in the smoke layer can be estimated using Equation 9.2.4.3, with C_p = 1.00 kJ/kg·K and the value of K = 0.5 recommended in 9.2.4.4.

$$\Delta T = \frac{0.5(70{,}000)}{1.00(62.8)} = 557 \text{ K} \quad \textbf{[D.6e]}$$

This value is considerably above 164 K; therefore, the floor radiant heat flux can be expected to be much higher than the limit 2.5 kW/m^2. Using the equation for radiant heat flux to the floor presented previously, the value 29.7 kW/m^2 is calculated for a smoke layer temperature of 557 + 294 = 851 K.

Not only is the smoke layer temperature, 557 + 21 = 578°C, so high that it produces unacceptable levels of radiant flux at the floor, but it is also close to the level, 600°C, where fire can flash over all the combustibles under the smoke layer. Furthermore, it exceeds the value, 540°C, where unprotected steel begins losing strength. Directly over the fire the temperatures might locally reach 1135°C (from Equation 9.2.4.3, with K=1), far in excess of the threshold for steel damage.

D.7 Sizing of Vents. This building arrangement will not meet design objectives. However, it might be instructive to investigate the venting requirements in order to illustrate general procedures that might be used to develop alternative designs.

All 16 vents are predicted to be open prior to 566 seconds — the time of interest.

The aerodynamic vent area, A_{va}, is determined with the aid of Equation 9.2.4.1:

$$\dot{m}_v = \left(2\rho_o^2 g\right)^{1/2}\left(\frac{T_o \Delta T}{T^2}\right)^{1/2} A_{va} d^{1/2} \quad \textbf{[D.7a]}$$

At equilibrium, the mass flow through the vents is equal to the smoke production rate, $\dot{m}_p$. Substituting $\dot{m}_p = 62.6$ kg/s for $\dot{m}_v$ in Equation 9.2.4.1, together with

ρ_o = 1.2 kg/m^3
g = 9.81 m/s^2
T_o = 294 K
ΔT = 559 K
T = 294 + 559 = 853 K
d = 9.1 – 3 = 6.1 m

the equation can be solved for the aerodynamic vent area. The result is

$$A_{va} = 10.04 \text{ m}^2 \quad \textbf{[D.7b]}$$

The vents are assumed to have a discharge coefficient of 0.61; therefore, the corresponding actual vent area is *(see* A.9.2.4.2*)*

$$A_v = \frac{10.04}{0.61} = 16.46 \text{ m}^2 \left(\text{geometric vent area}\right) \cong 16.5 \text{ m}^2 \quad \textbf{[D.7c]}$$

The building design contemplates that inlet air openings will be 1.5 times the vent area. Equation F.2 is used to calculate a correction, M, for the limited inlet air openings.

$$M = \left[1 + \left(\frac{A_v}{A_i^2}\right)\left(\frac{T_o}{T}\right)\right]^{1/2} \quad \textbf{[D.7d]}$$

$$M = \left[1 + \left(\frac{1}{1.5^2}\right)\left(\frac{294}{853}\right)\right]^{1/2} = 1.07 \quad \textbf{[D.7e]}$$

The corrected actual vent area is

$$(1.07)(16.5) = 17.66 \text{ m}^2 \quad \textbf{[D.7f]}$$

Distributed among the 16 vent locations, the actual area per vent is

$$\frac{17.66}{16} = 1.10 \text{ m}^2 \qquad \textbf{[D.7g]}$$

The nearest commercial vent size equal to or larger than this unit vent area would be selected.

The following equation is used to check for $Q_{feasible}$:

$$Q_{feasible} = 23{,}200(H-d)^{5/2}$$
$$Q_{feasible} = 229{,}265 \text{ kW} \cong 230 \text{ MW} \qquad \textbf{[D.7h]}$$

where:
$Q_{feasible}$ = feasible fire heat release rate (kW)
H = 9.1 − 0.5 = 8.6 m
d = 6.1 m

This value is higher than the projected heat release rate, 100 MW, and by itself is not of direct concern.

D.8 Increased Height of Smoke Interface. Inspection of Equation 9.2.3.7 indicates that the larger the height of the smoke interface above the base of the fire, the larger the value of mass entrained in the plume, $\dot{m}_p$, and Equation 9.2.4.3 indicates that the temperature rise in the smoke layer will be reduced. The calculations just completed for a smoke layer height of 3 m above the floor can be repeated for other smoke layer heights in search of acceptable alternative designs. The two additional smoke layer heights of 6 m and 7.3 m have been investigated, the latter near the maximum associated with the minimum recommended curtain depth for the 9.1 m high building *(see Section* 7.3*)*. The final results of these additional calculations indicate values of temperature rise in the smoke layer of 253 K for the 6 m high level and 205 K for the 7.3 m high level. Although these values for smoke layer temperature rise are still a little high compared to the target of 164 K, they represent a major improvement. Furthermore, the temperatures are low enough so as not to represent a flashover hazard or endanger structural steel.

The calculations for the three smoke layer heights at the maximum heat release rate are summarized in Table D.8, entered as cases 1–3. In the table, H_c represents the height of the ceiling above the floor, $H_c - d$ is the height of the smoke interface above the floor, and $H - d$ is the height of the smoke interface above the base of the fire. In cases 1–3, the radiant heat flux at floor level, $flux_{fl}$, is seen to decrease to 5.1 kW/m^2 and 3.5 kW/m^2 as the smoke interface is raised but still remains above 2.5 kW/m^2. The total required vent area (corrected A_v) increases sharply as the smoke layer interface is raised. For the largest interface height, the total vent area of 89.2 m^2 corresponds to an area per vent of 89.2/16 = 5.57 m^2, which is still smaller than the maximum vent area discussed in 5.4.1 [(i.e., $2d^2 = 2(1.8)^2 = 6.48$ m^2].

D.9 Growing Fire. Cases 4–6 in Table D.8 correspond to the growing fire with detection at 230 seconds using heat detectors. The state of the fire is represented at a time 300 seconds following detection with heat detectors (i.e., at 230 + 300 = 530 seconds). It is assumed that all 16 vents are operated together at the alarm of the first heat detector; alternatively, the vents are actuated individually with fusible links of the same RTI and activation temperature as the heat detectors, for which it might be confirmed with DETACT-QS that all vents open prior to 530 seconds. The calculations are parallel to cases 1–3, except that the fire is slightly smaller, as determined from the following:

$$Q = 0.36(t-39)^2 = 0.36(530-39)^2 = 86{,}800 \text{ kW} \qquad \textbf{[D.9a]}$$

In cases 4–6, the smoke layer temperatures (ΔT) and radiant fluxes to the floor are only slightly reduced from the corresponding steady fire situations, cases 1–3. Also, there is little change in the required vent areas.

Cases 7–9 in Table D.8 correspond to the growing fire, with detection at 48 seconds using smoke detectors. Again, the state of the fire is represented at a time 300 seconds from detection (i.e., at 348 seconds). It is assumed that the 16 vents are operated together at the alarm of the first smoke detector. The calculations are executed at a state of fire development as follows:

$$Q = 0.36(t-39)^2 = 0.36(348-39)^2 = 34{,}400 \text{ kW} \qquad \textbf{[D.9b]}$$

It is seen that case 9 meets the design objective of heat fluxes to the floor that are calculated as being lower than 2.5 kW/m^2, and case 8 nearly does so. The required vent areas are 28.3 m^2 and 47.8 m^2 for cases 8 and 9, respectively, corresponding to unit vent areas (16 vents) of 1.8 m^2 and 3.0 m^2, both of which are well below their respective maxima, $2d^2$, based on 5.4.1.

It will be noted that the case 8 solution using "hand calculations" provides an approximation close to the LAVENT predictions, which are summarized next.

D.10 LAVENT Analysis. The case 8 vent design in Table D.8 will now be analyzed using the computer program LAVENT [3]. LAVENT is able to assess the time-varying events associ-

Table D.8 Results of Calculations for Vent Design

Case	Time (s)	Q (MW)	D (m)	L (m)	$H_c - d$ (m)	$H - d$ (m)	d (m)	ΔT (K)	$flux_{fl}$ (kW/m^2)	m_p (kg/s)	M	corr. A_v (m^2)
1	≥566	100.0	7.7	15.6	3.0	2.5	6.1	557	29.7	62.8	1.07	17.6
2	≥566	100.0	7.7	15.6	6.0	5.5	3.1	253	5.1	137.8	1.11	53.8
3	≥566	100.0	7.7	15.6	7.3	6.8	1.8	205	3.5	170.4	1.12	89.2
4	530	86.8	7.2	14.9	3.0	2.5	6.1	531	26.4	57.2	1.08	16.1
5	530	86.8	7.2	14.9	6.0	5.5	3.1	241	4.7	125.9	1.12	49.7
6	530	86.8	7.2	14.9	7.3	6.8	1.8	195	3.3	155.7	1.13	82.6
7	348	34.4	4.5	10.7	3.0	2.5	6.1	383	11.8	31.4	1.09	8.6
8	348	34.4	4.5	10.7	6.0	5.5	3.1	174	2.7	69.0	1.13	28.3
9	348	34.4	4.5	10.7	7.3	6.8	1.8	141	2.0	85.3	1.14	47.8

ated with the predicted fire. The fire has been previously determined as follows:

$$Q = 0.18t^2 \text{ for } 0 < t \leq 134 \text{ s}$$
$$Q = 0.36(t-39)^2 \text{ for } 134 < t \leq 566 \text{ s} \quad \textbf{[D.10]}$$
$$Q = 100{,}000 \text{ kW for } t > 566 \text{ s}$$

The values for this fire will be used as input for LAVENT. The fire is assumed to start in the center of the building.

A complete smoke detection system is to be installed with detectors spaced 9.1 m on center. Detectors are located a maximum of 6.5 m from the fire axis (i.e., one-half the diagonal distance between detectors). As noted in A.9.2.5.4.4.1, detectors have an activation temperature of 31°C (10°C above ambient) and are located 0.1 m below the ceiling.

The vent design will use sixteen 1.76 m^2 vents located 18.3 m on center. All vents automatically open on activation of the first smoke detector.

LAVENT predicts that the upper-layer temperature will be 377°C and that the upper "hot" layer will be 4.6 m above floor level at 600 seconds. A 3 m clear layer is maintained throughout the 600 second time interval. However, heat flux at floor level is projected to be approximately 10 kW/m^2 at 600 seconds, and the design objective of limiting heat flux to 2.5 kW/m^2 at floor level is exceeded. At 342 seconds, the time of detection plus 300 seconds, however, the design objectives are met. At 360 seconds, LAVENT predicts the upper-layer temperature as 444 K (171°C), with the layer being 7.3 m above the floor. The predicted 150 K temperature rise is limited to less than the target value of 164 K, and heat flux at floor level is predicted to be 2.2 kW/m^2. Therefore, the design objectives are satisfied for a time interval greater than the time of detection plus 300 seconds.

Inlet air is 1.5 times the vent area. To maintain the vent flow predicted by LAVENT, inlet air net free area should be maintained at a minimum of twice the open vent area. Although the net free inlet air area is less than required, the inlet area is sufficiently large that LAVENT predictions can be assumed to be reasonably valid. However, consideration should be given to increasing the vent area to account for the restrictions in inlet air.

See Figure D.10(a) through Figure D.10(h) for results of the program, and Figure D.10(i) for a computer printout of the LAVENT output.

D.11 References for Annex D.

1. Purser, D. A. "Toxicity Assessment of Combustion Products," Section 2/Chapter 8, in *The SFPE Handbook of Fire Protection Engineering,* 2nd edition, Society of Fire Protection Engineers and National Fire Protection Association, Quincy, MA, 1995.

2. Peacock, R. D., et al. *Software User's Guide for the Hazard I Fire Hazard Assessment Method, Version 1.1,* NIST Handbook 146, Volume I, United States Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD, 1991.

3. Cooper, L. Y., and W. D. Davis. *Estimating the Environment and the Response of Sprinkler Links in Compartment Fires with Draft Curtains and Fusible Link-Actuated Ceiling Vents — Part II: User Guide for the Computer Code Lavent,* NISTIR 89-4122, United States Department of Commerce, National Institute of Standards and Technology, Gaithersburg, MD, July 1989.

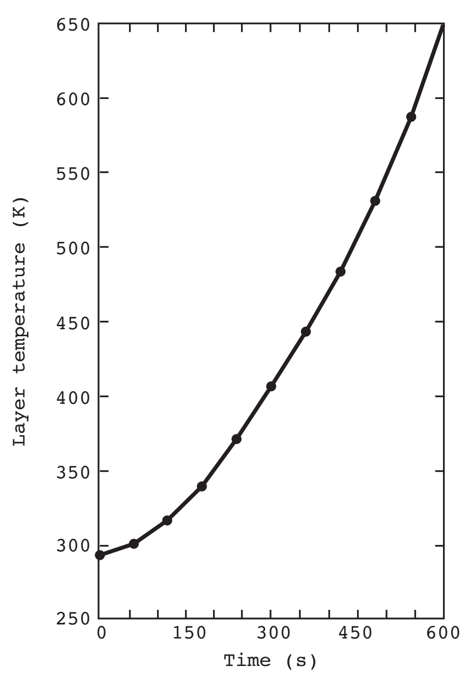

FIGURE D.10(a) Layer Temperature.

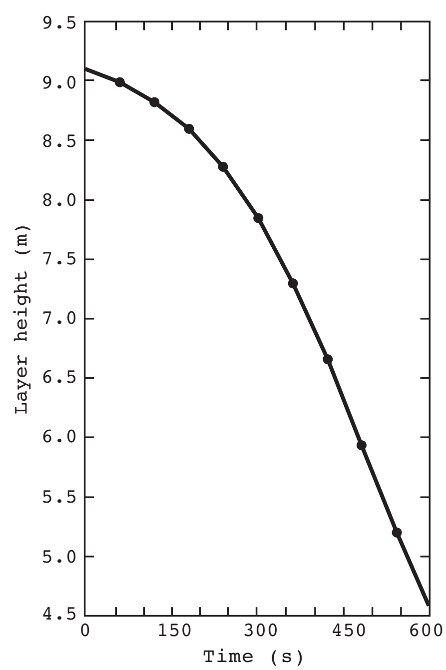

FIGURE D.10(b) Layer Height.

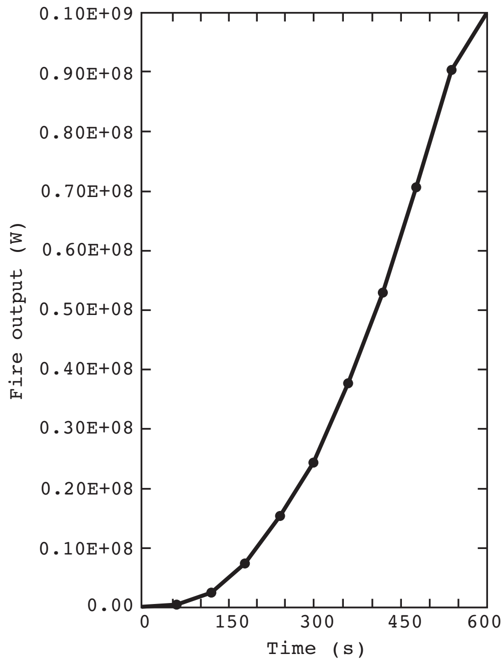

FIGURE D.10(c) Fire Output.

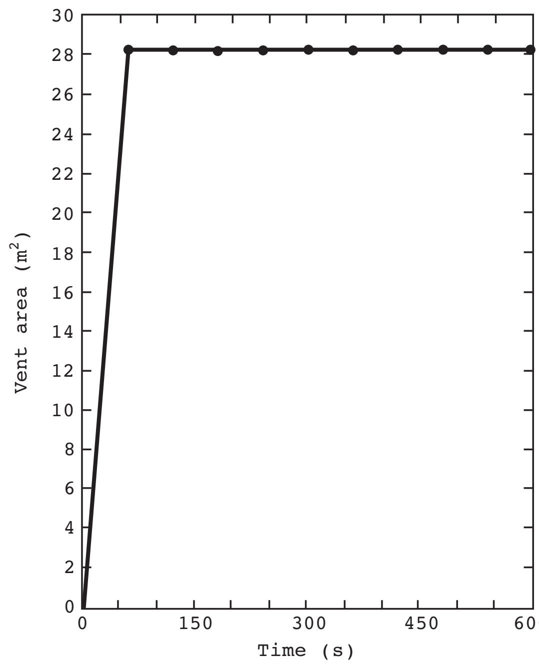

FIGURE D.10(d) Vent Area.

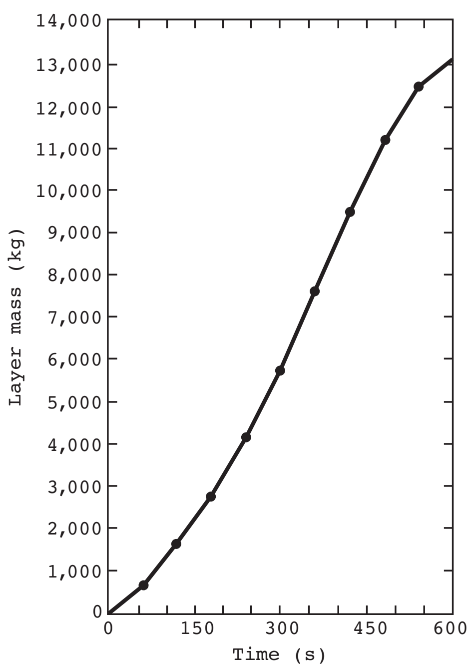

FIGURE D.10(e) Layer Mass.

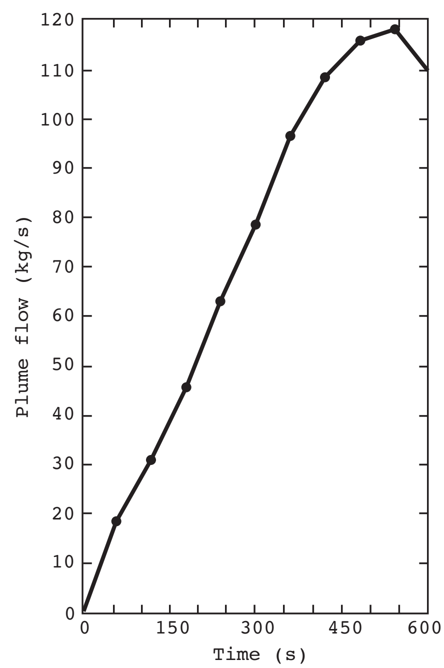

FIGURE D.10(f) Plume Flow.

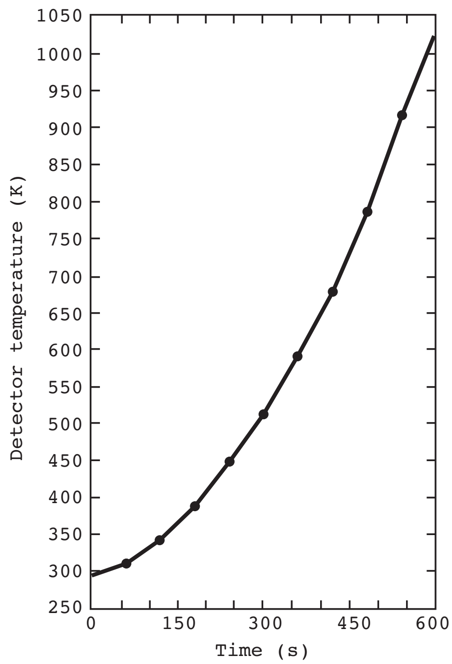

FIGURE D.10(g) Detector Temperature.

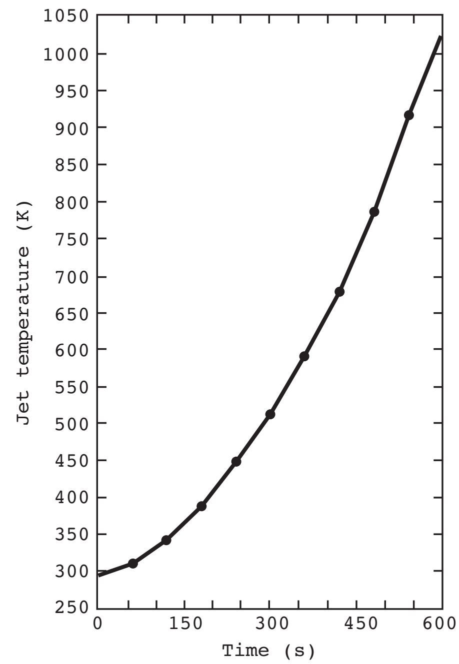

FIGURE D.10(h) Jet Temperature.

```
CEILING HEIGHT =                   9.1 M
ROOM LENGTH =                     73.0 M
ROOM WIDTH =                      73.0 M
CURTAIN LENGTH =                 292.0 M
CURTAIN HEIGHT =                   0.0 M
MATERIAL =                       INSULATED DECK (SOLID POLYSTYRENE)
CEILING CONDUCTIVITY =      .149E+00 W/M K
CEILING DENSITY =           .116E+04 KG/M3
CEILING HEAT CAPACITY  =    .105E+04 J/M K
CEILING THICKNESS =         .152E+00 M
FIRE HEIGHT =                      0.5 M
FIRE POWER/AREA =           0.2136E+07 W/M2

LINK NO =  1       RADIUS =     6.5 M  DIST CEILING =     0.1 M
RTI =    1.00 SQRT(MS)      FUSION TEMPERATURE FOR LINK =   304.00  VENT =   1
VENT AREA =     28.2 M2            LINK CONTROLLING VENT =   1

TIME (S)=    0.0000 LYR TEMP (K)=   294.0 LYR HT (M) =    9.10
LYR MASS (KG)=0. 000E+00  FIRE OUTPUT (W) =   0.0000E+00 VENT AREA (M2) =  0.00
LINK =  1 LINK TEMP (K) =   294.00 JET VELOCITY (M/S) =  0.000 JET TEMP (K) = 294.0
R (M) =     0.00 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =     1.74 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =     3.48 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =     5.22 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =     6.95 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =     8.69 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    10.43 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    12.17 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    13.91 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    15.65 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    17.39 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    19.12 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    20.86 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    22.60 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    24.34 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    26.08 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    27.82 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    29.56 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    31.29 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    33.03 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    34.77 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    36.51 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    38.25 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    39.99 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    41.73 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    43.46 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    45.20 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    46.94 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    48.68 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00
R (M) =    50.42 TSL (K) =  294.0 QB (W/M2) = 0.000E+00 QT (W/M2) =  0.000E+00

TIME (S)=   60.0000 LYR TEMP (K)=   301.4 LYR HT (M) =    8.99
LYR MASS (KG)=0.657E+03  FIRE OUTPUT (W) =   0.6480E+06 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   309.95 JET VELOCITY (M/S) =      1.104
JET TEMP (K) =   310.2  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  302.1 QB (W/M2) = 0.834E+03 QT (W/M2) =  0.000E+00
R (M) =     1.74 TSL (K) =  299.5 QB (W/M2) = 0.587E+03 QT (W/M2) =  0.000E+00
R (M) =     3.48 TSL (K) =  297.8 QB (W/M2) = 0.417E+03 QT (W/M2) =  0.000E+00
R (M) =     5.22 TSL (K) =  296.6 QB (W/M2) = 0.287E+03 QT (W/M2) =  0.000E+00
R (M) =     6.95 TSL (K) =  295.8 QB (W/M2) = 0.205E+03 QT (W/M2) =  0.000E+00
R (M) =     8.69 TSL (K) =  295.4 QB (W/M2) = 0.153E+03 QT (W/M2) =  0.000E+00
R (M) =    10.43 TSL (K) =  295.0 QB (W/M2) = 0.117E+03 QT (W/M2) =  0.000E+00
R (M) =    12.17 TSL (K) =  294.8 QB (W/M2) = 0.925E+02 QT (W/M2) =  0.000E+00
R (M) =    13.91 TSL (K) =  294.7 QB (W/M2) = 0.748E+02 QT (W/M2) =  0.000E+00
```

FIGURE D.10(i) LAVENT Analysis Output.

```
R (M) =    15.65 TSL (K) =  294.6 QB (W/M2) = 0.619E+02 QT (W/M2) =  0.000E+00
R (M) =    17.39 TSL (K) =  294.5 QB (W/M2) = 0.522E+02 QT (W/M2) =  0.000E+00
R (M) =    19.12 TSL (K) =  294.4 QB (W/M2) = 0.448E+02 QT (W/M2) =  0.000E+00
R (M) =    20.86 TSL (K) =  294.3 QB (W/M2) = 0.389E+02 QT (W/M2) =  0.000E+00
R (M) =    22.60 TSL (K) =  294.3 QB (W/M2) = 0.343E+02 QT (W/M2) =  0.000E+00
R (M) =    24.34 TSL (K) =  294.3 QB (W/M2) = 0.305E+02 QT (W/M2) =  0.000E+00
R (M) =    26.08 TSL (K) =  294.2 QB (W/M2) = 0.274E+02 QT (W/M2) =  0.000E+00
R (M) =    27.82 TSL (K) =  294.2 QB (W/M2) = 0.248E+02 QT (W/M2) =  0.000E+00
R (M) =    29.56 TSL (K) =  294.2 QB (W/M2) = 0.226E+02 QT (W/M2) =  0.000E+00
R (M) =    31.29 TSL (K) =  294.2 QB (W/M2) = 0.207E+02 QT (W/M2) =  0.000E+00
R (M) =    33.03 TSL (K) =  294.2 QB (W/M2) = 0.191E+02 QT (W/M2) =  0.000E+00
R (M) =    34.77 TSL (K) =  294.2 QB (W/M2) = 0.177E+02 QT (W/M2) =  0.000E+00
R (M) =    36.51 TSL (K) =  294.1 QB (W/M2) = 0.165E+02 QT (W/M2) =  0.000E+00
R (M) =    38.25 TSL (K) =  294.1 QB (W/M2) = 0.154E+02 QT (W/M2) =  0.000E+00
R (M) =    39.99 TSL (K) =  294.1 QB (W/M2) = 0.144E+02 QT (W/M2) =  0.000E+00
R (M) =    41.73 TSL (K) =  294.1 QB (W/M2) = 0.136E+02 QT (W/M2) =  0.000E+00
R (M) =    43.46 TSL (K) =  294.1 QB (W/M2) = 0.128E+02 QT (W/M2) =  0.000E+00
R (M) =    45.20 TSL (K) =  294.1 QB (W/M2) = 0.121E+02 QT (W/M2) =  0.000E+00
R (M) =    46.94 TSL (K) =  294.1 QB (W/M2) = 0.115E+02 QT (W/M2) =  0.000E+00
R (M) =    48.68 TSL (K) =  294.0 QB (W/M2) = 0.122E+01 QT (W/M2) =  0.000E+00
R (M) =    50.42 TSL (K) =  294.0 QB (W/M2) = 0.110E+01 QT (W/M2) =  0.000E+00

TIME (S)=  120.0000 LYR TEMP (K)=   317.2 LYR HT (M) =     8.83
LYR MASS (KG)=0.162E+04  FIRE OUTPUT (W) =   0.2743E+07 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   339.83 JET VELOCITY (M/S) =      1.761
JET TEMP (K) =   340.2  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  332.0 QB (W/M2) = 0.242E+04 QT (W/M2) =  0.000E+00
R (M) =     1.74 TSL (K) =  322.4 QB (W/M2) = 0.188E+04 QT (W/M2) =  0.000E+00
R (M) =     3.48 TSL (K) =  314.9 QB (W/M2) = 0.142E+04 QT (W/M2) =  0.000E+00
R (M) =     5.22 TSL (K) =  308.8 QB (W/M2) = 0.102E+04 QT (W/M2) =  0.000E+00
R (M) =     6.95 TSL (K) =  304.7 QB (W/M2) = 0.753E+03 QT (W/M2) =  0.000E+00
R (M) =     8.69 TSL (K) =  302.1 QB (W/M2) = 0.569E+03 QT (W/M2) =  0.000E+00
R (M) =    10.43 TSL (K) =  300.2 QB (W/M2) = 0.441E+03 QT (W/M2) =  0.000E+00
R (M) =    12.17 TSL (K) =  298.9 QB (W/M2) = 0.350E+03 QT (W/M2) =  0.000E+00
R (M) =    13.91 TSL (K) =  298.0 QB (W/M2) = 0.285E+03 QT (W/M2) =  0.000E+00
R (M) =    15.65 TSL (K) =  297.3 QB (W/M2) = 0.236E+03 QT (W/M2) =  0.000E+00
R (M) =    17.39 TSL (K) =  296.8 QB (W/M2) = 0.199E+03 QT (W/M2) =  0.000E+00
R (M) =    19.12 TSL (K) =  296.4 QB (W/M2) = 0.171E+03 QT (W/M2) =  0.000E+00
R (M) =    20.86 TSL (K) =  296.1 QB (W/M2) = 0.149E+03 QT (W/M2) =  0.000E+00
R (M) =    22.60 TSL (K) =  295.8 QB (W/M2) = 0.131E+03 QT (W/M2) =  0.000E+00
R (M) =    24.34 TSL (K) =  295.6 QB (W/M2) = 0.117E+03 QT (W/M2) =  0.000E+00
R (M) =    26.08 TSL (K) =  295.5 QB (W/M2) = 0.105E+03 QT (W/M2) =  0.000E+00
R (M) =    27.82 TSL (K) =  295.3 QB (W/M2) = 0.951E+02 QT (W/M2) =  0.000E+00
R (M) =    29.56 TSL (K) =  295.2 QB (W/M2) = 0.867E+02 QT (W/M2) =  0.000E+00
R (M) =    31.29 TSL (K) =  295.1 QB (W/M2) = 0.795E+02 QT (W/M2) =  0.000E+00
R (M) =    33.03 TSL (K) =  295.0 QB (W/M2) = 0.734E+02 QT (W/M2) =  0.000E+00
R (M) =    34.77 TSL (K) =  294.9 QB (W/M2) = 0.680E+02 QT (W/M2) =  0.000E+00
R (M) =    36.51 TSL (K) =  294.9 QB (W/M2) = 0.633E+02 QT (W/M2) =  0.000E+00
R (M) =    38.25 TSL (K) =  294.8 QB (W/M2) = 0.592E+02 QT (W/M2) =  0.000E+00
R (M) =    39.99 TSL (K) =  294.8 QB (W/M2) = 0.555E+02 QT (W/M2) =  0.000E+00
R (M) =    41.73 TSL (K) =  294.7 QB (W/M2) = 0.522E+02 QT (W/M2) =  0.000E+00
R (M) =    43.46 TSL (K) =  294.7 QB (W/M2) = 0.492E+02 QT (W/M2) =  0.000E+00
R (M) =    45.20 TSL (K) =  294.6 QB (W/M2) = 0.466E+02 QT (W/M2) =  0.000E+00
R (M) =    46.94 TSL (K) =  294.6 QB (W/M2) = 0.442E+02 QT (W/M2) =  0.000E+00
R (M) =    48.68 TSL (K) =  294.1 QB (W/M2) = 0.504E+01 QT (W/M2) =  0.000E+00
R (M) =    50.42 TSL (K) =  294.1 QB (W/M2) = 0.455E+01 QT (W/M2) =  0.000E+00

TIME (S)=  180.0000 LYR TEMP (K)=   339.8 LYR HT (M) =     8.60
LYR MASS (KG)=0.276E+04  FIRE OUTPUT (W) =   0.7483E+07 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   385.73 JET VELOCITY (M/S) =      2.493
JET TEMP (K) =   386.3  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  386.4 QB (W/M2) = 0.514E+04 QT (W/M2) =  0.000E+00
R (M) =     1.74 TSL (K) =  367.0 QB (W/M2) = 0.421E+04 QT (W/M2) =  0.000E+00
R (M) =     3.48 TSL (K) =  349.7 QB (W/M2) = 0.329E+04 QT (W/M2) =  0.000E+00
```

FIGURE D.10(i) ***Continued***

```
R (M) =     5.22 TSL (K) =  334.5 QB (W/M2) = 0.244E+04 QT (W/M2) =  0.000E+00
R (M) =     6.95 TSL (K) =  324.0 QB (W/M2) = 0.183E+04 QT (W/M2) =  0.000E+00
R (M) =     8.69 TSL (K) =  316.7 QB (W/M2) = 0.140E+04 QT (W/M2) =  0.000E+00
R (M) =    10.43 TSL (K) =  311.6 QB (W/M2) = 0.109E+04 QT (W/M2) =  0.000E+00
R (M) =    12.17 TSL (K) =  308.0 QB (W/M2) = 0.864E+03 QT (W/M2) =  0.000E+00
R (M) =    13.91 TSL (K) =  305.3 QB (W/M2) = 0.702E+03 QT (W/M2) =  0.000E+00
R (M) =    15.65 TSL (K) =  303.4 QB (W/M2) = 0.582E+03 QT (W/M2) =  0.000E+00
R (M) =    17.39 TSL (K) =  301.9 QB (W/M2) = 0.491E+03 QT (W/M2) =  0.000E+00
R (M) =    19.12 TSL (K) =  300.8 QB (W/M2) = 0.420E+03 QT (W/M2) =  0.000E+00
R (M) =    20.86 TSL (K) =  299.9 QB (W/M2) = 0.365E+03 QT (W/M2) =  0.000E+00
R (M) =    22.60 TSL (K) =  299.2 QB (W/M2) = 0.321E+03 QT (W/M2) =  0.000E+00
R (M) =    24.34 TSL (K) =  298.6 QB (W/M2) = 0.286E+03 QT (W/M2) =  0.000E+00
R (M) =    26.08 TSL (K) =  298.1 QB (W/M2) = 0.256E+03 QT (W/M2) =  0.000E+00
R (M) =    27.82 TSL (K) =  297.7 QB (W/M2) = 0.232E+03 QT (W/M2) =  0.000E+00
R (M) =    29.56 TSL (K) =  297.4 QB (W/M2) = 0.211E+03 QT (W/M2) =  0.000E+00
R (M) =    31.29 TSL (K) =  297.1 QB (W/M2) = 0.193E+03 QT (W/M2) =  0.000E+00
R (M) =    33.03 TSL (K) =  296.9 QB (W/M2) = 0.178E+03 QT (W/M2) =  0.000E+00
R (M) =    34.77 TSL (K) =  296.7 QB (W/M2) = 0.165E+03 QT (W/M2) =  0.000E+00
R (M) =    36.51 TSL (K) =  296.5 QB (W/M2) = 0.154E+03 QT (W/M2) =  0.000E+00
R (M) =    38.25 TSL (K) =  296.3 QB (W/M2) = 0.143E+03 QT (W/M2) =  0.000E+00
R (M) =    39.99 TSL (K) =  296.2 QB (W/M2) = 0.134E+03 QT (W/M2) =  0.000E+00
R (M) =    41.73 TSL (K) =  296.0 QB (W/M2) = 0.126E+03 QT (W/M2) =  0.000E+00
R (M) =    43.46 TSL (K) =  295.9 QB (W/M2) = 0.119E+03 QT (W/M2) =  0.000E+00
R (M) =    45.20 TSL (K) =  295.8 QB (W/M2) = 0.113E+03 QT (W/M2) =  0.000E+00
R (M) =    46.94 TSL (K) =  295.7 QB (W/M2) = 0.107E+03 QT (W/M2) =  0.000E+00
R (M) =    48.68 TSL (K) =  294.2 QB (W/M2) = 0.136E+02 QT (W/M2) =  0.000E+00
R (M) =    50.42 TSL (K) =  294.2 QB (W/M2) = 0.123E+02 QT (W/M2) =  0.000E+00

TIME (S)=  240.0000 LYR TEMP (K)=   371.5 LYR HT (M) =    8.28
LYR MASS (KG)=0.414E+04  FIRE OUTPUT (W) =   0.1541E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   447.57 JET VELOCITY (M/S) =      3.186
JET TEMP (K) =   448.2  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  469.7 QB (W/M2) = 0.816E+04 QT (W/M2) =  0.000E+00
R (M) =     1.74 TSL (K) =  439.3 QB (W/M2) = 0.700E+04 QT (W/M2) =  0.000E+00
R (M) =     3.48 TSL (K) =  408.8 QB (W/M2) = 0.570E+04 QT (W/M2) =  0.000E+00
R (M) =     5.22 TSL (K) =  380.2 QB (W/M2) = 0.439E+04 QT (W/M2) =  0.000E+00
R (M) =     6.95 TSL (K) =  359.0 QB (W/M2) = 0.335E+04 QT (W/M2) =  0.000E+00
R (M) =     8.69 TSL (K) =  343.8 QB (W/M2) = 0.259E+04 QT (W/M2) =  0.000E+00
R (M) =    10.43 TSL (K) =  332.8 QB (W/M2) = 0.203E+04 QT (W/M2) =  0.000E+00
R (M) =    12.17 TSL (K) =  324.9 QB (W/M2) = 0.162E+04 QT (W/M2) =  0.000E+00
R (M) =    13.91 TSL (K) =  319.1 QB (W/M2) = 0.132E+04 QT (W/M2) =  0.000E+00
R (M) =    15.65 TSL (K) =  314.8 QB (W/M2) = 0.109E+04 QT (W/M2) =  0.000E+00
R (M) =    17.39 TSL (K) =  311.6 QB (W/M2) = 0.922E+03 QT (W/M2) =  0.000E+00
R (M) =    19.12 TSL (K) =  309.1 QB (W/M2) = 0.790E+03 QT (W/M2) =  0.000E+00
R (M) =    20.86 TSL (K) =  307.1 QB (W/M2) = 0.687E+03 QT (W/M2) =  0.000E+00
R (M) =    22.60 TSL (K) =  305.5 QB (W/M2) = 0.604E+03 QT (W/M2) =  0.000E+00
R (M) =    24.34 TSL (K) =  304.2 QB (W/M2) = 0.536E+03 QT (W/M2) =  0.000E+00
R (M) =    26.08 TSL (K) =  303.2 QB (W/M2) = 0.481E+03 QT (W/M2) =  0.000E+00
R (M) =    27.82 TSL (K) =  302.3 QB (W/M2) = 0.435E+03 QT (W/M2) =  0.000E+00
R (M) =    29.56 TSL (K) =  301.6 QB (W/M2) = 0.396E+03 QT (W/M2) =  0.000E+00
R (M) =    31.29 TSL (K) =  300.9 QB (W/M2) = 0.363E+03 QT (W/M2) =  0.000E+00
R (M) =    33.03 TSL (K) =  300.4 QB (W/M2) = 0.334E+03 QT (W/M2) =  0.000E+00
R (M) =    34.77 TSL (K) =  299.9 QB (W/M2) = 0.309E+03 QT (W/M2) =  0.000E+00
R (M) =    36.51 TSL (K) =  299.5 QB (W/M2) = 0.288E+03 QT (W/M2) =  0.000E+00
R (M) =    38.25 TSL (K) =  299.1 QB (W/M2) = 0.269E+03 QT (W/M2) =  0.000E+00
R (M) =    39.99 TSL (K) =  298.8 QB (W/M2) = 0.252E+03 QT (W/M2) =  0.000E+00
R (M) =    41.73 TSL (K) =  298.5 QB (W/M2) = 0.237E+03 QT (W/M2) =  0.000E+00
R (M) =    43.46 TSL (K) =  298.3 QB (W/M2) = 0.223E+03 QT (W/M2) =  0.000E+00
R (M) =    45.20 TSL (K) =  298.0 QB (W/M2) = 0.211E+03 QT (W/M2) =  0.000E+00
R (M) =    46.94 TSL (K) =  297.8 QB (W/M2) = 0.200E+03 QT (W/M2) =  0.000E+00
R (M) =    48.68 TSL (K) =  296.6 QB (W/M2) = 0.198E+03 QT (W/M2) =  0.000E+00
R (M) =    50.42 TSL (K) =  294.5 QB (W/M2) = 0.250E+02 QT (W/M2) =  0.000E+00
```

FIGURE D.10(i) ***Continued***

```
TIME (S)=  300.0000 LYR TEMP (K)=   406.7 LYR HT (M) =    7.86
LYR MASS (KG)=0.575E+04  FIRE OUTPUT (W) =   0.2452E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   511.85 JET VELOCITY (M/S) =      3.699
JET TEMP (K) =   512.4  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  561.4 QB (W/M2) = 0.962E+04 QT (W/M2) = -0.297E-11
R (M) =     1.74 TSL (K) =  523.2 QB (W/M2) = 0.859E+04 QT (W/M2) = -0.297E-11
R (M) =     3.48 TSL (K) =  481.7 QB (W/M2) = 0.731E+04 QT (W/M2) = -0.297E-11
R (M) =     5.22 TSL (K) =  439.7 QB (W/M2) = 0.588E+04 QT (W/M2) = -0.297E-11
R (M) =     6.95 TSL (K) =  406.1 QB (W/M2) = 0.464E+04 QT (W/M2) = -0.297E-11
R (M) =     8.69 TSL (K) =  381.0 QB (W/M2) = 0.365E+04 QT (W/M2) = -0.297E-11
R (M) =    10.43 TSL (K) =  362.4 QB (W/M2) = 0.289E+04 QT (W/M2) = -0.297E-11
R (M) =    12.17 TSL (K) =  348.8 QB (W/M2) = 0.234E+04 QT (W/M2) = -0.297E-11
R (M) =    13.91 TSL (K) =  338.7 QB (W/M2) = 0.191E+04 QT (W/M2) = -0.297E-11
R (M) =    15.65 TSL (K) =  331.1 QB (W/M2) = 0.159E+04 QT (W/M2) = -0.297E-11
R (M) =    17.39 TSL (K) =  325.4 QB (W/M2) = 0.135E+04 QT (W/M2) = -0.297E-11
R (M) =    19.12 TSL (K) =  320.9 QB (W/M2) = 0.116E+04 QT (W/M2) = -0.297E-11
R (M) =    20.86 TSL (K) =  317.4 QB (W/M2) = 0.101E+04 QT (W/M2) = -0.297E-11
R (M) =    22.60 TSL (K) =  314.6 QB (W/M2) = 0.887E+03 QT (W/M2) = -0.297E-11
R (M) =    24.34 TSL (K) =  312.3 QB (W/M2) = 0.789E+03 QT (W/M2) = -0.297E-11
R (M) =    26.08 TSL (K) =  310.4 QB (W/M2) = 0.708E+03 QT (W/M2) = -0.297E-11
R (M) =    27.82 TSL (K) =  308.8 QB (W/M2) = 0.640E+03 QT (W/M2) = -0.297E-11
R (M) =    29.56 TSL (K) =  307.5 QB (W/M2) = 0.583E+03 QT (W/M2) = -0.297E-11
R (M) =    31.29 TSL (K) =  306.4 QB (W/M2) = 0.535E+03 QT (W/M2) = -0.297E-11
R (M) =    33.03 TSL (K) =  305.4 QB (W/M2) = 0.493E+03 QT (W/M2) = -0.297E-11
R (M) =    34.77 TSL (K) =  304.6 QB (W/M2) = 0.456E+03 QT (W/M2) = -0.297E-11
R (M) =    36.51 TSL (K) =  303.8 QB (W/M2) = 0.425E+03 QT (W/M2) = -0.297E-11
R (M) =    38.25 TSL (K) =  303.2 QB (W/M2) = 0.397E+03 QT (W/M2) = -0.297E-11
R (M) =    39.99 TSL (K) =  302.6 QB (W/M2) = 0.372E+03 QT (W/M2) = -0.297E-11
R (M) =    41.73 TSL (K) =  302.1 QB (W/M2) = 0.350E+03 QT (W/M2) = -0.297E-11
R (M) =    43.46 TSL (K) =  301.6 QB (W/M2) = 0.330E+03 QT (W/M2) = -0.297E-11
R (M) =    45.20 TSL (K) =  301.2 QB (W/M2) = 0.312E+03 QT (W/M2) = -0.297E-11
R (M) =    46.94 TSL (K) =  300.8 QB (W/M2) = 0.296E+03 QT (W/M2) = -0.297E-11
R (M) =    48.68 TSL (K) =  299.8 QB (W/M2) = 0.286E+03 QT (W/M2) = -0.297E-11
R (M) =    50.42 TSL (K) =  294.9 QB (W/M2) = 0.390E+02 QT (W/M2) = -0.297E-11

TIME (S)=  360.0000 LYR TEMP (K)=   443.6 LYR HT (M) =    7.31
LYR MASS (KG)=0.760E+04  FIRE OUTPUT (W) =   0.3795E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   590.31 JET VELOCITY (M/S) =      4.317
JET TEMP (K) =   590.9  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  658.1 QB (W/M2) = 0.117E+05 QT (W/M2) = -0.297E-11
R (M) =     1.74 TSL (K) =  614.7 QB (W/M2) = 0.107E+05 QT (W/M2) = -0.297E-11
R (M) =     3.48 TSL (K) =  564.3 QB (W/M2) = 0.939E+04 QT (W/M2) = -0.297E-11
R (M) =     5.22 TSL (K) =  510.0 QB (W/M2) = 0.780E+04 QT (W/M2) = -0.297E-11
R (M) =     6.95 TSL (K) =  463.8 QB (W/M2) = 0.631E+04 QT (W/M2) = -0.297E-11
R (M) =     8.69 TSL (K) =  427.5 QB (W/M2) = 0.505E+04 QT (W/M2) = -0.297E-11
R (M) =    10.43 TSL (K) =  399.9 QB (W/M2) = 0.405E+04 QT (W/M2) = -0.297E-11
R (M) =    12.17 TSL (K) =  379.3 QB (W/M2) = 0.329E+04 QT (W/M2) = -0.297E-11
R (M) =    13.91 TSL (K) =  363.9 QB (W/M2) = 0.271E+04 QT (W/M2) = -0.297E-11
R (M) =    15.65 TSL (K) =  352.2 QB (W/M2) = 0.226E+04 QT (W/M2) = -0.297E-11
R (M) =    17.39 TSL (K) =  343.2 QB (W/M2) = 0.192E+04 QT (W/M2) = -0.297E-11
R (M) =    19.12 TSL (K) =  336.2 QB (W/M2) = 0.165E+04 QT (W/M2) = -0.297E-11
R (M) =    20.86 TSL (K) =  330.7 QB (W/M2) = 0.143E+04 QT (W/M2) = -0.297E-11
R (M) =    22.60 TSL (K) =  326.3 QB (W/M2) = 0.126E+04 QT (W/M2) = -0.297E-11
R (M) =    24.34 TSL (K) =  322.7 QB (W/M2) = 0.112E+04 QT (W/M2) = -0.297E-11
R (M) =    26.08 TSL (K) =  319.8 QB (W/M2) = 0.101E+04 QT (W/M2) = -0.297E-11
R (M) =    27.82 TSL (K) =  317.3 QB (W/M2) = 0.910E+03 QT (W/M2) = -0.297E-11
R (M) =    29.56 TSL (K) =  315.2 QB (W/M2) = 0.828E+03 QT (W/M2) = -0.297E-11
R (M) =    31.29 TSL (K) =  313.4 QB (W/M2) = 0.759E+03 QT (W/M2) = -0.297E-11
R (M) =    33.03 TSL (K) =  311.9 QB (W/M2) = 0.699E+03 QT (W/M2) = -0.297E-11
R (M) =    34.77 TSL (K) =  310.6 QB (W/M2) = 0.647E+03 QT (W/M2) = -0.297E-11
R (M) =    36.51 TSL (K) =  309.4 QB (W/M2) = 0.602E+03 QT (W/M2) = -0.297E-11
R (M) =    38.25 TSL (K) =  308.4 QB (W/M2) = 0.562E+03 QT (W/M2) = -0.297E-11
R (M) =    39.99 TSL (K) =  307.5 QB (W/M2) = 0.527E+03 QT (W/M2) = -0.297E-11
R (M) =    41.73 TSL (K) =  306.7 QB (W/M2) = 0.495E+03 QT (W/M2) = -0.297E-11
```

FIGURE D.10(i) ***Continued***

```
R (M) =    43.46 TSL (K) =  306.0 QB (W/M2) = 0.467E+03 QT (W/M2) = -0.297E-11
R (M) =    45.20 TSL (K) =  305.3 QB (W/M2) = 0.442E+03 QT (W/M2) = -0.297E-11
R (M) =    46.94 TSL (K) =  304.7 QB (W/M2) = 0.419E+03 QT (W/M2) = -0.297E-11
R (M) =    48.68 TSL (K) =  303.7 QB (W/M2) = 0.402E+03 QT (W/M2) = -0.297E-11
R (M) =    50.42 TSL (K) =  295.4 QB (W/M2) = 0.597E+02 QT (W/M2) = -0.297E-11

TIME (S)=  420.0000 LYR TEMP (K)=   483.7 LYR HT (M) =    6.66
LYR MASS (KG)=0.949E+04  FIRE OUTPUT (W) =   0.5283E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   677.18 JET VELOCITY (M/S) =      4.879
JET TEMP (K) =   677.9  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  747.8 QB (W/M2) = 0.129E+05 QT (W/M2) = -0.297E-11
R (M) =     1.74 TSL (K) =  701.8 QB (W/M2) = 0.120E+05 QT (W/M2) = -0.297E-11
R (M) =     3.48 TSL (K) =  646.0 QB (W/M2) = 0.108E+05 QT (W/M2) = -0.297E-11
R (M) =     5.22 TSL (K) =  583.0 QB (W/M2) = 0.920E+04 QT (W/M2) = -0.297E-11
R (M) =     6.95 TSL (K) =  526.3 QB (W/M2) = 0.764E+04 QT (W/M2) = -0.297E-11
R (M) =     8.69 TSL (K) =  479.6 QB (W/M2) = 0.625E+04 QT (W/M2) = -0.297E-11
R (M) =    10.43 TSL (K) =  443.0 QB (W/M2) = 0.510E+04 QT (W/M2) = -0.297E-11
R (M) =    12.17 TSL (K) =  414.9 QB (W/M2) = 0.419E+04 QT (W/M2) = -0.297E-11
R (M) =    13.91 TSL (K) =  393.6 QB (W/M2) = 0.347E+04 QT (W/M2) = -0.297E-11
R (M) =    15.65 TSL (K) =  377.2 QB (W/M2) = 0.292E+04 QT (W/M2) = -0.297E-11
R (M) =    17.39 TSL (K) =  364.6 QB (W/M2) = 0.249E+04 QT (W/M2) = -0.297E-11
R (M) =    19.12 TSL (K) =  354.7 QB (W/M2) = 0.214E+04 QT (W/M2) = -0.297E-11
R (M) =    20.86 TSL (K) =  346.8 QB (W/M2) = 0.187E+04 QT (W/M2) = -0.297E-11
R (M) =    22.60 TSL (K) =  340.5 QB (W/M2) = 0.165E+04 QT (W/M2) = -0.297E-11
R (M) =    24.34 TSL (K) =  335.4 QB (W/M2) = 0.147E+04 QT (W/M2) = -0.297E-11
R (M) =    26.08 TSL (K) =  331.1 QB (W/M2) = 0.132E+04 QT (W/M2) = -0.297E-11
R (M) =    27.82 TSL (K) =  327.6 QB (W/M2) = 0.119E+04 QT (W/M2) = -0.297E-11
R (M) =    29.56 TSL (K) =  324.6 QB (W/M2) = 0.108E+04 QT (W/M2) = -0.297E-11
R (M) =    31.29 TSL (K) =  322.0 QB (W/M2) = 0.994E+03 QT (W/M2) = -0.297E-11
R (M) =    33.03 TSL (K) =  319.8 QB (W/M2) = 0.916E+03 QT (W/M2) = -0.297E-11
R (M) =    34.77 TSL (K) =  317.9 QB (W/M2) = 0.849E+03 QT (W/M2) = -0.297E-11
R (M) =    36.51 TSL (K) =  316.2 QB (W/M2) = 0.790E+03 QT (W/M2) = -0.297E-11
R (M) =    38.25 TSL (K) =  314.8 QB (W/M2) = 0.737E+03 QT (W/M2) = -0.297E-11
R (M) =    39.99 TSL (K) =  313.5 QB (W/M2) = 0.691E+03 QT (W/M2) = -0.297E-11
R (M) =    41.73 TSL (K) =  312.3 QB (W/M2) = 0.650E+03 QT (W/M2) = -0.297E-11
R (M) =    43.46 TSL (K) =  311.3 QB (W/M2) = 0.613E+03 QT (W/M2) = -0.297E-11
R (M) =    45.20 TSL (K) =  310.3 QB (W/M2) = 0.580E+03 QT (W/M2) = -0.297E-11
R (M) =    46.94 TSL (K) =  309.5 QB (W/M2) = 0.549E+03 QT (W/M2) = -0.297E-11
R (M) =    48.68 TSL (K) =  308.3 QB (W/M2) = 0.525E+03 QT (W/M2) = -0.297E-11
R (M) =    50.42 TSL (K) =  296.2 QB (W/M2) = 0.820E+02 QT (W/M2) = -0.297E-11

TIME (S)=  480.0000 LYR TEMP (K)=   530.8 LYR HT (M) =    5.94
LYR MASS (KG)=0.112E+05  FIRE OUTPUT (W) =   0.7059E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   784.41 JET VELOCITY (M/S) =      5.462
JET TEMP (K) =   785.2  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  837.6 QB (W/M2) = 0.137E+05 QT (W/M2) = -0.297E-11
R (M) =     1.74 TSL (K) =  789.0 QB (W/M2) = 0.128E+05 QT (W/M2) = -0.297E-11
R (M) =     3.48 TSL (K) =  729.0 QB (W/M2) = 0.117E+05 QT (W/M2) = -0.297E-11
R (M) =     5.22 TSL (K) =  659.2 QB (W/M2) = 0.103E+05 QT (W/M2) = -0.297E-11
R (M) =     6.95 TSL (K) =  593.8 QB (W/M2) = 0.876E+04 QT (W/M2) = -0.297E-11
R (M) =     8.69 TSL (K) =  537.8 QB (W/M2) = 0.736E+04 QT (W/M2) = -0.297E-11
R (M) =    10.43 TSL (K) =  492.4 QB (W/M2) = 0.613E+04 QT (W/M2) = -0.297E-11
R (M) =    12.17 TSL (K) =  456.6 QB (W/M2) = 0.511E+04 QT (W/M2) = -0.297E-11
R (M) =    13.91 TSL (K) =  428.8 QB (W/M2) = 0.429E+04 QT (W/M2) = -0.297E-11
R (M) =    15.65 TSL (K) =  407.2 QB (W/M2) = 0.363E+04 QT (W/M2) = -0.297E-11
R (M) =    17.39 TSL (K) =  390.4 QB (W/M2) = 0.311E+04 QT (W/M2) = -0.297E-11
R (M) =    19.12 TSL (K) =  377.0 QB (W/M2) = 0.270E+04 QT (W/M2) = -0.297E-11
R (M) =    20.86 TSL (K) =  366.4 QB (W/M2) = 0.236E+04 QT (W/M2) = -0.297E-11
R (M) =    22.60 TSL (K) =  357.9 QB (W/M2) = 0.209E+04 QT (W/M2) = -0.297E-11
R (M) =    24.34 TSL (K) =  350.9 QB (W/M2) = 0.186E+04 QT (W/M2) = -0.297E-11
R (M) =    26.08 TSL (K) =  345.1 QB (W/M2) = 0.167E+04 QT (W/M2) = -0.297E-11
R (M) =    27.82 TSL (K) =  340.2 QB (W/M2) = 0.152E+04 QT (W/M2) = -0.297E-11
R (M) =    29.56 TSL (K) =  336.1 QB (W/M2) = 0.138E+04 QT (W/M2) = -0.297E-11
R (M) =    31.29 TSL (K) =  332.6 QB (W/M2) = 0.127E+04 QT (W/M2) = -0.297E-11
```

FIGURE D.10(i) ***Continued***

```
R (M) =    33.03 TSL (K) =  329.6 QB (W/M2) = 0.117E+04 QT (W/M2) = -0.297E-11
R (M) =    34.77 TSL (K) =  327.0 QB (W/M2) = 0.109E+04 QT (W/M2) = -0.297E-11
R (M) =    36.51 TSL (K) =  324.7 QB (W/M2) = 0.101E+04 QT (W/M2) = -0.297E-11
R (M) =    38.25 TSL (K) =  322.7 QB (W/M2) = 0.944E+03 QT (W/M2) = -0.297E-11
R (M) =    39.99 TSL (K) =  320.9 QB (W/M2) = 0.886E+03 QT (W/M2) = -0.297E-11
R (M) =    41.73 TSL (K) =  319.3 QB (W/M2) = 0.833E+03 QT (W/M2) = -0.297E-11
R (M) =    43.46 TSL (K) =  317.8 QB (W/M2) = 0.786E+03 QT (W/M2) = -0.297E-11
R (M) =    45.20 TSL (K) =  316.5 QB (W/M2) = 0.743E+03 QT (W/M2) = -0.297E-11
R (M) =    46.94 TSL (K) =  315.4 QB (W/M2) = 0.705E+03 QT (W/M2) = -0.297E-11
R (M) =    48.68 TSL (K) =  313.9 QB (W/M2) = 0.673E+03 QT (W/M2) = -0.297E-11
R (M) =    50.42 TSL (K) =  297.1 QB (W/M2) = 0.108E+03 QT (W/M2) = -0.297E-11

TIME (S)=  540.0000 LYR TEMP (K)=   586.5 LYR HT (M) =    5.20
LYR MASS (KG)=0.125E+05  FIRE OUTPUT (W) =   0.9073E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =   915.64 JET VELOCITY (M/S) =      6.041
JET TEMP (K) =   916.6  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  921.9 QB (W/M2) = 0.146E+05 QT (W/M2) = -0.297E-11
R (M) =     1.74 TSL (K) =  870.2 QB (W/M2) = 0.137E+05 QT (W/M2) = -0.297E-11
R (M) =     3.48 TSL (K) =  806.7 QB (W/M2) = 0.126E+05 QT (W/M2) = -0.297E-11
R (M) =     5.22 TSL (K) =  731.6 QB (W/M2) = 0.112E+05 QT (W/M2) = -0.297E-11
R (M) =     6.95 TSL (K) =  660.0 QB (W/M2) = 0.972E+04 QT (W/M2) = -0.297E-11
R (M) =     8.69 TSL (K) =  597.0 QB (W/M2) = 0.834E+04 QT (W/M2) = -0.297E-11
R (M) =    10.43 TSL (K) =  544.2 QB (W/M2) = 0.709E+04 QT (W/M2) = -0.297E-11
R (M) =    12.17 TSL (K) =  501.5 QB (W/M2) = 0.601E+04 QT (W/M2) = -0.297E-11
R (M) =    13.91 TSL (K) =  467.5 QB (W/M2) = 0.511E+04 QT (W/M2) = -0.297E-11
R (M) =    15.65 TSL (K) =  440.7 QB (W/M2) = 0.437E+04 QT (W/M2) = -0.297E-11
R (M) =    17.39 TSL (K) =  419.5 QB (W/M2) = 0.377E+04 QT (W/M2) = -0.297E-11
R (M) =    19.12 TSL (K) =  402.6 QB (W/M2) = 0.329E+04 QT (W/M2) = -0.297E-11
R (M) =    20.86 TSL (K) =  389.0 QB (W/M2) = 0.290E+04 QT (W/M2) = -0.297E-11
R (M) =    22.60 TSL (K) =  378.0 QB (W/M2) = 0.257E+04 QT (W/M2) = -0.297E-11
R (M) =    24.34 TSL (K) =  368.9 QB (W/M2) = 0.230E+04 QT (W/M2) = -0.297E-11
R (M) =    26.08 TSL (K) =  361.4 QB (W/M2) = 0.207E+04 QT (W/M2) = -0.297E-11
R (M) =    27.82 TSL (K) =  355.0 QB (W/M2) = 0.188E+04 QT (W/M2) = -0.297E-11
R (M) =    29.56 TSL (K) =  349.7 QB (W/M2) = 0.172E+04 QT (W/M2) = -0.297E-11
R (M) =    31.29 TSL (K) =  345.1 QB (W/M2) = 0.158E+04 QT (W/M2) = -0.297E-11
R (M) =    33.03 TSL (K) =  341.1 QB (W/M2) = 0.146E+04 QT (W/M2) = -0.297E-11
R (M) =    34.77 TSL (K) =  337.7 QB (W/M2) = 0.136E+04 QT (W/M2) = -0.297E-11
R (M) =    36.51 TSL (K) =  334.7 QB (W/M2) = 0.126E+04 QT (W/M2) = -0.297E-11
R (M) =    38.25 TSL (K) =  332.0 QB (W/M2) = 0.118E+04 QT (W/M2) = -0.297E-11
R (M) =    39.99 TSL (K) =  329.6 QB (W/M2) = 0.111E+04 QT (W/M2) = -0.297E-11
R (M) =    41.73 TSL (K) =  327.5 QB (W/M2) = 0.104E+04 QT (W/M2) = -0.297E-11
R (M) =    43.46 TSL (K) =  325.6 QB (W/M2) = 0.986E+03 QT (W/M2) = -0.297E-11
R (M) =    45.20 TSL (K) =  323.9 QB (W/M2) = 0.933E+03 QT (W/M2) = -0.297E-11
R (M) =    46.94 TSL (K) =  322.4 QB (W/M2) = 0.885E+03 QT (W/M2) = -0.297E-11
R (M) =    48.68 TSL (K) =  320.7 QB (W/M2) = 0.844E+03 QT (W/M2) = -0.297E-11
R (M) =    50.42 TSL (K) =  298.2 QB (W/M2) = 0.138E+03 QT (W/M2) = -0.297E-11

TIME (S)=  600.0000 LYR TEMP (K)=   649.9 LYR HT (M) =    4.57
LYR MASS (KG)=0.131E+05  FIRE OUTPUT (W) =   0.9999E+08 VENT AREA (M2) =  28.20
LINK =  1 LINK TEMP (K) =  1029.11 JET VELOCITY (M/S) =      6.247
JET TEMP (K) =  1029.6  TIME LINK    1  OPENS EQUALS      41.7098 (S)
R (M) =     0.00 TSL (K) =  976.8 QB (W/M2) = 0.123E+05 QT (W/M2) = -0.297E-11
R (M) =     1.74 TSL (K) =  923.1 QB (W/M2) = 0.115E+05 QT (W/M2) = -0.297E-11
R (M) =     3.48 TSL (K) =  859.1 QB (W/M2) = 0.107E+05 QT (W/M2) = -0.297E-11
R (M) =     5.22 TSL (K) =  783.3 QB (W/M2) = 0.965E+04 QT (W/M2) = -0.297E-11
R (M) =     6.95 TSL (K) =  710.1 QB (W/M2) = 0.861E+04 QT (W/M2) = -0.297E-11
R (M) =     8.69 TSL (K) =  644.7 QB (W/M2) = 0.761E+04 QT (W/M2) = -0.297E-11
R (M) =    10.43 TSL (K) =  588.5 QB (W/M2) = 0.667E+04 QT (W/M2) = -0.297E-11
R (M) =    12.17 TSL (K) =  541.7 QB (W/M2) = 0.582E+04 QT (W/M2) = -0.297E-11
R (M) =    13.91 TSL (K) =  503.6 QB (W/M2) = 0.506E+04 QT (W/M2) = -0.297E-11
R (M) =    15.65 TSL (K) =  472.9 QB (W/M2) = 0.442E+04 QT (W/M2) = -0.297E-11
R (M) =    17.39 TSL (K) =  448.1 QB (W/M2) = 0.387E+04 QT (W/M2) = -0.297E-11
R (M) =    19.12 TSL (K) =  428.2 QB (W/M2) = 0.342E+04 QT (W/M2) = -0.297E-11
R (M) =    20.86 TSL (K) =  411.9 QB (W/M2) = 0.304E+04 QT (W/M2) = -0.297E-11
```

FIGURE D.10(i) ***Continued***

```
R (M) =    22.60 TSL (K) =  398.6 QB (W/M2) = 0.272E+04 QT (W/M2) = -0.297E-11
R (M) =    24.34 TSL (K) =  387.6 QB (W/M2) = 0.245E+04 QT (W/M2) = -0.297E-11
R (M) =    26.08 TSL (K) =  378.4 QB (W/M2) = 0.223E+04 QT (W/M2) = -0.297E-11
R (M) =    27.82 TSL (K) =  370.6 QB (W/M2) = 0.203E+04 QT (W/M2) = -0.297E-11
R (M) =    29.56 TSL (K) =  364.0 QB (W/M2) = 0.187E+04 QT (W/M2) = -0.297E-11
R (M) =    31.29 TSL (K) =  358.4 QB (W/M2) = 0.172E+04 QT (W/M2) = -0.297E-11
R (M) =    33.03 TSL (K) =  353.5 QB (W/M2) = 0.160E+04 QT (W/M2) = -0.297E-11
R (M) =    34.77 TSL (K) =  349.2 QB (W/M2) = 0.149E+04 QT (W/M2) = -0.297E-11
R (M) =    36.51 TSL (K) =  345.4 QB (W/M2) = 0.139E+04 QT (W/M2) = -0.297E-11
R (M) =    38.25 TSL (K) =  342.1 QB (W/M2) = 0.130E+04 QT (W/M2) = -0.297E-11
R (M) =    39.99 TSL (K) =  339.2 QB (W/M2) = 0.123E+04 QT (W/M2) = -0.297E-11
R (M) =    41.73 TSL (K) =  336.5 QB (W/M2) = 0.116E+04 QT (W/M2) = -0.297E-11
R (M) =    43.46 TSL (K) =  334.1 QB (W/M2) = 0.109E+04 QT (W/M2) = -0.297E-11
R (M) =    45.20 TSL (K) =  332.0 QB (W/M2) = 0.104E+04 QT (W/M2) = -0.297E-11
R (M) =    46.94 TSL (K) =  330.1 QB (W/M2) = 0.986E+03 QT (W/M2) = -0.297E-11
R (M) =    48.68 TSL (K) =  328.0 QB (W/M2) = 0.941E+03 QT (W/M2) = -0.297E-11
R (M) =    50.42 TSL (K) =  299.4 QB (W/M2) = 0.147E+03 QT (W/M2) = -0.297E-11
```

FIGURE D.10(i) ***Continued***

Annex E Predicting the Rate of Heat Release of Fires

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

E.1 Introduction. Annex E presents techniques for estimating the heat release rate of various fuel arrays likely to be present in buildings where smoke and heat venting is a potential fire safety provision. This annex primarily addresses the estimation of fuel concentrations found in storage and manufacturing locations. NFPA 92 addresses the types of fuel arrays more common to the types of building situations covered by that document.

This standard is applicable to situations in which the hot layer does not enhance the burning rate. The methods provided in this annex for estimating the rate of heat release, therefore, are based on free burning conditions in which no ceiling or hot gas layer effects are involved. It is assumed, therefore, that the burning rate is relatively unaffected by the hot layer.

E.2 Sources of Data. The following sources of data appear in their approximate order of priority, given equal quality of data acquisition:

(1) Actual tests of the array involved
(2) Actual tests of similar arrays
(3) Algorithms derived from tests of arrays having similar fuels and dimensional characteristics
(4) Calculations based on tested properties and materials and expected flame flux
(5) Mathematical models of fire spread and development

E.3 Actual Tests of the Array Involved. Where an actual calorific test of the specific array under consideration has been conducted and the data are in a form that can be expressed as rate of heat release, the data can be used as input for the methods in this standard. Because actual test data seldom produce the steady state assumed for a limited-growth fire or the square-of-time growth assumed for a continuous-growth fire, engineering judgment is usually needed to derive the actual input necessary if either of these approaches is used. If LAVENT or another computer model capable of responding to a rate of heat release versus time curve is used, the data can be used directly. Currently there is a listing of limited information from tests of specific arrays. Some test data can be found in technical reports. Alternatively, individual tests can be conducted.

Many fire tests do not include a direct measurement of rate of heat release. In some cases, that measure can be derived, based on measurement of mass loss rate using the following equation:

$$Q = m\left(h_c\right) \quad \textbf{[E.3a]}$$

where:
Q = total heat release rate (kW)
m = mass loss rate (kg/s)
h_c = heat of combustion (kJ/kg)

In other cases, a direct measurement can be derived based on measurement of flame height above the base of the fire as follows:

$$Q = 37\left(L + 1.02D\right)^{5/2} \quad \textbf{[E.3b]}$$

where:
Q = total heat release rate (kW)
L = mean flame height above the base of the fire (m)
D = base diameter of the fire (m)

E.4 Actual Tests of Arrays Similar to That Involved. Where an actual calorific test of the specific array under consideration cannot be found, it might be possible to find data on one or more tests that are similar to the fuel of concern in important matters such as type of fuel, arrangement, or ignition scenario. The more the actual tests are similar to the fuel of concern, the higher is the confidence that can be placed in the derived rate of heat release. Added engineering judgment, however, might be needed to adjust the test data to that approximating the fuel of concern. If the rate of heat release has not been measured directly, it can be estimated using the methods provided in Section E.3.

E.5 Algorithms Derived from Tests of Arrays Having Similar Fuels and Dimensional Characteristics.

E.5.1 Pool Fires. In many cases, the rate of heat release of a tested array has been divided by a common dimension, such as occupied floor area, to derive a normalized rate of heat release per unit area. The rate of heat release of pool fires is the best documented and accepted algorithm in this class.

An equation for the mass release rate from a pool fire is as follows [Babrauskas, 2008]:

$$\dot{m}'' = \dot{m}''_{\infty}\left(1 - e^{-(k_e\beta)D}\right) \qquad \textbf{[E.5.1]}$$

The variables $\dot{m}''_{\infty}$ and $(k_e\beta)^D$ for Equation E.5.1 are as shown in Table E.5.1.

The mass rates derived from Equation E.5.1 are converted to rates of heat release using Equation E.3a and the heat of combustion, h_c, from Table E.5.1. The rate of heat release per unit area times the area of the pool yields heat release data for the anticipated fire.

E.5.2 Other Normalized Data. Other data based on burning rate per unit area in tests have been developed. Table E.5.2(a) and Table E.5.2(b) list these data.

E.5.3 Other Useful Data. Examples of other data that are not normalized but that might be useful in developing the rate of heat release curve are included in Table E.5.3(a) through Table E.5.3(d).

E.6 Calculated Fire Description Based on Tested Properties.

E.6.1 Background. It is possible to make general estimates of the rate of heat release of burning materials based on the fire properties of that material. The fire properties involved are determined by small-scale tests. The most important of these tests are the calorimeter tests involving both oxygen depletion calorimetry and the application of external heat flux to the sample while determining time to ignition, rate of mass release, and rate of heat release for the specific applied flux. Most prominent of the current test apparatus are the cone calorimeter (ASTM E 1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*) and the Factory Mutual Fire Propagation Apparatus [ASTM E 2058, *Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*].

In addition to the directly measured properties, it is possible to derive ignition temperature, critical ignition flux, effective thermal inertia (kc), heat of combustion, and heat of gasification based on results from these calorimeters. Properties not derivable from these calorimeters and essential to determining flame spread in directions not concurrent with the flow of the flame can be obtained from the LIFT (lateral ignition and flame travel) apparatus (ASTM E 1321, *Standard Test Method for Determining Material Ignition and Flame Spread Properties*).

This section presents a concept of the use of fire property test data as the basis of an analytical evaluation of the rate of

Table E.5.1 Data for Large Pool Burning Rate Estimates

Material	Density (kg/m^3)	h_c (MJ/kg)	$\dot{m}''_{\infty}$	$k_e\beta^D$ (m^{-1})
Cryogenics[a]				
Liquid H_2	70	120.0	0.017	6.1
LNG (mostly CH_4)	415	50.0	0.078	1.1
LPG (mostly C_3H_8)	585	46.0	0.099	1.4
Alcohols				
Methanol (CH_3OH)	796	20.0	0.017	∞[b]
Ethanol (C_2H_5OH)	794	26.8	0.015	∞[b]
Simple organic fuels				
Butane (C_4H_{10})	573	45.7	0.078	2.7
Benzene (C_5H_6)	874	40.1	0.085	2.7
Hexane (C_6H_{14})	650	44.7	0.074	1.9
Heptane (C_7H_{16})	675	44.6	0.101	1.1
Xylene (C_8H_{10})	870	40.8	0.090	1.4
Acetone (C_3H_6O)	791	25.8	0.041	1.9
Dioxane ($C_4H_8O_2$)	1035	26.2	0.018[c]	5.4[c]
Diethyl ether ($C_4H_{10}O$)	714	34.2	0.085	0.7
Petroleum products				
Benzine	740	44.7	0.048	3.6
Gasoline	740	43.7	0.055	2.1
Kerosene	820	43.2	0.039	3.5
JP-4	760	43.5	0.051	3.6
JP-5	810	43.0	0.054	1.6
Transformer oil, hydrocarbon	760	46.4	0.039[c]	0.7[c]
Fuel oil, heavy	940–1000	39.7	0.035	1.7
Crude oil	830–880	42.5–42.7	0.022–0.045	2.8
Solids				
Polymethylmethacrylate $(C_5H_8O_2)_n$	1184	24.9	0.020	3.3
Polypropylene $(C_3H_6)_n$	905	43.2	0.018	
Polystyrene $(C_8H_8)_n$	1050	39.7	0.034	

[a] For pools on dry land, not over water.
[b] Value is independent of the diameter in a turbulent regimen.
[c] Estimate is uncertain, since only two data points are available.

Table E.5.2(a) Unit Heat Release Rates for Fuels Burning in the Open

Commodity	Heat Release Rate (kW)
Wood or PMMA* (vertical)	
0.61 m height	100/m of width
1.83 m height	240/m of width
2.44 m height	620/m of width
3.66 m height	1000/m of width
Wood or PMMA	
Top of horizontal surface	720/m^2 of surface
Solid polystyrene (vertical)	
0.61 m height	220/m of width
1.83 m height	450/m of width
2.44 m height	1400/m of width
3.66 m height	2400/m of width
Solid polystyrene (horizontal)	1400/m^2 of surface
Solid polypropylene (vertical)	
0.61 m height	220/m of width
1.83 m height	350/m of width
2.44 m height	970/m of width
3.66 m height	1600/m of width
Solid polypropylene (horizontal)	800/m^2 of surface

* PMMA: polymethyl methacrylate (Plexiglas, Lucite, acrylic).

Table E.5.2(b) Unit Heat Release Rate for Commodities

Commodity	Heat Release Rate (kW per m^2 of floor area)*
Wood pallets, stacked 0.46 m high (6%–12% moisture)	1,420
Wood pallets, stacked 1.52 m high (6%–12% moisture)	4,000
Wood pallets, stacked 3.05 m high (6%–12% moisture)	6,800
Wood pallets, stacked 4.88 m high (6%–12% moisture)	10,200
Mail bags, filled, stored 1.52 m high	400
Cartons, compartmented, stacked 4.5 m high	1,700
PE letter trays, filled, stacked 1.5 m high on cart	8,500
PE trash barrels in cartons, stacked 4.5 m high	2,000
PE fiberglass shower stalls in cartons, stacked 4.6 m high	1,400
FRP bottles packed in cartons, stacked 4.6 m high	6,200
PE bottles in cartons, stacked 4.5 m high	2,000
PU insulation board, rigid foam, stacked 4.6 m high	1,900
FRP jars packed in cartons, stacked 4.6 m high	14,200
PS tubs nested in cartons, stacked 4.2 m high	5,400
PS toy parts in cartons, stacked 4.5 m high	2,000
PS insulation board, rigid foam, stacked 4.2 m high	3,300
FRP bottles packed in cartons, stacked 4.6 m high	3,400
FRP tubs packed in cartons, stacked 4.6 m high	4,400
PP and PE film in rolls, stacked 4.1 m high	6,200
Methyl alcohol	600
Gasoline	2,500
Kerosene	1,700
Fuel oil, no. 2	1,700

PE: polyethylene. PP: polypropylene. PS: polystyrene. PU: polyurethane. FRP: fiberglass-reinforced polyester.
*Heat release rate per unit floor area of fully involved combustibles, based on negligible radiative feedback from the surroundings and 100 percent combustion efficiency.

Table E.5.3(a) Characteristics of Ignition Sources

Fuel	Typical Heat Output (W)	Burn Time[a] (s)	Maximum Flame Height (mm)	Flame Width (mm)	Maximum Heat Flux (kW/m²)
Cigarette 1.1 g (not puffed, laid on solid surface)					
Bone dry	5	1,200	—	—	42
Conditioned to 50% relative humidity	5	1,200	—	—	35
Methenamine pill, 0.15 g	45	90	—	—	4
Match, wooden (laid on solid surface)	80	2030	30	14	18–20
Wood cribs, BS 5852 Part 2					
No. 4 crib, 8.5 g	1,000	190			15[b]
No. 5 crib, 17 g	1,900	200			17[b]
No. 6 crib, 60 g	2,600	190			20[b]
No. 7 crib, 126 g	6,400	350			25[b]
Crumpled brown lunch bag, 6 g	1,200	80			
Crumpled wax paper, 4.5 g (tight)	1,800	25			
Crumpled wax paper, 4.5 g (loose)	5,300	20			
Folded double-sheet newspaper, 22 g (bottom ignition)	4,000	100			
Crumpled double-sheet newspaper, 22 g (top ignition)	7,400	40			
Crumpled double-sheet newspaper, 22 g (bottom ignition)	17,000	20			
Polyethylene wastebasket, 285 g, filled with 12 milk cartons (390 g)	50,000	200[c]	550	200	35[d]
Plastic trash bags, filled with cellulosic trash (1.2–14 kg)[e]	120,000 to 50,000	200[c]			

[a]Time duration of significant flaming.
[b]Measured from 25 mm away.
[c]Total burn time in excess of 1800 seconds.
[d]As measured on simulation burner.
[e]Results vary greatly with packing density.

Table E.5.3(b) Characteristics of Typical Furnishings as Ignition Sources

Fuel	Total Mass (kg)	Total Heat Content (MJ)	Maximum Rate of Heat Release (kW)	Maximum Thermal Radiation to Center of Floor* (kW/m²)
Wastepaper basket	0.73–1.04	0.7–7.3	4–18	0.1
Curtains, velvet/cotton	1.9	24	160–240	1.3–3.4
Curtains, acrylic/cotton	1.4	15–16	130–150	0.9–1.2
TV set	27–33	145–150	120–290	0.3–2.6
Chair mockup	1.36	21–22	63–66	0.4–0.5
Sofa mockup	2.8	42	130	0.9
Arm chair	26	18	160	1.2
Christmas tree, dry	6.5–7.4	11–41	500–650	3.4–14

*Measured at approximately 2 m from the burning object.

Table E.5.3(c) Maximum Heat Release Rates from Fire Detection Institute Analysis

Fuel	Approximate Value (kW)
Medium wastebasket with milk cartons	100
Large barrel with milk cartons	140
Upholstered chair with polyurethane foam	350
Latex foam mattress (heat at room door)	1200
Furnished living room (heat at open door)	4000–8000

Table E.5.3(d) Mass Loss and Heat Release Rates of Chairs

Specimen	Mass (kg)	Mass Combustible (kg)	Style	Frame	Padding	Fabric	Inter-liner	Peak, m (g/s)	Peak, Q (kW)
C12	17.9	17.0	Traditional easy chair	Wood	Cotton	Nylon		19.0	290[a]
F22	31.9		Traditional easy chair	Wood	Cotton (FR)	Cotton		25.0	370[a]
F23	31.2		Traditional easy chair	Wood	Cotton (FR)	Olefin		42.0	700[b]
F27	29.0		Traditional easy chair	Wood	Mixed	Cotton		58.0	920[b]
F28	29.2		Traditional easy chair	Wood	Mixed	Cotton		42.0	730[b]
CO2	13.1	12.2	Traditional easy chair	Wood	Cotton, PU	Olefin		13.2	800[b]
CO3	13.6	12.7	Traditional easy chair	Wood	Cotton, PU	Cotton		17.5	460[a]
CO1	12.6	11.7	Traditional easy chair	Wood	Cotton, PU	Cotton		17.5	260[a]
CO4	12.2	11.3	Traditional easy chair	Wood	PU	Nylon		75.7	1350[b]
C16	19.1	18.2	Traditional easy chair	Wood	PU	Nylon	Neoprene	NA	180[b]
F25	27.8		Traditional easy chair	Wood	PU	Olefin		80.0	1990
T66	23.0		Traditional easy chair	Wood	PU, polyester	Cotton		27.7	640
F21	28.3		Traditional easy chair	Wood	PU (FR)	Olefin		83.0	1970
F24	28.3		Traditional easy chair	Wood	PU (FR)	Cotton		46.0	700
C13	19.1	18.2	Traditional easy chair	Wood	PU	Nylon	Neoprene	15.0	230[a]
C14	21.8	20.9	Traditional easy chair	Wood	PU	Olefin	Neoprene	13.7	220[a]
C15	21.8	20.9	Traditional easy chair	Wood	PU	Olefin	Neoprene	13.1	210[b]
T49	15.7		Easy chair	Wood	PU	Cotton		14.3	210
F26	19.2		Thinner easy chair	Wood	PU (FR)	Olefin		61.0	810
F33	39.2		Traditional loveseat	Wood	Mixed	Cotton		75.0	940
F31	40.0		Traditional loveseat	Wood	PU (FR)	Olefin		130.0	2890
F32	51.5		Traditional sofa	Wood	PU (FR)	Olefin		145.0	3120
T57	54.6		Loveseat	Wood	PU, cotton	PVC		61.9	1100
T56	11.2		Office chair	Wood	Latex	PVC		3.1	80
CO9/T64	16.6	16.2	Foam block chair	Wood (part)	PU, polyester	PU		19.9	460
CO7/T48	11.4	11.2	Modern easy chair	PS foam	PU	PU		38.0	960
C10	12.1	8.6	Pedestal chair	Rigid PU foam	PU	PU		15.2	240[a]
C11	14.3	14.3	Foam block chair		PU	Nylon		NA	810[b]
F29	14.0		Traditional easy chair	PP foam	PU	Olefin		72.0	1950
F30	25.2		Traditional easy chair	Rigid PU foam	PU	Olefin		41.0	1060
CO8	16.3	15.4	Pedestal swivel chair	Molded PE	PU	PVC		112.0	830[b]
CO5	7.3	7.3	Bean bag chair		Polystyrene	PVC		22.2	370[a]
CO6	20.4	20.4	Frameless foam back chair		PU	Acrylic		151.0	2480[b]
T50	16.5		Waiting room chair	Metal	Cotton	PVC		NA	10
T53	15.5	1.9	Waiting room chair	Metal	PU	PVC		13.1	270
T54	27.3	5.8	Metal frame loveseat	Metal	PU	PVC		19.9	370
T75/F20	7.5(4)	2.6	Stacking chairs (4)	Metal	PU	PVC		7.2	160

[a]Estimated from mass loss records and assumed Wh_c.
[b]Estimated from doorway gas concentrations.

heat release involved in the use of a tested material. The approach outlined in this section is based on that presented by Nelson and Forssell [1994].

E.6.2 Discussion of Measured Properties. Table E.6.2(a) lists the type of fire properties obtainable from the cone calorimeter [NFPA 287], the Factory Mutual Fire Propagation Apparatus [ASTM E 2058, *Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*], and similar instruments.

In Table E.6.2(a), the rate of heat release, mass loss, and time to ignition are functions of the externally applied incident radiant heat flux imposed on the tested sample. The purpose of the externally applied flux is to simulate the fire environment surrounding a burning item.

In general, it can be estimated that a free-burning fuel package (i.e., one that burns in the open and is not affected by energy feedback from a hot gas layer of a heat source other than its own flame) is impacted by a flux in the range of 25 kW/m^2 to 50 kW/m^2. If the fire is in a space and conditions are approaching flashover, the flux can increase to the range of 50 kW/m^2 to 75 kW/m^2. In a fully developed, postflashover fire, a range of 75 kW/m^2 to greater than 100 kW/m^2 can be expected. The following is a discussion of the individual properties measured or derived and the usual form used to report the property.

Table E.6.2(a) Relation of Calorimeter-Measured Properties to Fire Analysis

Property	Ignition	Flame Spread	Fire Size (energy)
Rate of heat release*		X	X
Mass loss*			X
Time to ignition*	X	X	
Effective thermal properties†	X	X	
Heat of combustion†		X	X
Heat of gasification†			X
Critical ignition flux†	X	X	
Ignition temperature†	X	X	

*Property is a function of the externally applied incident flux.
†Derived properties from calorimeter measurements.

Rate of Heat Release. The rate of heat release is determined by oxygen depletion calorimetry. Each test is run at a user-specific incident flux, either for a predetermined period of time or until the sample is consumed. The complete results are presented in the form of a plot of heat release rate versus time, with the level of applied flux noted. In some cases, the rate of heat release for several tests of the same material at different levels of applied flux is plotted on a single curve for comparison. Figure E.6.2 is an example of such a plotting.

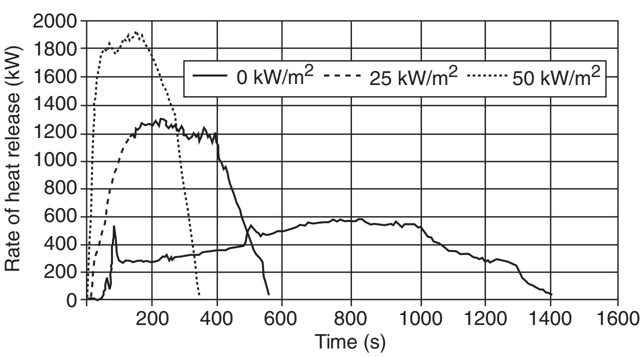

FIGURE E.6.2 Typical Graphic Output of Cone Calorimeter Test.

Often, only the peak rate of heat release at a specific flux is reported. Table E.6.2(b) is an example.

Mass Loss Rate. Mass loss rate is determined by a load cell. The method of reporting is identical to that for rate of heat release. In the typical situation in which the material has a consistent heat of combustion, the curves for mass loss rate and rate of heat release are similar in shape.

Time to Ignition. Time to ignition is reported for each individual test and applied flux level conducted.

Effective Thermal Inertia ($k\rho c$). Effective thermal inertia is a measurement of the heat rise response of the tested material to the heat flux imposed on the sample. It is derived at the time of ignition and is based on the ratio of the actual incident flux to the critical ignition flux and the time to ignition. A series of tests at different levels of applied flux is necessary to derive the effective thermal inertia. Effective thermal inertia derived in this manner can differ from, and be preferable to,

Table E.6.2(b) Average Maximum Heat Release Rates (kW/m2)

Material	Orientation	25 kW/m² Exposing Flux	50 kW/m² Exposing Flux	75 kW/m² Exposing Flux
PMMA	Horizontal	650	900	1300
	Vertical	560	720	1300
Pine	Horizontal	140	240	265
	Vertical	130	170	240
Sample A	Horizontal	125	200	250
	Vertical	90	130	220
Sample B	Horizontal	140	175	240
	Vertical	60	200	330
Sample C	Horizontal		215	250
	Vertical		165	170
Sample D	Horizontal	70	145	145
	Vertical		125	125

handbook data for the values of k, ρ, and c that are derived without a fire.

Heat of Combustion. Heat of combustion is derived by dividing the measured rate of heat release by the measured mass loss rate. It is normally reported as a single value, unless the sample is a composite material and the rates of heat release and mass loss vary significantly with time and exposure.

Heat of Gasification. Heat of gasification is the flux needed to pyrolyze a unit mass of fuel. It is derived as a heat balance and is usually reported as a single value in terms of the amount of energy per unit mass of material released (e.g., kJ/g).

Critical Ignition Flux. Critical ignition flux is the minimum level of incident flux on the sample needed to ignite the sample, given an unlimited time of application. At incident flux levels less than the critical ignition flux, ignition does not take place.

Ignition Temperature. Ignition temperature of a sample is the surface temperature at which flame occurs. This sample material value is independent of the incident flux and is derivable from the calorimeter tests, the LIFT apparatus test, and other tests. It is derived from the time to ignite in a given test, the applied flux in that test, and the effective thermal inertia of the sample. It is reported at a single temperature. If the test includes a pilot flame or spark, the reported temperature is for piloted ignition; if there is no pilot present, the temperature is for auto-ignition. Most available data are for piloted ignition.

E.6.3 Ignition. Equations for time to ignition, t_{ig}, are given for both thermally thin and thermally thick materials, defined as follows. For materials of intermediate depth, estimates for t_{ig} necessitate considerations beyond the scope of this presentation [Drysdale, 2011, Carslaw and Jaeger, 1959].

Thermally Thin Materials. Relative to ignition from a constant incident heat flux, q_i, at the exposed surface and with relatively small heat transfer losses at the unexposed surface, a thermally thin material is one whose temperature is relatively uniform throughout its entire thickness, l, at $t = t_{ig}$. For example, at $t = t_{ig}$:

$$T_{exposed} - T_{unexposed} = T_{ig} - T_{unexposed} < 0.1\left(T_{ig} - T_o\right) \quad \textbf{[E.6.3a]}$$

Equation E.6.3a can be used to show that a material is thermally thin [Carslaw and Jaeger, 1959] where:

$$l < 0.6\left(t_{ig}\alpha\right)^{1/2} \qquad \textbf{[E.6.3b]}$$

For example, for sheets of maple or oak wood (where the thermal diffusivity = $1.28\ 10^{7}\ m^2/s$ [DiNenno et al., 1995]), if t_{ig} = 35 s is measured in a piloted ignition test, then, according to Equation E.6.3b, if the sample thickness is less than approximately 0.0013 m, the unexposed surface of the sample can be expected to be relatively close to T_{ig} at the time of ignition, and the sample is considered to be thermally thin.

The time to ignition of a thermally thin material subjected to incident flux above a critical incident flux is as follows:

$$t_{ig} = \rho c l \frac{\left(T_{ig} - T_o\right)}{\dot{q}''_i} \qquad \textbf{[E.6.3c]}$$

Thermally Thick Materials. Relative to the type of ignition test described for thermally thin materials, a sample of a material of a thickness, *l*, is considered to be thermally thick if the increase in temperature of the unexposed surface is relatively small compared to that of the exposed surface at $t = t_{ig}$. For example, at $t = t_{ig}$,

$$T_{unexposed} - T_o < 0.1\left(T_{exposed} - T_o\right) = 0.1\left(T_{ig} - T_o\right) \qquad \textbf{[E.6.3d]}$$

Equation E.6.3d can be used to show that a material is thermally thick [Carslaw and Jaeger, 1959] where:

$$l > 2\left(t_{ig}\alpha\right)^{1/2} \qquad \textbf{[E.6.3e]}$$

For example, according to Equation E.6.3e, in the case of an ignition test on a sheet of maple or oak wood, if t_{ig} = 35 s is measured in a piloted ignition test and if the sample thickness is greater than approximately 0.0042 m, the unexposed surface of the sample can be expected to be relatively close to T_o at the time of ignition, and the sample is considered to be thermally thick.

Time to ignition of a thermally thick material subjected to incident flux above a critical incident flux is as follows:

$$t_{ig} = \frac{\pi}{4} k \rho c \left(\frac{T_{ig} - T_o}{\dot{q}''_i}\right)^2 \qquad \textbf{[E.6.3f]}$$

It should be noted that a particular material is not intrinsically thermally thin or thick (i.e., the characteristic of being thermally thin or thick is not a material characteristic or property), but rather depends on the thickness of the particular sample (i.e., a particular material can be implemented in either a thermally thick or a thermally thin configuration).

Propagation between Separate Fuel Packages. Where the concern is for propagation between individual, separated fuel packages, incident flux can be calculated using traditional radiation heat transfer procedures [Tien, et al., 2008].

The rate of radiation heat transfer from a flaming fuel package of total energy release rate, *Q*, to a facing surface element of an exposed fuel package can be estimated from the following equation:

$$\dot{q}''_i = \frac{\chi_r}{4\pi r^2} \qquad \textbf{[E.6.3g]}$$

E.6.4 Estimating Rate of Heat Release. As discussed in E.6.2, tests have demonstrated that the energy feedback from a burning fuel package ranges from approximately 25 kW/m^2 to 50 kW/m^2. For a reasonably conservative analysis, it is recommended that test data developed with an incident flux of 50 kW/m^2 be used. For a first-order approximation, it should be assumed that all of the surfaces that can be simultaneously involved in burning are releasing energy at a rate equal to that determined by testing the material in a fire properties calorimeter with an incident flux of 50 kW/m^2 for a free-burning material and 75 kW/m^2 to 100 kW/m^2 for postflashover conditions.

In making this estimate, it is necessary to assume that all surfaces that can "see" an exposing flame (or superheated gas, in the postflashover condition) are burning and releasing energy and mass at the tested rate. If sufficient air is present, the rate of heat release estimate is then calculated as the product of the exposed area and the rate of heat release per unit area as determined in the test calorimeter. Where test data are taken at the incident flux of the exposing flame, the tested rate of heat release should be used. Where the test data are for a different incident flux, the burning rate should be estimated using the heat of gasification as expressed in Equation E.6.4a to calculate the mass burning rate per unit area.

$$\dot{m}'' = \frac{\dot{q}''_i}{h_g} \qquad \textbf{[E.6.4a]}$$

The resulting mass loss rate is then multiplied by the derived effective heat of combustion and the burning area exposed to the incident flux to produce the estimated rate of heat release as follows:

$$Q = \dot{m}'' h_c A \qquad \textbf{[E.6.4b]}$$

E.6.5 Flame Spread. If it is desired to predict the growth of fire as it propagates over combustible surfaces, it is necessary to estimate flame spread. The computation of flame spread rates is an emerging technology still in an embryonic stage. Predictions should be considered as order of magnitude estimates.

Flame spread is the movement of the flame front across the surface of a material that is burning (or exposed to an ignition flame), but whose exposed surface is not yet fully involved. Physically, flame spread can be treated as a succession of ignitions resulting from the heat energy produced by the burning portion of a material, its flame, and any other incident heat energy imposed on the unburned surface. Other sources of incident energy include another burning object, high-temperature gases that can accumulate in the upper portion of an enclosed space, and the radiant heat sources used in a test apparatus such as the cone calorimeter or the LIFT mechanism.

For analysis purposes, flame spread can be divided into the following two categories:

(1) Concurrent, or wind-aided, flame spread, which moves in the same direction as the flame
(2) Lateral, or opposed, flame spread, which moves in any other direction

Concurrent flame spread is assisted by the incident heat flux from the flame to unignited portions of the burning material. Lateral flame spread is not so assisted and tends to be much slower in progression unless an external source of heat flux is present. Concurrent flame spread for thermally thick materials can be expressed as follows:

$$V = \frac{\left(\dot{q}''_i\right)^2 L_f}{k \rho c \left(T_{ig} - T_s\right)^2} \qquad \textbf{[E.6.5]}$$

The values for $k\rho c$ and ignition temperature are calculated from the cone calorimeter as discussed. For this equation, the flame length, L_f, is measured from the leading edge of the burning region, and T_s is the initial temperature of the solid material.

E.6.6 Classification of Fires for Engineering Equations. The engineering equations in Chapter 8 are appropriate for steady fires, limited-growth fires, and *t*-squared forms of continuous-growth fires.

Annex F Design Information

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

F.1 Growth times for combustible arrays have been obtained *[see Table F.1(a)]*. These are specified for certain storage heights.

Actual tests [Yu and Stavrianidis, 1991] have demonstrated that it is reasonable to assume that the instantaneous heat release rate per unit height of the storage array is insensitive to the storage height. Such behavior corresponds to the growth time, t_g, being inversely proportional to the square root of the storage height. Alternatively, it corresponds to the fire growth coefficient, α_g, being directly proportional to the storage height. For example, if the storage height is one-third the tested height, the growth time is $[1/(⅓)]^{1/2}$ = 1.73 times the growth time from the test. If the storage height is three times the tested height, the growth time is $(⅓)^{1/2}$ = 0.58 times the growth time from the test. For fuel configurations that have not been tested, the procedures discussed in Annex E might be applicable.

t-Squared Fires. Over the past decade, those interested in developing generic descriptions of the rate of heat release of accidental open flaming fires have used a *t-squared* approximation for this purpose. A *t*-squared fire is one in which the burning rate varies proportionally to the square of time. Frequently, *t*-squared fires are classified by their speed of growth as fast, medium, or slow (and occasionally ultra-fast). Where these classes are used, they are determined by the time needed for the fire to grow to a rate of heat release of 1000 kW. The times for each of these classes are provided in Table F.1(b). For many fires involving storage arrays, the time to reach 1000 kW might be much shorter than the 75 seconds depicted for ultra-fast fires.

The general equation is as follows:

$$Q = \alpha_g t^2 \quad \textbf{[F.1]}$$

where:

Q = rate of heat release (kW)

α_g = a constant describing the speed of growth (kW/s^2)

t = time (s)

A *t*-squared fire can be viewed as a fire in which the rate of heat release per unit area is constant over the entire ignited surface, and in which the fire spreads in circular form with a steadily increasing radius. In such cases, the increase in the burning area is the square of the steadily increasing fire radius. Of course, other fires that do not have such a conveniently regular fuel array and consistent burning rate might or might not actually produce a *t*-squared curve. The tacit assumption is that the *t*-squared approximation is close enough for reasonable design decisions.

Table F.1(a) Continuous-Growth Fires

Fuel	Growth Time* (s)
Wood pallets, stacked 0.46 m high (6%–12% moisture)	160–320
Wood pallets, stacked 1.52 m high (6%–12% moisture)	90–190
Wood pallets, stacked 3.05 m high (6%–12% moisture)	80–120
Wood pallets, stacked 4.88 m high (6%–12% moisture)	75–120
Mail bags, filled, stored 1.52 m high	190
Cartons, compartmented, stacked 4.57 m high	60
Paper, vertical rolls, stacked 6.10 m high	17–28
Cotton (also PE, PE/cot acrylic/nylon/PE), garments in 3.66 m high rack	22–43
Ordinary combustibles rack storage, 4.57 m–9.14 m high	40–270
Paper products, densely packed in cartons, rack storage, 6.10 m high	470
PE letter trays, filled, stacked 1.52 m high on cart	180
PE trash barrels in cartons, stacked 4.57 m high	55
FRP shower stalls in cartons, stacked 4.57 m high	85
PE bottles packed in compartmented cartons, stacked 4.57 m high	85
PE bottles in cartons, stacked 4.57 m high	75
PE pallets, stacked 0.91 m high	150
PE pallets, stacked 1.83 m–2.44 m high	32–57
PU mattress, single, horizontal	120
PU insulation board, rigid foam, stacked 4.57 m high	8
PS jars packed in compartmented cartons, stacked 4.57 m high	55
PS tubs nested in cartons, stacked 4.27 m high	110
PS toy parts in cartons, stacked 4.57 m high	120
PS insulation board, rigid foam, stacked 4.27 m high	7
PVC bottles packed in compartmented cartons, stacked 4.57 m high	9
PP tubs packed in compartmented cartons, stacked 4.57 m high	10
PP and PE film in rolls, stacked 4.27 m high	40
Distilled spirits in barrels, stacked 6.10 m high	25–40

FRP: fiberglass-reinforced polyester. PE: polyethylene. PP: polypropylene. PS: polystyrene. PU: polyurethane. PVC: polyvinyl chloride.

*Growth times of developing fires in various combustibles, assuming 100 percent combustion efficiency.

Table F.1(b) Classifications of t-Squared Fires

Class	Time to Reach 1000 kW (s)
Ultra-fast	75
Fast	150
Medium	300
Slow	600

Figure 8.3.1 demonstrates that most fires have an incubation period during which the fire does not conform to a *t*-squared approximation. In some cases, this incubation period might be a serious detriment to the use of the *t*-squared approximation. In most instances, this is not a serious concern in large spaces covered by this standard. It is expected that the rate of heat release during the incubation period will not usually be sufficient to cause activation of the smoke detection system. In any case, where such activation occurs, or where human observation results in earlier activation of the smoke-venting system, a fortuitous safeguard will result.

Figure F.1(a) compares rate of heat release curves developed by the aforementioned classes of *t*-squared fires and two test fires commonly used for test purposes. The test fires are shown as dashed lines labeled as furniture and 6 ft storage. The dashed curves farther from the fire origin show the actual rates of heat release of the test fires used in the development of the residential sprinkler and a standard 6 ft high array of test cartons containing foam plastic pails that also are frequently used as a standard test fire.

The other set of dashed lines in Figure F.1(a) shows these same fire curves relocated to the origin of the graph. This is a more appropriate comparison with the generic curves. It can be seen that the rate of growth in these fires is actually faster than that prescribed for an ultra-fast fire. This is appropriate for a test fire designed to challenge the fire suppression system being tested.

Figure F.1(b) relates the classes of *t*-squared fire growth curves to a selection of actual fuel arrays.

F.2 For consistency with Annex B and with referenced documents on the fire model LAVENT, the nomenclature for this section differs from that of the other section in this annex. The definitions for the variables used in this section are provided in Section B.7.

A ceiling vent design is successful to the extent that it controls a fire-generated environment developing in a space of fire origin according to any of a variety of possible specified criteria. For example, if the likely growth rate of a fire in a particular burning commodity is known, a vent system with a large enough vent area, designed to provide for timely opening of the vents, can be expected to lead to rates of smoke removal that are so large that fire fighters, arriving at the fire at a specified time subsequent to fire detection, are able to attack the fire successfully and protect commodities in adjacent spaces from being damaged.

To evaluate the success of a particular design, it is necessary to predict the development of the fire environment as a function of any of a number of physical characteristics that define and might have a significant effect on the fire scenario. Examples of such characteristics include the following:

(1) The floor-to-ceiling height and area of the space and the thermal properties of its ceiling, walls, and floor
(2) The type of barriers that separate the space of fire origin and adjacent spaces (e.g., full walls with vertical door-like vents or ceiling-mounted draft curtains)
(3) The material type and arrangement of the burning commodities (e.g., wood pallets in plan-area arrays of 3 m × 3 m and stacked 2 m high)
(4) The type, location, and method of deployment of devices that detect the fire and actuate the opening of the vents (e.g., fusible links of specified RTI and distributed at a specified spacing distance below the ceiling)
(5) The size of the open area of the vents themselves

The best way to predict the fire environment and evaluate the likely effectiveness of a vent design is to use a reliable mathematical model that simulates the various relevant physical phenomena that come into play during the fire scenario. Such an analytical tool should be designed to solve well-formulated mathematical problems, based on basic relevant principles of physics and on fundamentally sound, well-established, empirical relationships. Even in the case of a particular class of problem, such as an engineering problem associated with successful vent design, there is a good deal of variation among applicable mathematical models that could be developed to carry out the task. Such models might differ from one another in the number and detail of the individual physical phenomena taken into account. Therefore, the list of physical characteristics that define and could have a significant effect on the fire scenario does not include outside wind conditions, which could have an important influence on the fire-generated environment. A model might or might not include the effect of wind. A model that does include the effect

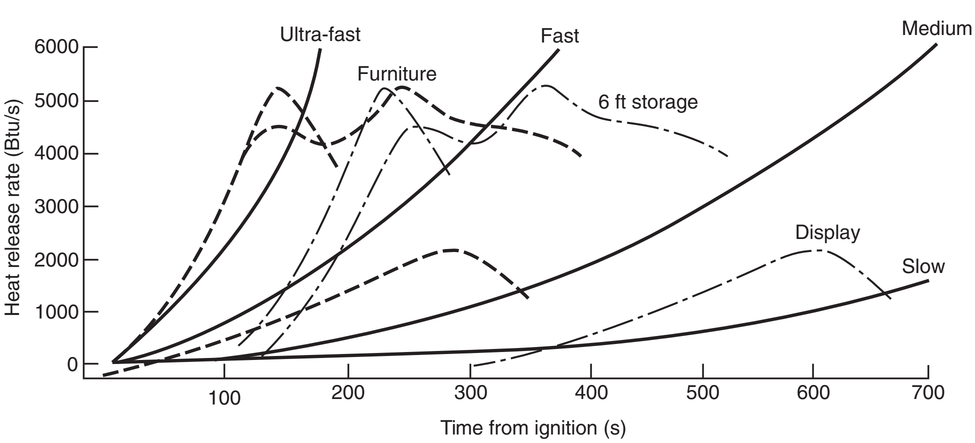

FIGURE F.1(a) Rates of Energy Release for *t*-Squared Fire. (Redrawn from NIST, 1987.)

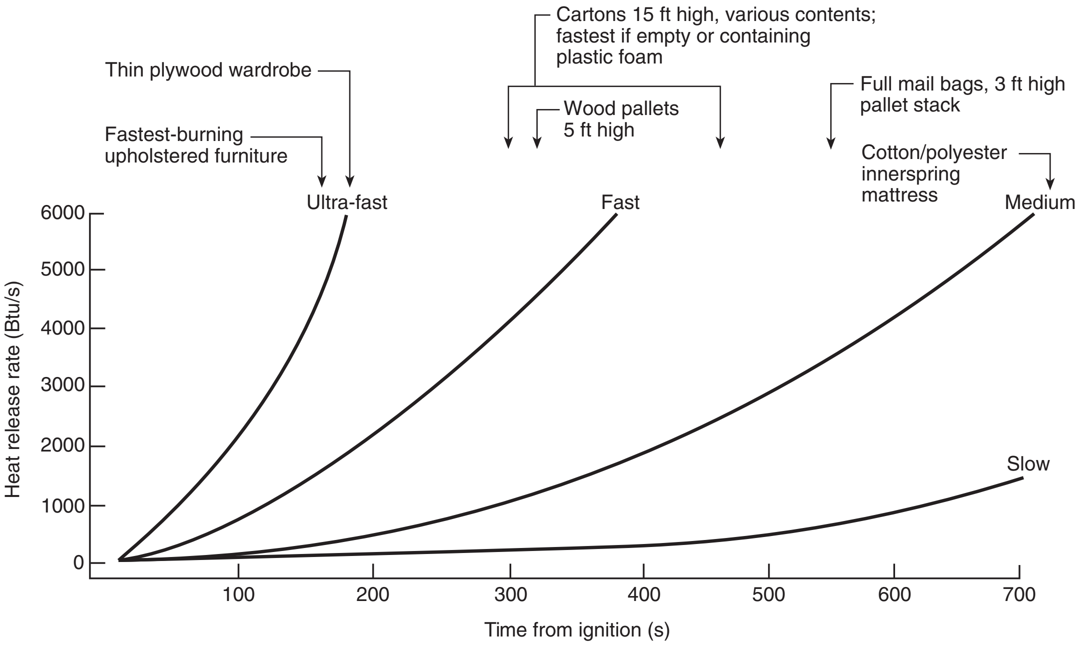

FIGURE F.1(b) Relation of *t*-Squared Fires to Some Fire Tests.

of wind is more difficult to develop and validate and is more complicated to use. Note that the effect of wind is not taken into account in the following discussion of the LAVENT model. However, by using reasonably well-accepted mathematical modeling concepts, LAVENT could be developed to the point that it could be used to simulate this effect.

The discussion that follows describes a group of phenomena that represent a physical basis for estimating the fire-generated environment and the response of heat-responsive elements in well-ventilated compartment fires with draft curtains and ceiling vents activated by fusible links, thermoplastic drop-out panels, or other alternative means of activation or smoke detectors. The phenomena include the following:

(1) Growth of the smoke layer in the curtained area
(2) The flow dynamics of the buoyant fire plume
(3) The flow of smoke through open ceiling vents
(4) The flow of smoke below draft curtains
(5) Continuation of the fire plume in the upper layer
(6) Heat transfer to the ceiling surface and the thermal response of the ceiling
(7) The velocity and temperature distribution of plume-driven, near-ceiling flows
(8) The response of near-ceiling deployed heat-responsive elements and smoke detectors

All the phenomena in items (1) through (8) are taken into account in the LAVENT model, which was developed to simulate well-ventilated compartment fires with draft curtains and fusible link-actuated or smoke detector–actuated ceiling vents. Other models that could be developed for a similar purpose typically would also be expected to simulate these basic phenomena.

The space to be considered is defined by ceiling-mounted draft curtains with a fire and with near-ceiling fusible link-actuated ceiling vents and sprinklers. The curtained area should be considered as one of several such spaces in a large building area. Also, by specifying that the curtains be deep enough, they can be thought of as simulating the walls of a single uncurtained area.

This section discusses critical physical phenomena that determine the overall environment in the curtained space up to the time of sprinkler actuation. The objective is to identify and describe the phenomena in a manner that captures the essential features of this generic class of fire scenario and that allows for a complete and general, but concise and relatively simple, mathematical/computer simulation.

The overall building area is assumed to have near-floor inlet air openings that are large enough to maintain the inside environment, below any near-ceiling smoke layers that might form, at outside-ambient conditions. Figure F.2(a) depicts the generic fire scenario considered. It is assumed that a two-layer zone-type model adequately describes the phenomena under investigation. The lower layer is identical to the outside ambient. The upper smoke layer thickness and properties change with time, but the layer is assumed to be uniform in space at any time. Conservation of energy and mass along with the perfect gas law is applied to the upper layer. This leads to equations that necessitate estimates of the net rate of enthalpy flow plus heat transfer and the net rate of mass flow to the upper layer. Qualitative features of the phenomena that contribute to these flows and heat transfer are described briefly.

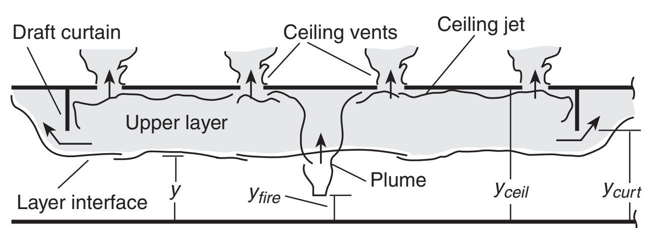

FIGURE F.2(a) LAVENT Model: Fire in a Building Space with Draft Curtains and Ceiling Vents.

Flow is driven through ceiling vents by cross-vent hydrostatic pressure differences. The traditional calculation uses orifice-type flow calculations. Bernoulli's equation is applied across a vent, and it is assumed that, away from and on either side of the vent, the environment is relatively quiescent. Figure F.2(b) depicts the known, instantaneous, hydrostatic pressure distribution in the outside environment and throughout the depth of the curtained space. These pressures are used to calculate the resulting cross-vent pressure difference, then the actual instantaneous mass and enthalpy flow rates through a vent.

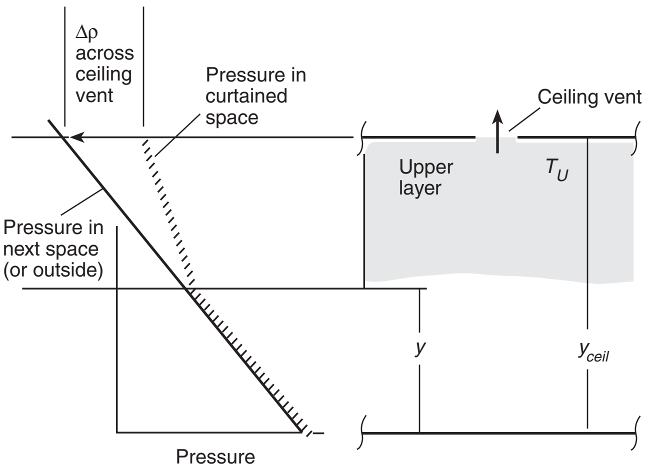

FIGURE F.2(b) Flow Through a Ceiling Vent.

If and when the smoke layer boundary face drops below the bottom of the draft curtains, the smoke starts to flow out of the curtained space. As with the ceiling vents, this flow rate is determined by the cross-vent hydrostatic pressure difference. As depicted in Figure F.2(c), however, the pressure difference in this case is not constant across the flow. Nonetheless, even in this configuration, the instantaneous flow rates are easily determined with well-known vertical-vent flow equations used traditionally in zone-type fire models.

The major contributors to the upper-layer flow and surface heat transfer are the fire and its plume. These properties are depicted in Figure F.2(d). It is assumed that the rate of energy

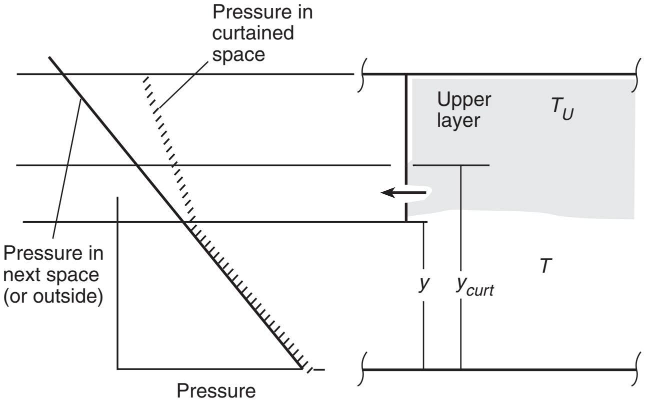

FIGURE F.2(c) Flow Below a Draft Curtain.

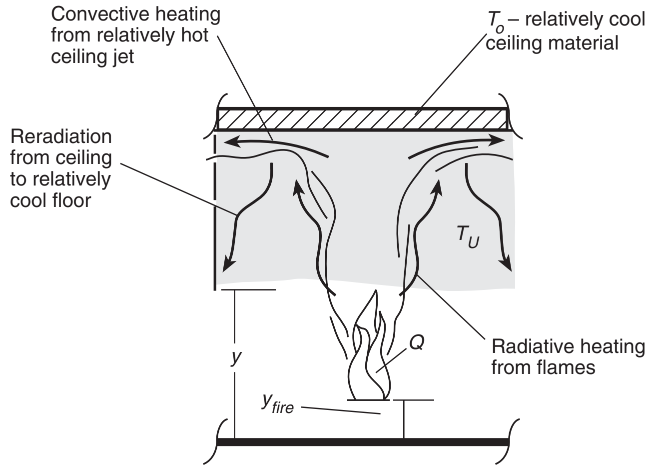

FIGURE F.2(d) The Fire, the Fire Plume, and Heat Transfer to the Ceiling.

release of the fire's combustion zone does not vary significantly from known free-burn values that are available and assumed to be specified *(see Chapter 8)*. A known, fixed fraction of this energy is assumed to be radiated isotropically, as in the case of a point source, from the combustion zone. The smoke layer is assumed to be relatively transparent (i.e., all radiation from the fire is incident on the bounding surfaces of the compartment).

A plume model, selected from the several available in the literature, is used to determine the rate of mass and enthalpy flow in the plume at the elevation of the smoke layer boundary. It is assumed that all of this flow penetrates the smoke layer boundary and enters the upper layer. As the plume flow enters the upper layer, the forces of buoyancy that act to drive the plume toward the ceiling are reduced immediately because of the temperature increase of the upper-layer environment over that of the lower ambient. As a result, the continued ascent of the plume gases is less vigorous (i.e., is at a reduced velocity) than it would be in the absence of the layer. Also, as the plume gases continue their ascent, the temperature becomes higher than it would be without the upper layer. Such higher temperatures are a result of the modified plume entrainment, which is now occurring in the relatively high-temperature upper layer rather than in the ambient-temperature lower layer. Methods of predicting the characteristics of the modified upper-plume flow are available.

Having penetrated the smoke layer boundary, the plume continues to rise toward the ceiling of the curtained area. As it impinges on the ceiling surface, the plume flow turns and forms a relatively high-temperature, high-velocity, turbulent-ceiling jet that flows radially outward along the ceiling and transfers heat to the relatively cool ceiling surface. The ceiling jet is cooled by convection, and the ceiling material is heated by conduction. Eventually, the now-cooled ceiling jet reaches the extremities of the curtained space and is deposited into and mixed with the upper layer. The convective heat transfer rate and the ceiling surface temperature on which it depends are both strong functions of the radial distance from the point of plume–ceiling impingement, and both decrease rapidly with increasing radius.

The thermal response of the ceiling is driven by transient heat conduction. For the time period typically considered, radial gradients in ceiling surface conditions are small enough so that the conduction heat transfer is quasi–one dimensional in space. Therefore, the thermal response of the ceiling can be obtained from the solution to a set of one-dimensional conduction problems at a few discrete radial positions. These problems can be solved subject to net convection and radiation heat flux boundary conditions.

Interpolation in the radial direction between the solutions leads to a sufficiently smooth representation of the distributions of ceiling surface temperature and convective heat transfer rate. The latter is integrated over the ceiling surface to obtain the net instantaneous rate of convective heat transfer losses from the ceiling jet.

Convective heating and the thermal response of a near-ceiling heat-responsive element, such as a fusible link or thermoplastic drop-out panel, are determined from the local ceiling jet velocity and temperature. Velocity and temperature depend on vertical distance below the ceiling and radial distance from the fire plume axis. If and when its fusion (activation) temperature is reached, the device(s) operated by the link or other heat-responsive element is actuated.

For specific radial distances that are relatively near the plume, the ceiling jet is an inertially dominated flow. Its velocity distribution, depicted in Figure F.2(e), can be estimated from the characteristics of the plume, upstream of ceiling impingement. The ceiling jet temperature distribution, depicted in Figure F.2(f) for a relative “hot” or “cool” ceiling surface, is

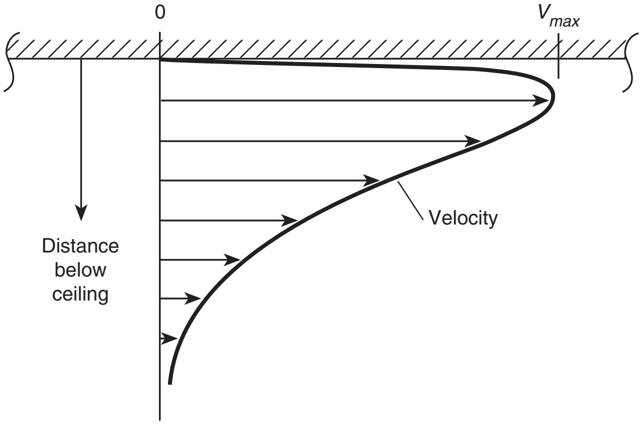

FIGURE F.2(e) Ceiling Jet Velocity.

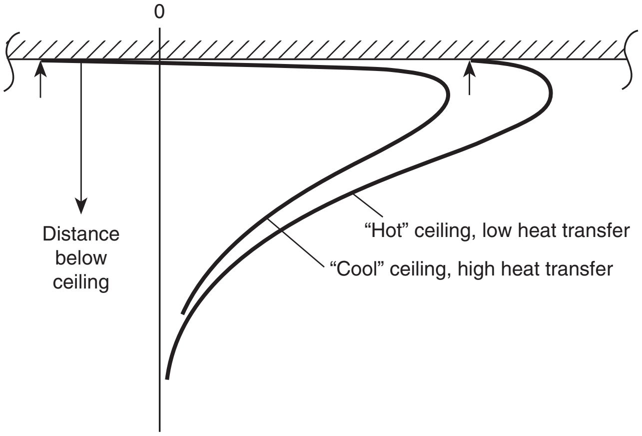

FIGURE F.2(f) Ceiling Jet Temperature.

then estimated from the velocity (which is now known), upper-layer temperature, ceiling-surface temperature, and heat flux distributions.

Annex B provides details of all equations of the LAVENT mathematical fire model and its associated computer program, developed to simulate all the phenomena described thus far. LAVENT can be used to simulate and study parametrically a wide range of relevant fire scenarios involving these phenomena.

Included in B.5.5 is a summary of guidelines, assumptions, and limitations to LAVENT. For example, as specified in that subsection, LAVENT assumes that, at all times during a simulated fire, the overall building space containing the curtained area of fire origin is vented to the outside (e.g., through open doorways). It is assumed, furthermore, that the area of the outside vents is large relative to the area of the open ceiling vents in the curtained area.

Therefore, if the total area of the outside vents is A_{out}, then $(A_{out}/A_V)^2$ is significantly larger than 1 (e.g., $A_{out}/A_V > 2$). If the outside vents are in the bounding walls of the curtained space, not in adjacent spaces, they should be located entirely below the smoke layer boundary. Subsection B.5.5 should be referenced for the details of other guidelines, assumptions, and limitations.

If the actual size of the outside vents is not significantly larger than the vent area, consideration should be given to increasing the vent area to account for the restrictions in inlet air using the following multiplier:

$$M\left[1+\left(\frac{A_v}{A_{V_{out}}}\right)^2 \frac{T_{amb}}{T_U}\right]^{1/2} \quad \textbf{[F.2]}$$

where:

M = multiplier
A_V = total area of open ceiling in curtained space
T_{amb} = outside temperature
A_{Vout} = total area of open vents to outside exclusive of A_V
T_U = upper layer temperature

Annex C is a user guide for the LAVENT computer code. Annex C includes a comprehensive discussion of the inputs and calculated results of a default simulation involving a fire growing in a large pile of wood pallets (t-squared growth to a steady 33 MW) in a 9.1 m high curtained warehouse-type space with multiple fusible-link–actuated vents and near-ceiling–deployed fusible sprinkler links. Vents actuated by alternative means such as thermoplastic “drop-out” panels with equivalent performance characteristics can also be modeled using LAVENT. Inputs to LAVENT include the following.

(1) *Dimensions of the Curtained Area of Fire Origin.* Length, width, and height of the curtained area of fire origin
(2) *Dimensions of the Draft Curtain.* Floor to bottom of the curtain separation distance and length of the curtain (a portion of the perimeter of the curtained space can include floor-to-ceiling walls)
(3) *Properties of the Ceiling.* Thickness, density, thermal conductivity, and heat capacity of the ceiling material
(4) *Characteristics of the Fire.* Elevation of the base of the fire above the floor *(see 9.2.3.6)*; total energy release rate of the fire, at different times during the course of the simulated fire scenario (the computer code uses linear interpolation to approximate between these times); and the

plan area of the fire, or the total energy release rate per unit area of the fire (in cases where the user supplies the latter input, the computer code estimates the changing area of the fire at any moment by using the current total energy release rate)

(5) *Characteristics of the Ceiling Vent–Actuating Fusible Links or Vent-Actuating Smoke Detectors and of the Corresponding Ceiling Vents.* Horizontal distance from the fire, vertical distance below the ceiling surface, RTI, and fuse temperature of the ceiling vent–actuating fusible links; also, the clear open area, A_V, of their associated ceiling vents

(6) *Characteristics of Fusible Sprinkler Links.* Horizontal distance from the fire, vertical distance below the ceiling surface, RTI, and fuse temperature of fusible sprinkler links

LAVENT is written in Fortran 77. The executable code operates on PC-compatible computers.

LAVENT has had some limited experimental validation in experiments with 3.34 m^2 pool fires in a 37 m × 40 m × 14 m high aircraft hangar [Walton and Notarianni, 1993; Notarianni, 1992]. The hangar was equipped with near-ceiling-mounted brass disks of known RTI, which were used to simulate sprinkler links or heat detector elements. The experiments did not involve ceiling vents. Experimental validation of the various mathematical submodel equation sets that comprise the generalized LAVENT simulation is also implicit. This is the case, since the mathematical submodels of LAVENT, presented in Annex B, are based on carefully reproduced correlations of data acquired in appropriate experimental studies of the isolated physical phenomena that, taken together, make up the combined effects of a LAVENT-simulated fire scenario. The experimental basis and validation of the LAVENT submodels can be found in the references listed in Section B.6.

If ceiling vents are actuated by smoke detectors, the guidelines outlined in 9.2.5.4.3 should be followed. LAVENT can be made to simulate this function with a very sensitive fusible link (i.e., a link with a negligibly small RTI) and an appropriate fuse temperature.

As specified in B.4.1, LAVENT always assumes that the flow coefficient, C, for ceiling vents is 0.68; if the user has reason to believe that a different value, C_{user}, is more appropriate for a particular vent (such as the value 0.6 suggested in 9.2.4.2), then the input vent area for that vent should be scaled up proportionately (i.e., A_V, input = $A_V C_{user}/0.68$).

LAVENT calculates the time that the first sprinkler link fuses and the fire environment that develops in the curtained space prior to that time. Because the model does not simulate the interaction of sprinkler sprays and fire environments, any LAVENT simulation results subsequent to sprinkler waterflow should be ignored.

F.3 Objectives of the vent system should be defined and considered. Objectives can include the following:

(1) Provide for fire fighter safety and facilitate post-fire smoke removal by the fire department. The two key issues include activation type (remote or manual removal at roof level by fire fighters), and vent ratio (gross vent area to roof area). Remote activation is a preferred method; however, manual activation at roof level does considerably reduce the time a fire fighter must spend on the roof (versus cutting a hole in the roof) and might be considered acceptable.
(2) Allow extended egress travel distances.
(3) Reduce smoke damage to the contents. Design features such as ganging all vents within a sprinkler zone, and automatically activating all of the vents within one zone following sprinkler activation might achieve objectives 2 and 3; however, additional research is needed to validate this concept.

Chapters 4 through 10 represent the state of technology of vent and draft curtain board design in the absence of sprinklers. A broadly accepted equivalent design basis for using sprinklers, vents, and curtain boards together for hazard control (e.g., property protection, life safety, water usage, obscuration) is currently not available. Designers are strongly cautioned that use of venting with automatic sprinklers is an area of ongoing research to determine its benefit and effect in conjunction with automatic suppression.

This annex section provides design considerations for venting systems in sprinkler-protected areas. These design considerations are based on the research that has been conducted.

Early Research. For occupancies that present a high challenge to sprinkler systems, concern has been raised that the inclusion of automatic roof venting, draft curtains, or both can be detrimental to the performance of automatic sprinklers. Although there is no universally accepted conclusion from fire experience [Miller, 1980], studies on a model scale [Heskestad, 1974] suggested the following:

(1) Venting delays loss of visibility.
(2) Venting results in increased fuel consumption.
(3) Depending on the location of the fire relative to the vents, the water demand necessary to achieve control is either increased or decreased over an unvented condition. With the fire directly under the vent, water demand is decreased. With the fire equidistant from the vents, water demand is increased.

A series of tests was conducted to increase the understanding of the role of automatic roof vents simultaneously employed with automatic sprinklers [Waterman et al., 1982]. The data submitted did not provide a consensus on whether sprinkler control was impaired or enhanced by the presence of automatic (roof) vents for the typical spacing and area.

Large-scale fire tests, conducted at the Factory Mutual Research fire test facility without vents, indicated that certain configurations of draft curtains can have a detrimental effect on the performance of a sprinkler system during a high-challenge fire [Troup, 1994]. Two tests were conducted, one in which a fire was initiated adjacent to a draft curtain, and one near the junction of two draft curtains. Sprinkler performance in these two tests was considered unsatisfactory because an excessive number of sprinklers operated and damage significantly increased in comparison to similar tests conducted without draft curtains.

Other large-scale fire tests were conducted [Hinkley et al., 1992] employing liquid fuels, small vent spacings (minimum of 4.7 m), and vents open at ignition. Hinkley reached the following conclusions:

(1) The prior opening of vents had little effect on the operation of the first sprinkler.
(2) Venting substantially reduced the total number of sprinkler operations.

In an independent analysis of these tests, Gustafsson [1992] noted that sprinklers near the fire source were often delayed or did not operate at all.

Recent Research. The Fire Protection Research Foundation, formerly known as the National Fire Protection Research Foundation, organized large-scale tests to study the interaction of sprinklers, roof vents, and draft curtains [McGrattan et al., 1998], involving heptane spray fires and arrays of cartoned plastic commodity of a standard configuration. The test space was ventilated by a smoke abatement system. The findings were as follows:

(1) In the heptane spray fires, venting had no significant effect on sprinkler operations, unless a fire was ignited directly under a vent, in which case the number of sprinkler operations decreased.
(2) When a draft curtain was installed in the heptane spray fires, the number of operating sprinklers increased.
(3) In five tests with the cartoned plastic commodity, three tests opened 20–23 sprinklers and two tests opened 5–7 sprinklers, which was attributed to variability in the initial fire growth and not to any of the variables under study.
(4) One of these tests with ignition near a draft curtain consumed much more fuel than the other tests, which was attributed to fire spread under the draft curtain.
(5) Effects of venting through roof vents on smoke obscuration could not be determined because of the dominant effect of the building smoke abatement system.
(6) In all experiments in this study where, in some cases, vents were open at the start of the fire, and in those instances where the fire was located directly under a vent, sprinklers performed satisfactorily. Satisfactory sprinkler performance is defined by all of the following criteria:
    (a) Fire did not jump the aisles.
    (b) The number of sprinklers operating did not exceed the design area.
    (c) Fire did not spread to an end of the fuel array.

While the use of automatic venting and draft curtains in sprinklered buildings is still under review, the designer is encouraged to use the available tools and data referenced in this document for solving problems peculiar to a particular type of hazard control [Miller, 1980; Heskestad, 1974; Waterman, 1982; Troup, 1994; Hinkley, et al., 1992; Gustafsson, 1992; McGrattan et al., 1998].

(7) In tests where the vents were opened by fusible link, a number of the vents failed to open, which was attributed to either the cooling effects of the control mode sprinklers on the smoke layer or direct spray cooling of the fusible links.

Design Considerations. As a result of the research, the following guidelines are provided for the design of venting systems in those areas of a building protected with an automatic sprinkler system designed and installed in accordance with NFPA 13 for the specific occupancy hazard.

(1) Draft curtains and open vents of venting systems should not adversely affect sprinklers that are capable of discharging water onto the fire, either in time of operation or in the water discharge pattern.
(2) Vents that are open prior to sprinkler operations in a region surrounding the ignition point, within a radius of 1½ sprinkler spacings, can interfere with the opening of sprinklers capable of delivering water to the fire. The vent system design should consider the following:
    (a) This interference is likely to be a factor if the total vent area is divided among many closely spaced vents, as in the investigation by Hinkley et al. [1992], commented on by Gustafsson [1992].
    (b) If the vent spacing is several times as large as the sprinkler spacing, model fire tests simulating a 1.2 m × 1.2 m vent in a 7.6 m high building [Heskestad, 2008] showed that sprinkler operations were significantly delayed whenever ignition occurred anywhere under the area of an open vent. Otherwise, there was little delay. This delay can be important for systems with early suppression fast response (ESFR) sprinklers.
    (c) Use of high-temperature, heat-responsive actuation mechanisms, compared to the sprinklers, can mitigate the problem of open vents. For example, for 74°C rated ESFR sprinklers, a minimum 180°C activation temperature should be provided for vents. Another approach would be to provide gang operation of the vents at the moment a conservative number of sprinklers are operating.
    (d) The vent system design should consider the effects of the venting system on the ceiling jet.
(3) The location of draft curtains should be determined considering the following:
    (a) Draft curtains can delay or prevent operation and can interfere with the discharge of sprinklers capable of delivering water to the fire. In practice, sprinklers capable of delivering water to the fire can be considered to be those that are within 1½ sprinkler spacings of the ignition point.
    (b) Draft curtains should be located in aisles and should be horizontally separated from combustible contents.
    (c) The layout of the sprinkler protection and the width of the aisle below the draft curtain should be sufficient to prevent the fire from jumping the aisle space. Accordingly, if a draft curtain is positioned midway between two sprinklers, the nearest possible ignition point should be at least ¾ of one sprinkler spacing away from the draft curtain. In other words, there can be no storage of combustible material within ¾ of one sprinkler spacing of a draft curtain. Aisles free of combustible storage, centered under draft curtains, should be at least 1½ sprinkler spacings wide (e.g., a minimum of 15 ft aisle for 10 ft sprinkler spacing in the direction perpendicular to the draft curtain). For situations where such an aisle width is not practical, the aisle space can be reduced to a minimum of 8 ft, when a line of sprinklers is provided on each side of the draft curtain, 4 in. to 12 in. horizontally from the face of the draft curtain. For existing sprinkler installations, these sprinklers near the draft curtain might need to be staggered horizontally with respect to adjacent line of sprinklers, in order to maintain the minimum separation required by NFPA 13 and to prevent sprinkler skipping.
    (d) Where aisles of sufficient width cannot be maintained, full-height partitions can be used in lieu of draft curtains.
(4) The design fire's rate of heat release rate–time history should account for the operation of the sprinkler system.
(5) Determination of the smoke layer temperature should take into account the operation of the control mode sprinkler system. Control mode sprinklers operate when a temperature-rated element fuses in each individual control mode sprinkler head. Since in most fires only a small

number of control mode sprinkler heads close to the seat of the fire operate, it follows that the bulk temperature of the smoke layer and/or the ceiling jet beyond the operating control mode sprinklers cannot be significantly higher than the control mode sprinkler fusible element operating temperature, due to the cooling effect on the smoke of the operating control mode sprinklers. Therefore once the first control mode sprinkler has operated, if calculations show the smoke layer temperature to be above the control mode sprinkler fusible element operating temperature, the smoke layer temperature should be modified to reflect this effect. A possible approach when vents are used would be to set the smoke layer temperature equal to the control mode sprinkler fusible elements operating temperature, this being a reasonably conservative design solution.

(6) The vent flow, smoke movement, and position of the smoke layer boundary should take into account the downdrag effect produced by operation of the sprinkler system.

(7) The effect of control mode sprinkler cooling may limit the number of vents opening if control of the vent is only by fusible link or if drop-out panels are used. If the fusible link or drop-out panel operating temperature is equal to or higher than the control mode sprinkler fusible element operating temperature, then vents outside the outer ring of operating control mode sprinklers are unlikely to open. This could significantly limit the effectiveness of the smoke vent system. Use of ganged vents operated from detectors or a sprinkler flow switch is a way to avoid this situation.

F.4 Recent Literature Review. A recent paper examines the interaction of control mode sprinklers with smoke and heat vents [Beyler and Cooper, 2001]. The paper reviews 13 experimental studies that have some relevance to the claims posed for and against the combined use of control mode sprinklers and smoke/heat vents. These studies are used to evaluate the positive and negative claims that have been made with regard to the combined use of control mode sprinklers and smoke/heat vents. Three of the studies investigate the use of smoke/heat vents alone. Four investigations include control mode sprinklers, but do not include roof vents. Three of these are test series in which perimeter vents were used in the test facility, and the fourth included control mode sprinklers, a partial draft curtain, and no smoke/heat vents. Four test series included control mode sprinklers, smoke/heat vents, and draft curtains, but utilized spray or pool fires that were not subject to extinguishment by the control mode sprinklers. Four test series included control mode sprinklers, smoke/heat vents, and draft curtains, and used Class A fuels that were subject to extinguishment.

The studies of smoke and heat venting used in conjunction with control mode sprinklers do not provide evidence that venting has a negative effect on control mode sprinkler performance.

Experimental studies have shown that venting does limit the spread of products of combustion by releasing them from the building within the curtained compartment of fire origin. This improves visibility for building occupants and fire fighters who need to find the seat of the fire to complete fire extinguishment. Limiting the spread of smoke and heat also reduces smoke and heat damage to the building. In the event that control mode sprinklers do not operate, venting remains a valuable aid to manual control of the fire.

The experimental studies have shown that early vent activation has no detrimental effects on control mode sprinkler performance and have also shown that current design practices are likely to limit the number of vents operated to one and vents may in fact not operate at all in very successful control mode sprinkler operations. Design practices should move to methods that assure early operation of vents, and vent operation should be ganged so that the benefit of roof vents is fully realized. Control mode sprinkler design with vents and draft curtains needs to take full account of draft curtains as obstructions.

Following the publication of the paper by Beyler and Cooper [2001], in a letter to the editor Heskestad [2002] reviewed the conclusions of the authors that: (1) venting clearly does not have a negative effect on sprinkler performance, (2) venting limits spread of combustion products, and (3) venting remains a valuable aid to manual control of the fire in the event the sprinklers do not operate. He argues the view that the first two of these conclusions are performance measures that are not met, or well met, by current technology based on the studies cited by the authors. With respect to the third conclusion, Heskestad refers to the FM Global position that venting, installed as backup to an automatic sprinkler system that is inadequate or impaired, is not cost-effective because it is unlikely a large loss will be averted solely due to the presence of vents.

Annex G Informational References

G.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons. There are additional lists of references at the ends of Annexes B, C, and D.

G.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2013 edition.

NFPA 68, *Standard on Explosion Protection by Deflagration Venting*, 2013 edition.

NFPA 72®, National Fire Alarm and Signaling Code, 2013 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2012 edition.

NFPA 92, *Standard for Smoke Control Systems*, 2015 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2014 edition.

NFPA 287, *Standard Test Methods for Measurement of Flammability of Materials in Cleanrooms Using a Fire Propagation Apparatus (FPA)*, 2012 edition.

G.1.2 Other Publications.

G.1.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E 1321, *Standard Test Method for Determining Material Ignition and Flame Spread Properties*,2013.

ASTM E 1354, *Standard Test Method for Heat and Visible Smoke Release Rates for Materials and Products Using an Oxygen Consumption Calorimeter*, 2011b.

ASTM E 2058, *Standard Test Methods for Measurement of Synthetic Polymer Material Flammability Using a Fire Propagation Apparatus (FPA)*,2013.

G.1.2.2 BSI Publications. British Standards Institution, 389 Chiswick High Road, London W4 4AL, U.K.

BS 7346–5, *Functional recommendations and calculation methods for smoke and heat exhaust ventilation systems employing time-dependent design fires*.

G.1.2.3 EN Publications. European Committee for Electrotechnical Standardization (CENELEC), 25, Rue de Stassartstraat, B-1050, Brussels, Belgium.

EN 12101-1, *Specification for smoke barriers*.

EN 12101-2, *Specification for natural smoke and heat exhaust ventilators*.

EN 12101-3, *Specification for powered smoke and heat exhaust ventilators*.

G.1.2.4 ISO Publications. International Organization for Standardization, 1, Rue de Varembé, Case postal 56, CH-1211 Geneve 20, Switzerland.

ISO 21927-1, *Specification for smoke barriers*.

ISO 21927-2, *Specification for natural smoke and heat exhaust ventilators*.

ISO 21927-3, *Specification for powered smoke and heat exhaust ventilators*.

G.1.2.5 NIST Publications. National Institute of Standards and Technology, 100 Bureau Drive, Gaithersburg, MD 20899-1070.

DETACT-QS, DETACT-T2, GRAPH, and LAVENT programs can be downloaded from NIST via the World Wide Web at http://www.bfrl.nist.gov. When downloading LAVENT, it is also necessary to download the file GRAPH, which is needed to display the graphics produced by LAVENT.

DETACT-QS (Detector — Actuation quasi-steady) software.

DETACT-T2 (Detector — Actuation time squared) software.

GRAPH graphics code.

LAVENT (Link-Actuated VENTS) software.

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G.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

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G.3 References for Extracts in Informational Sections. (Reserved)

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NFPA®211

Standard for

Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances

2016 Edition

This edition of NFPA 211, *Standard for Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances*, was prepared by the Committee on Chimneys, Fireplaces, and Venting Systems for Heat-Producing Appliances. It was issued by the Standards Council on November 14, 2015, with an effective date of December 4, 2015, and supersedes all previous editions.

This edition of NFPA 211 was approved as an American National Standard on December 4, 2015.

Origin and Development of NFPA 211

In 1906, the NFPA Committee on Chimneys and Flues presented its first report. In 1914, under the jurisdiction of the then Committee on Field Practice, recommendations on chimneys and flues were prepared as Chapter VII of the *Field Practice Manual*, presented in 1914, and adopted in 1915. In 1926, the Association adopted the Chimney Construction Ordinance of the National Board of Fire Underwriters. In 1944, the Association adopted Article XI of the 1943 edition of the *Building Code of the National Board of Fire Underwriters* to supersede the former chimney ordinance. That action was taken by the Board of Directors in the name of the Association on the recommendation of the Committee on Field Practice.

In 1948, the subject of chimneys and flues was transferred to the Committee on Building Construction. In 1950, the Association adopted Article X of the 1949 *National Building Code of the National Board of Fire Underwriters* to supersede the 1944 standard, on the recommendation of the Committee on Building Construction and action by the Board of Directors.

In 1955, the subject of chimneys and flues was transferred to the newly appointed Committee on Chimneys and Heating Equipment. NFPA 211 was revised in 1957 to make the text consistent with the provisions on the same subject appearing in the *National Building Code of the National Board of Fire Underwriters*. NFPA 211 was revised in 1961 and completely rewritten in 1964. The 1964 edition included requirements for chimney connectors, which were previously covered in NFPA 212, which was withdrawn in 1964. Since 1964, revised editions of the standard were adopted by the Association in 1966, 1968, 1970, 1971, 1972, and 1977. In 1969, new text was added to cover the subject of spark arresters, previously covered in NFPA 213, which was withdrawn in 1969.

In 1980, the scope of NFPA 211 was expanded to include solid-fuel appliances, and in the 1984 edition, major revisions were made to many sections, including important tables and graphs.

The 1988 edition included revisions to wall pass-through systems, including a new Table 5.7, which showed four chimney connector systems. A complete revision to Table 5.5(b) and changes to upgrade test requirements for factory-built chimneys were included.

The 1992 edition included new figures to show fireplace clearance requirements and other construction details, new requirements for combustion air ducts for fireplaces, and a new maintenance chapter that addressed inspection, cleaning, and repair of chimneys, vents, and fireplaces. Definitions for *vent* and *chimney* were revised in the 1996 edition, and the chimney and vent selection charts were moved from Chapter 1 to a new Chapter 2. The new Chapter 2 included new figures to aid in the selection of chimney types.

The 2000 edition included new material that addressed mechanical draft systems, carbon monoxide detection and alarms, and sizing of masonry chimneys. A new chapter, Chapter 11, was added to give detailed direction for the inspection of existing chimneys.

The 2003 edition included a major editorial revision to comply with the *Manual of Style for NFPA Technical Committee Documents*. There were also technical changes in the requirements for the flue cross-sectional area and solid fuel–burning appliance connections to masonry fireplaces.

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The 2006 edition of the standard included new structural and foundation requirements for chimneys and fireplaces, requirements for the effective area of the chimney connector, and requirements for firebox and fireplace construction and sizing, as well as minor editorial changes.

The 2010 edition of the standard included extensive revisions to definitions, deleting those not used in the standard, and clarifying many definitions. Terminology for gas appliances was made consistent with NFPA 54, *National Fuel Gas Code*, by substituting "appliance" for "gas utilization appliance." New minimum requirements for opening for rain caps and spacing of electrical wire from dryer vents were added.

In the 2013 edition, masonry heaters were relocated to a new chapter, and requirements addressing clearance from masonry heaters to combustibles were added. In addition, the 2013 edition included a new prohibition on the use of a duct wrap system to provide enclosure of a factory-built chimney.

The 2016 edition has new provisions for a physical barrier for insulation installed close to a chimney, metal clips to provide structural support, and maximum duct run lengths to harmonize NFPA 211 with other standards. The 2016 edition also sees new requirements for masonry fireplace accessories installation.

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Fireplace Investigation, Research & Education Service, CA [SE]

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on fire safety for the construction, installation, and use of chimneys, fireplaces, vents, venting systems, and solid fuel-burning appliances. It also shall be responsible for documents on clearances of heat-producing appliances from combustible materials and terms relating to chimneys, vents, and heat-producing appliances.

NFPA 211

Standard for

Chimneys, Fireplaces, Vents, and Solid Fuel–Burning Appliances

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1 Scope. This standard applies to the design, installation, maintenance, and inspection of all chimneys, fireplaces, venting systems, and solid fuel–burning appliances.

1.2 Purpose.

1.2.1 The primary concern of this standard is the removal of waste gases; the reduction of fire hazards associated with the construction and installation of chimneys, fireplaces, and venting systems for residential, commercial, and industrial appliances; and the installation of solid fuel–burning appliances.

1.2.2 This standard provides minimum construction and installation requirements for chimneys and vents suitable for use with fuel-burning appliances.

1.3 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.3.1 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.3.2 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.3.3 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction and only where it is clearly evident that a reasonable degree of safety is provided.

1.4 Equivalency.

1.4.1 General. Nothing in this standard shall prohibit methods of construction, materials, and designs not specifically prescribed in this standard where equivalent alternatives are approved by the authority having jurisdiction.

1.4.2 Approval of Alternatives. Alternative systems, methods, or devices approved as equivalent by the authority having jurisdiction shall be recognized as being in compliance with this standard.

1.4.3 Tests.

1.4.3.1 Whenever the authority having jurisdiction determines that there is insufficient evidence of proof of equivalency with the prescribed requirements of this standard, the authority having jurisdiction shall be authorized to require tests showing proof of equivalency.

1.4.3.2 Tests required by the authority having jurisdiction shall be provided at no expense to the jurisdiction.

1.4.3.3 Tests shall be conducted as specified in this standard or, where test methods are not specified in this standard, they shall be conducted as required by the authority having jurisdiction.

1.4.4 Approval. The authority having jurisdiction shall determine whether the proposed alternative methods of construction, materials, and designs are at least equivalent to the prescribed requirements of this standard.

1.5 Dimensions. Where used to describe building construction components, all minimum dimensions specified in this standard are actual unless otherwise stated. Nominal dimensions shall be permitted to vary from their specified dimensions by no more than ½ in. (12.7 mm).

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2016 edition.
NFPA 54, *National Fuel Gas Code,* 2015 edition.
NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.
NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment,* 2014 edition.
NFPA 90B, *Standard for the Installation of Warm Air Heating and Air-Conditioning Systems,* 2015 edition.
NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations,* 2014 edition.
NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

2.3 Other Publications.

2.3.1 ASHRAE Publications. ASHRAE, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.

ASHRAE Handbook: HVAC Systems and Equipment, 2012.

2.3.2 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*, 1998 (2008).

ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*, 1984 (2011).

ASTM C315, *Standard Specification for Clay Flue Liners and Chimney Pots*, 2007.

ASTM C476, *Standard Specification for Grout for Masonry*, 2010.

ASTM C1261, *Standard Specification for Firebox Brick for Residential Fireplaces*, 2010.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2011.

ASTM E1602, *Standard Guide for Construction of Solid Fuel Burning Masonry Heaters*, 2003 (2010).

2.3.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*, 2010.

ANSI/UL 127, *Standard for Factory-Built Fireplaces*, 2008, Revised 2011.

UL 378, *Standard for Draft Equipment*, 2006.

ANSI/UL 959, *Standard for Medium Heat Appliance Factory-Built Chimneys*, 2010.

2.3.4 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment,* 2016 edition.
NFPA 54, *National Fuel Gas Code,* 2015 edition.
NFPA 85, *Boiler and Combustion Systems Hazards Code,* 2015 edition.
NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary,* 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1* Accessible (for Inspections). Capable of being exposed for inspection, maintenance, or repair without damage to the chimney or building structure or finish, but which may require the removal of doors, panels, or coverings using commonly available tools.

3.3.1.1* ***Readily Accessible (for Inspections).*** Exposed, or capable of being exposed, for operation, inspection, maintenance, or repair without the use of tools to open or remove doors, panels, or coverings.

3.3.2 Accessory. Supplementary part or device added to an appliance to make it more useful, versatile, attractive, and so forth.

3.3.2.1* ***Factory-Built Fireplace Accessories.*** Accessories intended for field installation into or attachment to factory-built fireplaces.

3.3.2.2* ***Masonry Fireplace Accessories.*** Accessories intended for field installation into or attachment to masonry fireplaces.

3.3.3 Air.

3.3.3.1 ***Combustion Air.*** The air necessary to provide for the complete combustion of fuel and usually consisting of primary air, secondary air, and excess air.

3.3.4 Appliance. Any device that utilizes a fuel to produce light, heat, power, refrigeration, or air conditioning.

3.3.4.1 ***Counter Appliance (Gas).*** Appliances such as gas-operated coffee brewers and coffee urns and any appurtenant water-heating equipment, food and dish warmers, hot plates, and griddles.

3.3.4.2* ***Direct Vent Appliance.*** A system consisting of an appliance, combustion air and flue gas connections between the appliance and the outside atmosphere, and a vent cap supplied by the manufacturer, and constructed so that all air for combustion is obtained from the outside atmosphere and all flue gases are discharged to the outside atmosphere.

3.3.4.3 ***Fuel-Burning Appliance.***

3.3.4.3.1 ***Pellet Fuel–Burning Appliance.*** A closed combustion pellet vent or chimney-connected solid pellet fuel–burning appliance incorporating a fuel–feed control mechanism.

3.3.4.3.2 ***Solid Fuel–Burning Appliance.*** A chimney-connected device that burns solid fuel designed for purposes of heating, cooking, or both.

3.3.4.4 ***Heating Appliance.***

3.3.4.4.1 ***Attic-Type Heating Appliance.*** A heating appliance designed specifically for installation in an attic or in a space with low headroom that normally is unoccupied.

3.3.4.4.2 ***Building Heating Appliance.*** See 3.3.4.8, Nonresidential, Low-Heat Appliance.

3.3.4.4.3 ***Residential-Type Heating Appliance.*** Fuel-burning appliances, not including high-pressure steam boilers, that are mainly used in residences but that might be used in other buildings, and that do not produce continuous flue gas temperatures exceeding 1000°F (538°C).

3.3.4.5 ***Heat-Producing Appliance.*** An appliance that produces heat by utilizing electric energy or by burning fuel.

3.3.4.6 ***Nonresidential Appliance, 1400°F.*** A commercial, industrial, or institutional appliance needing a chimney capable of withstanding a continuous flue gas temperature not exceeding 1400°F (760°C).

3.3.4.7 ***Nonresidential, High-Heat Appliance.*** A commercial, industrial, or institutional appliance needing a chimney capable of withstanding a continuous flue gas temperature exceeding 1800°F (982°C).

3.3.4.8 ***Nonresidential, Low-Heat Appliance.*** A commercial, industrial, or institutional appliance needing a chimney capable of withstanding a continuous flue gas temperature not exceeding 1000°F (538°C).

3.3.4.9 ***Nonresidential, Medium-Heat Appliance.*** A commercial, industrial, or institutional appliance needing a chimney capable of withstanding a continuous flue gas temperature not exceeding 1800°F (982°C).

3.3.4.10 ***Vented Appliance.*** An indirect-fired appliance provided with a flue collar to accommodate a venting system for conveying flue gases to the outside atmosphere.

3.3.5 Appliance Casing (or Jacket). An enclosure forming the outside of the appliance.

3.3.6 Appliance Categories. See 3.3.80, Gas Appliance Categories.

3.3.7 Appliance Flue. See 3.3.73.1.

3.3.8 Ash. The solid residue that remains after combustion is complete.

3.3.9 Ash Receptacle Door. A door below the grade level providing access to the ash receptacle.

3.3.10 Attic-Type Heating Appliance. See 3.3.4.4.1.

3.3.11 Automatically Operated Damper. See 3.3.52.1.

3.3.12 Automatic Electric Igniter. A device for fuel burners designed to utilize electric energy for ignition of a fuel–air mixture at the burner.

3.3.13 Barometric Draft Regulator. A device built into a fuel-burning appliance, or made a part of a chimney connector or vent connector, that functions to reduce excessive draft through an appliance to a desired value by admitting ambient air into the appliance chimney, chimney connector, vent, or vent connector.

3.3.14 Boiler. A closed vessel in which water is heated, steam is generated, steam is superheated, or any combination thereof by the application of heat from combustible fuels in a self-contained or attached furnace. [**85,** 2015]

3.3.14.1 ***Combination-Fuel Boiler.*** A single boiler unit designed to burn more than one type of fuel (gas, oil, or solid), either separately or simultaneously, using either separate or common combustion chambers and flues.

3.3.14.2 ***High-Pressure Boiler.*** A boiler for generating steam at gauge pressures in excess of 15 psi (103 kPa), or for heating water to a temperature in excess of 250°F (121°C) or at a gauge pressure in excess of 160 psi (gauge pressure of 1103 kPa).

3.3.14.3 ***Low-Pressure Boiler.*** A boiler for generating steam at gauge pressures not in excess of 15 psi (gauge pressure of 103 kPa) or for furnishing water at a maximum temperature of 250°F (121°C) at a maximum gauge pressure of 160 psi (gauge pressure of 1100 kPa). [**31,** 2016]

3.3.14.4 ***Supplementary Boiler.*** A boiler, designed to burn one type of fuel (gas, oil, or solid), that is intended for supplementing a boiler burning another type of fuel (gas, oil, or solid) by means of a common heat transfer medium.

3.3.15 Bond. Where referring to bricklaying and masonry chimneys, that connection between brick, stone, or other masonry units formed by lapping them upon one another in carrying up the work, thereby forming an inseparable mass.

3.3.16 Breeching. The conduit conveying flue gas from the appliance to the chimney.

3.3.17 Btu. Abbreviation for British thermal unit. The quantity of heat needed to raise the temperature of 1 pound of water 1°F.

3.3.18 Building Heating Appliances. See 3.3.4.8, Nonresidential, Low-Heat Appliance.

3.3.19 Cap.

3.3.19.1 ***Chimney Cap.*** A protective covering or housing for the top of a chimney intended to prevent the entry of rain, snow, animals, and birds, and to prevent downdrafts.

3.3.19.2 ***Vent Cap.*** A protective covering or housing attached to the vent termination, intended for preventing downdrafts and the entry of rain, snow, and animals.

3.3.20 Central Warm-Air, Forced-Air, Attic-Type Furnace. See 3.3.79.1.

3.3.21 Central Warm-Air, Forced-Air, Downflow-Type Furnace. See 3.3.79.2.

3.3.22 Central Warm-Air, Forced-Air, Horizontal-Type Furnace. See 3.3.79.3.

3.3.23 Central Warm-Air, Forced-Air-Type Furnace. See 3.3.79.4.

3.3.24 Central Warm-Air, Forced-Air, Upflow-Type Furnace. See 3.3.79.5.

3.3.25 Central Warm-Air Furnace. See 3.3.79.6.

3.3.26 Central Warm-Air, Gravity-Type Furnace. See 3.3.79.7.

3.3.27 Central Warm-Air, Gravity-Type Furnace with Booster Fan. See 3.3.79.8.

3.3.28 Central Warm-Air, Gravity-Type Furnace with Integral Fan. See 3.3.79.9.

3.3.29 Chimney. A structure containing one or more vertical or nearly vertical passageways for conveying flue gases to the outside atmosphere. *[See also 3.3.142.1, Gas Vent; 3.3.142, Vent; and 3.3.131.2, Venting System (Flue Gases).]*

3.3.29.1 ***Building Heating Appliance Type Chimney.***

3.3.29.1.1 ***Factory-Built, Building Heating Appliance–Type Chimney.*** A heating appliance chimney suitable for continuous use at 1000°F (538°C), composed of listed, factory-built components, designed for open, nonenclosed use at specified minimum clearances to combustibles, and assembled in accordance with the terms of the listing to form the completed chimney.

3.3.29.1.2 ***Factory-Built, Residential-Type and Building Heating Appliance–Type Chimney.*** A chimney suitable for use at 1000°F (538°C), which complies with the 10-minute 1700°F (927°C) temperature test of ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances,* and is composed of listed, factory-built components that might be fully enclosed in combustible, residential-type construction, and that is assembled in accordance with the terms of the listing to form a completed chimney.

3.3.29.1.3* ***Type HT Factory-Built, Residential-Type and/or Building Heating Appliance–Type Chimney.*** A residential type and building heating appliance chimney suitable for use at 1000°F (538°C), which complies with the optional 10-minute 2100°F (1449°C) temperature test of ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*. Such chimneys are labeled as Type HT and are required for certain solid fuel–fired applications.

3.3.29.2 ***Factory-Built, 1400°F Type Chimney.*** A chimney suitable for continuous use at 1400°F (760°C), composed of listed, factory-built components, intended for open, nonenclosed use at specified minimum clearances to combustibles and for use in noncombustible locations, and assembled in accordance with the terms of the listing to form the completed chimney.

3.3.29.3 ***Factory-Built, Medium-Heat Appliance Type Chimney.*** A chimney used with appliances that produce maximum flue gas temperatures of 1800°F (982°C), composed of listed, factory-built components, suitable for open, nonenclosed use at specified minimum clearances to combustibles, and assembled in accordance with the terms of the listing to form the completed chimney.

3.3.29.4 ***Factory-Built, Positive Pressure Capable Chimney.*** A residential-type or building heating appliance chimney, or both, listed for use in positive internal pressure applications.

3.3.29.5 ***Masonry Chimney.*** A field-constructed chimney of solid masonry units, bricks, stones, listed masonry chimney units, or reinforced Portland cement concrete, lined with suitable chimney flue liners. [**54,** 2015]

3.3.29.6 ***Unlisted Metal (Smokestack) Chimney.*** A manufactured or field-constructed chimney intended only for nonresidential applications having one or more metal walls, or made of metal with a refractory lining, and that is capable of withstanding the flue gas conditions of its use.

3.3.30 Chimney Cap. See 3.3.19.1.

3.3.31 Chimney Connector. See 3.3.48.1.

3.3.32 Chimney Connector-Type Heat Reclaimer. A heat exchanger intended to be installed in a chimney connector between a heating appliance and the chimney to transfer heat from the flue gases through metal to air or water.

3.3.33 Chimney Flue. See 3.3.73.2.

3.3.34 Chimney Flue Base (Base of Flue). The lowest point of a flue within a chimney.

3.3.35 Chute-Fed Incinerator (Class IIA). See 3.3.91.1.

3.3.36 Circulating Room Heater. See 3.3.88.2.1.

3.3.37 Cleanout Opening. An opening or hole in a chimney, usually located near its base, designed to allow access to the flue for purposes of removing ash, creosote, soot, and other extraneous matter that becomes trapped.

3.3.38 Clearance. The distance between a heat-producing appliance, chimney, chimney connector, vent, vent connector, or plenum and other surfaces.

3.3.39 Clothes Dryer. A device used to dry wet laundry by means of heat derived from the combustion of fuel or from electric heating elements.

3.3.39.1 ***Type 1 Clothes Dryer.*** A factory-built, mass-produced dryer, primarily used in a family living environment. It might or might not be coin-operated for public use and usually is the smallest unit both physically and in function.

3.3.39.2 ***Type 2 Clothes Dryer.*** A factory-built, mass-produced dryer used in a commercial business. It might or might not be operated by the public or a hired attendant. It might or might not be coin-operated and is not designed for use in an individual family living environment. It can be small, medium, or large in size.

3.3.40 Combination-Fuel Boiler. See 3.3.14.1.

3.3.41 Combination-Fuel Furnace. See 3.3.79.10.

3.3.42 Combination Room Heater/Fireplace Stove. See 3.3.70.1.

3.3.43 Combustible Material. See 3.3.100.1.

3.3.44 Combustion. A chemical process of oxidation that occurs at a rate fast enough to produce heat and usually light in the form of either a glow or flame. [**5000,** 2015]

3.3.45 Combustion Air. See 3.3.3.1.

3.3.46 Combustion Products. Constituents resulting from the combustion of a fuel with the oxygen of the air, including the inert but excluding excess air. [**54,** 2015]

3.3.47 Commercial-Industrial-Type Incinerator (Classes III, IV, V, VI, and VII). See 3.3.91.2.

3.3.48 Connector.

3.3.48.1 ***Chimney Connector.*** The pipe that connects a fuel-burning appliance to a chimney.

3.3.48.2 ***Vent Connector.*** The pipe that connects a fuel-burning appliance to a gas vent or Type L vent.

3.3.49 Corbel. Units of masonry projecting from or projecting upward and outward from the face of a wall or chimney in courses to form a support or ledge for a beam, rafter, or other member.

3.3.50 Counter Appliance (Gas). See 3.3.4.1.

3.3.51* Crown. A sloped covering for the top of a masonry chimney that is designed to shed water away from the flue liner and the chimney and to allow expansion and movement of the flue liner.

3.3.52 Damper. A valve or plate for controlling draft or the flow of gases, including air.

3.3.52.1 ***Automatically Operated Damper.*** A damper operated by an automatic control.

3.3.52.2 ***Flue Gas Damper.*** A damper located on the downstream side of the combustion chamber of a fuel-burning appliance, usually in a flue passage of the appliance or in the chimney or vent connector.

3.3.52.3 ***Manually Operated Damper.*** An adjustable damper manually set and locked in the desired position.

3.3.53 Decorative Shroud. A partial enclosure for aesthetic purposes that is installed at the termination of a venting system that surrounds or conceals the chimney or vent cap.

3.3.54 Dilution Flue. See 3.3.73.3.

3.3.55 Direct Vent Appliance. See 3.3.4.2.

3.3.56 Draft. A pressure difference that causes gases or air to flow through a chimney, vent, flue, or appliance. [**54,** 2015]

3.3.56.1* ***Mechanical Draft.*** Draft produced by a fan or an air or steam jet.

3.3.56.2 ***Natural Draft.*** Draft produced by the difference in the weight of a column of flue gases within a chimney or vent system and a corresponding column of air of equal dimension outside the chimney or venting system. [**31,**2016]

3.3.57 Draft Hood. A nonadjustable device built into an appliance, or made a part of the vent connector from an appliance, that is designed to (1) provide for the ready escape of the flue gases from the appliance in the event of no draft, backdraft, or stoppage beyond the draft hood, (2) prevent a backdraft from entering the appliance, and (3) neutralize the effect of stack action of the chimney or gas vent upon the operation of the appliance. [**54,** 2015]

3.3.58 Duct Furnace. See 3.3.79.11.

3.3.59 Engineered Venting or Chimney System. See 3.3.131.1.

3.3.60 Factory-Built, 1400°F Type Chimney. See 3.3.29.2.

3.3.61 Factory-Built, Building Heating Appliance Type Chimney. See 3.3.29.1.1.

3.3.62 Factory-Built Fireplace. See 3.3.68.1.

3.3.63 Factory-Built, Medium-Heat Appliance Type Chimney. See 3.3.29.3.

3.3.64 Factory-Built, Positive Pressure Capable Chimney. See 3.3.29.4.

3.3.65 Factory-Built, Residential Type and Building Heating Appliance Type Chimney. See 3.3.29.1.2.

3.3.66 Fan. A blower or exhauster assembly comprising blades or runners and housings or casings.

3.3.67 Fan-Type Floor Furnace. See 3.3.79.12.1.

3.3.68 Fireplace. A hearth, fire chamber, or similarly prepared area and a chimney.

3.3.68.1 ***Factory-Built Fireplace.*** A fireplace composed of listed, factory-built components assembled in accordance with the terms of the listing.

3.3.68.2 ***Masonry Fireplace.*** A hearth and fire chamber of solid masonry units, such as bricks, stones, listed masonry units, or reinforced concrete, provided with a suitable chimney.

3.3.69 Fireplace Insert. A factory-built, field-installed product consisting of a firebox assembly designed to be installed within or partially within the fire chamber of a fireplace that uses the fireplace flue to vent the products of combustion.

3.3.70 Fireplace Stove. A freestanding, chimney-connected, solid fuel–burning appliance that is designed to be operated with the fire chamber either open or closed.

3.3.70.1 ***Combination Room Heater/Fireplace Stove.*** A chimney-connected, solid fuel–burning room heater that is designed to be operated with the fire chamber either open or closed.

3.3.71 Floor Furnace. See 3.3.79.12.

3.3.72 Floor Protector. A noncombustible surfacing applied to the floor area underneath and extending in front, to the sides, and to the rear of a heat-producing appliance.

3.3.73 Flue. The general term for a passage through which gases are conveyed from the combustion chamber to the outer air.

3.3.73.1 ***Appliance Flue.*** The flue passage within an appliance.

3.3.73.2 ***Chimney Flue.*** The passage in a chimney for conveying the flue gases to the outside atmosphere.

3.3.73.3 ***Dilution Flue.*** A passage designed to effect the dilution of flue gases with air before discharge from an appliance.

3.3.74 Flue Collar. That portion of an appliance designed for attachment of a chimney or vent connector or a draft hood.

3.3.75 Flue-Fed Incinerator (Class II). See 3.3.91.3.

3.3.76 Flue Gas Damper. See 3.3.52.2.

3.3.77 Flue Gases. See 3.3.82.1.

3.3.78 Fuel. A material used to produce heat or power by burning.

3.3.78.1 ***Pellet Fuel.*** A solid processed fuel of specified size and composition capable of being fed to the appliance combustion system at a controlled rate.

3.3.78.2 ***Solid Fuel.*** Wood, coal, and other similar organic materials and any combination of them.

3.3.79 Furnace.

3.3.79.1 ***Central Warm-Air, Forced-Air, Attic-Type Furnace.*** A forced-air-type furnace designed specifically for installation in an attic or in a space with low headroom that is normally occupied.

3.3.79.2 ***Central Warm-Air, Forced-Air, Downflow-Type Furnace.*** A forced-air-type furnace designed with airflow essentially in a vertical path, discharging air at or near the bottom of the furnace.

3.3.79.3 ***Central Warm-Air, Forced-Air, Horizontal-Type Furnace.*** A forced-air-type furnace designed with airflow through the furnace, essentially in a horizontal path.

3.3.79.4 ***Central Warm-Air, Forced-Air-Type Furnace.*** A central furnace equipped with a blower that provides the primary means for the circulation of air.

3.3.79.5 ***Central Warm-Air, Forced-Air, Upflow-Type Furnace.*** A forced-air-type furnace designed with airflow essentially in a vertical path, discharging air at or near the top of the furnace.

3.3.79.6 ***Central Warm-Air Furnace.*** A self-contained indirect-fired or electrically heated appliance designed to supply heated air through ducts to spaces remote from or adjacent to the appliance location.

3.3.79.7 ***Central Warm-Air, Gravity-Type Furnace.*** A central furnace depending primarily on circulation of air by gravity.

3.3.79.8 ***Central Warm-Air, Gravity-Type Furnace with Booster Fan.*** A central furnace equipped with a booster fan that does not materially restrict free circulation of air by gravity flow when such a fan is not in operation.

3.3.79.9 ***Central Warm-Air, Gravity-Type Furnace with Integral Fan.*** A central furnace equipped with a fan as an integral part of its construction and operable on gravity systems only. The fan is used only to overcome the internal resistance to airflow.

3.3.79.10 ***Combination-Fuel Furnace.*** A single furnace unit designed to burn more than one type of fuel (gas, oil, or solid), either separately or simultaneously, using either separate or common combustion chambers and flues.

3.3.79.11 ***Duct Furnace.*** A central furnace designed for installation in a duct of an air distribution system to supply warm air for heating and that depends on a blower not furnished as part of the furnace for air circulation.

3.3.79.12 ***Floor Furnace.*** A self-contained indirect-fired or electrically heated furnace designed to be suspended from the floor of the space to be heated. A fuel-burning floor furnace is designed to take air for combustion from outside the space being heated and is provided with means for observing the flame and lighting the appliance from such space.

3.3.79.12.1 ***Fan-Type Floor Furnace.*** A floor furnace equipped with a blower that provides the primary means for circulation of air.

3.3.79.12.2 ***Gravity-Type Floor Furnace.*** A floor furnace depending primarily on circulation of air by gravity. This classification also includes floor furnaces equipped with booster-type fans that do not materially restrict free circulation of air by gravity flow when such fans are not in operation.

3.3.79.13 ***Supplementary Furnace.*** A furnace designed to burn one type of fuel (gas, oil, or solid) that is intended for supplementing a central warm-air furnace burning another type of fuel (gas, oil, or solid) by means of a common warm-air supply plenum.

3.3.80* Gas Appliance Categories. Vented gas appliances are classified for venting purposes into four categories as follows: (1) Category I — An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent; (2) Category II — An appliance that operates with a non-positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent; (3) Category III — An appliance that operates with a positive vent static pressure and with a vent gas temperature that avoids excessive condensate production in the vent; (4) Category IV — An appliance that operates with a positive vent static pressure and with a vent gas temperature that may cause excessive condensate production in the vent.

3.3.81 Gas Vent. See 3.3.142.1.

3.3.82 Gases.

3.3.82.1 ***Flue Gases.*** Combustion products from fuel-burning appliances along with excess air.

3.3.82.2 ***Vent Gases.*** Products of combustion from fuel-burning appliances along with excess air, plus any dilution air in the venting system above a draft hood or draft regulator.

3.3.83 Gravity-Type Floor Furnace. See 3.3.79.12.2.

3.3.84 Header. Where referring to chimneys, a beam set at right angles to floor or roof joists to provide support and framing around the opening.

3.3.85 Hearth. The floor area within the fire chamber of a fireplace or a fireplace stove.

3.3.86 Hearth Extension. The noncombustible surfacing applied to the floor area extending in front of and at the sides of the hearth opening of a fireplace or a fireplace stove; also where applied to the floor area beneath a fireplace stove or beneath an elevated overhanging fireplace hearth.

3.3.87 Heat Exchanger. A chamber in which heat resulting directly from the combustion of fuel, or heat from a medium such as air, water, or steam, is transferred through the walls of the chamber to air passing through the exchanger; or a chamber in which heat from electric resistors is transferred to the air.

3.3.88 Heater.

3.3.88.1 ***Masonry Heater.*** A vented heating system of predominantly masonry construction having a mass of at least 1760 lb (800 kg) excluding the chimney and masonry heater base.

3.3.88.2 ***Room Heater.*** A heating appliance intended for installation in the space being heated and not intended for duct connection.

3.3.88.2.1 ***Circulating Room Heater.*** A room heater with an outer jacket surrounding the heat exchanger, arranged with openings at top and bottom so that air circulates between the heat exchanger and the outer jacket. Room heaters that have openings in an outer jacket to allow some direct radiation from the heat exchanger are classified as a radiant type.

3.3.88.2.2 ***Radiant Room Heater.*** A room heater designed to transfer heat primarily by direct radiation.

3.3.88.2.3 ***Solid Fuel Room Heater.*** A chimney-connected, solid fuel–burning room heater that is designed to be operated with the fire chamber closed.

3.3.88.3 ***Unit Heater.*** A self-contained heating appliance that is intended for the heating of the space in which it is installed. A unit heater can be an indirect-fired fuel-burning appliance or might utilize steam, hot water, or electricity.

3.3.88.4 ***Water Heater.*** A fuel-burning appliance for heating water to a temperature not more than 200°F (93°C).

3.3.89 Heat-Producing Appliance. See 3.3.4.5.

3.3.90 High-Pressure Boiler. See 3.3.14.2.

3.3.91 Incinerator. An appliance or combustion chamber for the reduction, by burning, of rubbish, garbage, and other wastes.

3.3.91.1 ***Chute-Fed Incinerator (Class IIA).*** An incinerator designed specifically to be fed refuse from one or more floors above the incinerator directly into the incinerator by a separate chute constructed with a positive means to avoid penetration by smoke or fumes and connected directly over the primary combustion chamber. The incinerator is built with a primary and a secondary combustion chamber and a settling chamber. It can include a flue gas washer or scrubber. A separate chimney serves to convey the combustion gases to the outdoors. This class of incinerator is suitable for Type 1 and Type 2 wastes. It generally is used in residential and institutional buildings, including apartments, clubs, dormitories, churches, schools, and other occupancies where Type 1 and Type 2 wastes are to be incinerated.

3.3.91.2 ***Commercial-Industrial-Type Incinerator (Classes III, IV, V, VI, and VII).*** An incinerator having a charging capacity in excess of 5 ft^3 (0.14 m^3) and suitable for a variety of wastes as follows: (1) Class III — Waste Type 0, Type 1, or Type 2; (2) Class IV — Waste Type 3; (3) Class V— Waste Types 0–4 (municipal incinerators); (4) Class VI — Waste Type 4; (5) Class VII — Waste Types 5 and 6.

3.3.91.3 ***Flue-Fed Incinerator (Class II).*** An incinerator served by a single chimney flue that serves also as the charging chute, where refuse is fed directly to the incinerator through this chimney flue from one or more floors above the incinerator. This class of incinerator is suitable for Type 1 and Type 2 waste materials and garbage incidental to residential occupancy in single-family and multifamily buildings. This class of incinerator is generally used in residential and institutional buildings, including apartments, clubs, dormitories, churches, schools, and other occupancies where Type 1 and Type 2 wastes are to be incinerated.

3.3.91.4 ***Residential-Type Incinerator.*** An incinerator for the burning of ordinary combustible waste material and garbage (Type 2 waste) incidental to residential occupancy and having a firebox or charging compartment not greater than 5 ft^3 (0.14 m^3) in capacity. Residential-type incinerators can be self-contained, factory-built units that do not necessitate field construction, or can be of a built-in type designed to be encased in masonry or installed in a masonry wall or chimney.

3.3.92 Low-Pressure Boiler. See 3.3.14.3.

3.3.93 Mantel. A shelf or facing ornament above a fireplace opening.

3.3.94 Manually Operated Damper. See 3.3.52.3.

3.3.95 Manufacturer. The person or persons, company, firm, corporation, partnership, or other organization responsible for turning raw materials or components into a finished product.

3.3.96 Masonry Chimney. See 3.3.29.5.

3.3.97 Masonry Fireplace. See 3.3.68.2.

3.3.98 Masonry Fireplace Lintel. The horizontal, noncombustible member, usually of masonry or steel, spanning the opening of a masonry fireplace to support the load above.

3.3.99 Masonry Heater. See 3.3.88.1.

3.3.100 Material.

3.3.100.1 ***Combustible Material.*** Material made of or surfaced with wood, compressed paper, plant fibers, plastics, or other material that can ignite and burn, whether flame-proofed or not, or whether plastered or unplastered.

3.3.100.2 ***Noncombustible Material.*** A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat; materials that are reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, shall be considered noncombustible materials.

3.3.101 Mechanical Draft. See 3.3.56.1.

3.3.102 Natural Draft. See 3.3.56.2.

3.3.103 Noncombustible Material. See 3.3.100.2.

3.3.104 Nonresidential Appliance, 1400°F. See 3.3.4.6.

3.3.105 Nonresidential, High-Heat Appliance. See 3.3.4.7.

3.3.106 Nonresidential, Low-Heat Appliance. See 3.3.4.8.

3.3.107 Nonresidential, Medium-Heat Appliance. See 3.3.4.9.

3.3.108 Pellet Fuel. See 3.3.78.1.

3.3.109 Pellet Fuel–Burning Appliance. See 3.3.4.3.1.

3.3.110 Pellet Vent. See 3.3.142.2.

3.3.111 Qualified Agency. Any individual, firm, corporation, or company that, either in person or through a representative, is engaged in and is responsible for the connection, venting, installation, inspection, repair, or servicing of heat-producing appliances and who is experienced in such work, is familiar with all precautions required, and has complied with all the requirements of the AHJ.

3.3.112 Radiant Room Heater. See 3.3.88.2.2.

3.3.113 Readily Accessible. See 3.3.1.1.

3.3.114 Residential-Type Heating Appliance. See 3.3.4.4.3.

3.3.115 Residential-Type Incinerator. See 3.3.91.4.

3.3.116 Roof Jack. A factory-built assembly for conveying flue gases through a roof and that includes a flue gas passageway, an insulating means, flashing, and a cap.

3.3.117 Room Heater. See 3.3.88.2.

3.3.118 Smoke Chamber. The transitional area from the damper opening to the beginning of the flue liner in a fireplace system.

3.3.119 Smoke Test. A procedure for ascertaining the tightness of a chimney and for detecting any cracks in a masonry chimney flue or deterioration or breaks in the integrity of a metal chimney flue, and that involves igniting a smoke bomb or building a smoky fire in a fireplace or solid fuel–burning appliance, covering the chimney termination, and checking for smoke escapage through the chimney walls.

3.3.120 Solid Fuel. See 3.3.78.2.

3.3.121 Solid Fuel–Burning Appliance. See 3.3.4.3.2.

3.3.122 Solid Fuel Room Heater. See 3.3.88.2.3.

3.3.123 Solid Masonry Construction. A bonded assembly of stones or solid masonry units.

3.3.124 Solid Masonry Unit. A masonry unit whose net cross-sectional area in every plane parallel to the bearing surface is 75 percent or more of its gross cross-sectional area measured in the same plane.

3.3.125 Spark Arresters. Screening material or a screening device attached to a chimney termination to prevent the passage of sparks and brands to the outside atmosphere.

3.3.126 Special Gas Vent. See 3.3.142.1.1.

3.3.127 Splay. See 3.3.150, Wash.

3.3.128 Steel Fireplace Unit. A unit consisting of a steel firebox and an air chamber adjacent to the sides and rear of the firebox, used to construct a masonry fireplace. The unit usually has ducts to circulate air to and heated air from the air chamber to the living space.

3.3.129 Supplementary Boiler. See 3.3.14.4.

3.3.130 Supplementary Furnace. See 3.3.79.13.

3.3.131 System.

3.3.131.1* ***Engineered Venting or Chimney System.*** A system that has been sized and configured in accordance with approved engineering methods.

3.3.131.2 ***Venting System (Flue Gases).*** A continuous, open passageway from the flue collar or draft hood of a fuel-burning appliance to the outside atmosphere for the purpose of removing flue gases.

3.3.132 Thimble. A fixed or removable ring, tube, or lining usually located in the hole where the chimney connector or vent connector passes through a wall or enters a chimney or vent.

3.3.133 Trimmer. Where referring to chimneys, the longer floor or roof framing member around a rectangular opening into which the end of a header is joined.

3.3.134 Type 1 Clothes Dryer. See 3.3.39.1.

3.3.135 Type 2 Clothes Dryer. See 3.3.39.2.

3.3.136 Type B Gas Vent. See 3.3.142.1.2.

3.3.137 Type BW Gas Vent. See 3.3.142.1.3.

3.3.138 Type HT Factory-Built, Residential-Type and/or Building Heating Appliance Type Chimney. See 3.3.29.1.3.

3.3.139 Type L Vent. See 3.3.142.3.

3.3.140 Unit Heater. See 3.3.88.3.

3.3.141 Unlisted Metal (Smokestack) Chimney. See 3.3.29.6.

3.3.142* Vent. A flue gas–conveying system intended for use only with certain gas-, liquid-, or pellet fuel–fired appliances that do not produce flue gas outlet temperatures higher than a value specified in the listing vent standards.

3.3.142.1 ***Gas Vent.*** A passageway composed of listed factory-built components assembled in accordance with the manufacturer's installation instructions for conveying vent gases from appliances or their vent connectors to the outdoors. [**54,** 2015]

3.3.142.1.1 ***Special Gas Vent.*** A gas vent for venting listed Category II, III, and IV gas appliances.

3.3.142.1.2 ***Type B Gas Vent.*** A vent for venting listed gas appliances with draft hoods and other Category I appliances listed for use with Type B gas vents. [**54,** 2015]

3.3.142.1.3 ***Type BW Gas Vent.*** A vertical or nearly vertical gas vent for venting listed gas-fired vented wall furnaces.

3.3.142.2 ***Pellet Vent.*** A venting system composed of listed, factory-built components assembled in accordance with the manufacturer's instructions for conveying flue gases from a listed pellet fuel–burning appliance to the outside atmosphere.

3.3.142.3 ***Type L Vent.*** A vertical or nearly vertical vent composed of listed factory-built components assembled in accordance with the terms of a listing for conveying flue gases from oil and gas appliances or their vent connectors to the outside atmosphere.

3.3.143 Vent Cap. See 3.3.19.2.

3.3.144 Vent Connector. See 3.3.48.2.

3.3.145 Vent Gases. See 3.3.82.2.

3.3.146 Vented Appliance. See 3.3.4.10.

3.3.147 Venting. Removal of combustion products as well as noxious or toxic fumes to the outside atmosphere.

3.3.148 Venting System (Flue Gases). See 3.3.131.2.

3.3.149 Wall Protector (Shield). Noncombustible surfacing applied to a wall area for the purpose of reducing the clearance between the wall and a heat-producing appliance.

3.3.150 Wash. A slight slope or beveled edge on the top surface of a chimney designed to shed water away from the flue liner; also called a *splay*.

3.3.151 Water Heater. See 3.3.88.4.

3.3.152 Wythe. Where referring to masonry chimneys, a course, a thickness, or a continuous vertical section of masonry separating flues in a chimney.

Chapter 4 General Requirements

4.1* Sizing and Draft.

4.1.1 Minimum Performance. A chimney or vent shall be so designed and constructed to develop a flow sufficient to remove completely all flue or vent gases to the outside atmosphere.

4.1.1.1 Chimneys or vents shall be evaluated to ensure proper performance with respect to draft, creosote buildup, and condensation.

4.1.1.2 The venting system shall satisfy the draft requirements of the connected appliance(s) in accordance with the manufacturers' instructions or approved methods.

4.1.2 Mechanical Draft Systems. A listed mechanical draft system of either forced or induced draft design shall be permitted to be used to increase draft or capacity.

4.1.2.1 Where a mechanical draft system is installed, provision shall be made to prevent the flow of fuel to an automatically fired appliance(s) when that system is not operating.

4.1.2.2 The operation of a mechanical draft system shall not adversely affect the performance or safety of, or cause spillage of combustion products from, other combustion equipment operating within the same building.

4.1.2.3 Proper performance and safety of other combustion equipment shall be verified by testing prior to the mechanical draft system being put into service.

4.1.2.4 Such testing shall include operation of the mechanical draft system together with other exhaust equipment likely to operate simultaneously.

4.1.2.5 Mechanical draft systems of either forced or induced draft serving manually fired appliances shall be one of the following:

(1) A mechanical draft system that is an integral part of a listed appliance
(2) A solid-fuel cooking appliance as addressed in NFPA 96
(3)* An engineered mechanical draft system that includes the following provisions:
    (a) Line voltage devices, when installed, shall be provided with a battery backup system, and the following detection and warning devices shall be installed:
        i. A device that produces an audible and visible warning upon failure of the mechanical draft system. The device shall be activated by loss of electrical power supply or by operational failure of the mechanical draft system at any time while the mechanical draft system is switched on.
        ii. A smoke detector and alarm installed and maintained in accordance with *NFPA 72*. The detector shall be installed in the same room as the appliance served by the mechanical draft system.
        iii. A listed carbon monoxide warning device installed in accordance with the manufacturer's instructions.
    (b) The mechanical draft system shall be listed in accordance with UL 378, *Standard for Draft Equipment*, for use with the type of appliance and range of chimney service appropriate for the application. The mechanical draft system shall not cause or permit blockage of the flue or electrical hazard after exposure to a chimney fire or over-fire conditions. The mechanical draft system shall be installed in accordance with the terms of the listing and the manufacturer's instructions.
    (c) The mechanical draft system shall be sized to maintain draft within the range specified by the appliance manufacturer.

4.1.3 Natural Draft Sizing. Chimneys serving incinerators or other process equipment where the combustion process cannot be stopped completely by fuel shutoff alone shall be sized for natural draft conditions.

4.1.3.1 Where air pollution control devices or other devices in the chimney system require a mechanical draft system, the chimney system shall be so arranged that, upon a power failure, the natural draft chimney alone can satisfactorily remove the products of combustion until the combustible material is completely consumed.

4.1.4 Forced/Induced Draft Systems. Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed to be gastight or to prevent the leakage of combustion products into a building.

4.1.5 Natural Draft Vent Connectors. Vent connectors serving appliances vented by natural draft shall not be connected into any portion of mechanical draft systems operating under positive pressure.

4.2 Termination (Height). Chimneys and vents shall terminate above the roof level in accordance with the requirements of this standard and as illustrated in Figure 4.2(a) and Figure 4.2(b).

4.2.1 Masonry chimneys shall extend above the highest point at which they pass through the roof of a building by at least the distance specified in Table 7.2, Column VI, and shall also extend at least the specified distance above any portion of any structure within the specified proximity (measured horizontally from the vertical chimney line) in Table 7.2, Column VII.

4.2.2 Natural draft chimneys and vents shall not terminate at an elevation less than 5 ft (1.53 m) above the flue collar or the highest connected draft hood outlet.

Exception: As provided in Section 10.7.

4.3 Enclosure.

4.3.1 General. Interior residential chimneys shall be enclosed where they extend through closets, storage areas, or habitable spaces where the surface of the chimney could come into contact with persons or combustible materials.

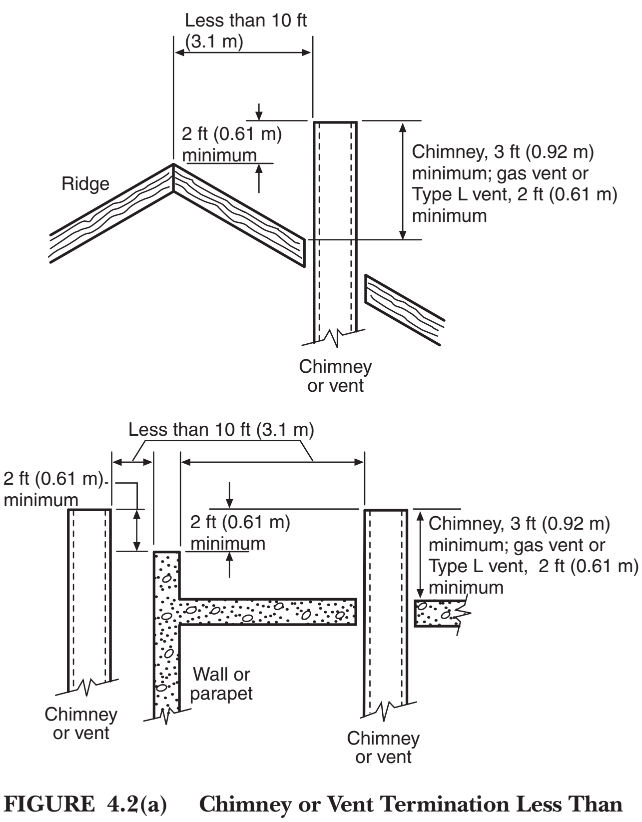


FIGURE 4.2(a) Chimney or Vent Termination Less Than 10 ft (3.1 m) from Ridge, Wall, or Parapet.

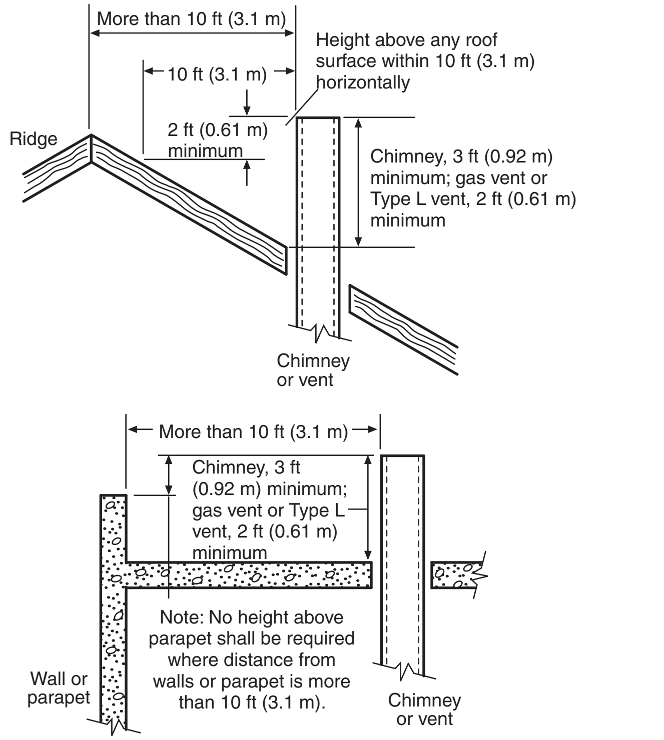


FIGURE 4.2(b) Chimney or Vent Termination More Than 10 ft (3.1 m) from Ridge, Wall, or Parapet.

4.3.2 Clearance. The space between the chimney and the enclosure shall be at least the minimum air space clearance specified in this standard *(see Table 7.2)* or the clearance specified in the manufacturer's instructions for listed chimneys.

4.4 Venting Systems in Ducts.

4.4.1 Circulating Air Ducts and Plenums. No portion of a venting system shall extend into or pass through a dedicated circulating air duct or plenum.

4.4.2 Above-Ceiling Spaces. Where a venting system passes through a space above a ceiling used as a return air plenum, it shall be installed according to one of the following methods:

(1) With joints within the above-ceiling return air plenum sealed airtight in a manner approved by the manufacturer of the venting system
(2) As a listed positive-pressure venting system
(3) Non-airtight venting system installed with no joints or fittings located within the above-ceiling return air plenum

4.5 Flue Lining.

4.5.1 Resistance Equivalency. Castable or plastic refractories used to line chimneys or connectors shall be the equivalent in resistance to heat and erosion by flue gases to that of the fireclay brick.

4.5.2 Lining Support. Lining made of castable or plastic refractories shall be secured to the supporting walls by anchors made of corrosion-resistant steel capable of supporting the refractory load at 1500°F (816°C).

4.5.3 Space Surrounding Liner or Vent. The remaining space surrounding a chimney liner, gas vent, special gas vent, or plastic piping installed within a chimney flue shall not be used to vent another appliance.

4.6 Caps and Spark Arresters for Chimneys and Vents.

4.6.1 Design. Chimney or vent caps, where required for the termination of chimneys or vents, shall be designed to prevent the entry of rain, snow, and birds and other animals.

4.6.2 Rain Cap Height. The minimum distance from the underside of an unlisted rain cap to the top of covered flues shall be the lesser dimension of the width or depth of the covered flue. Where more than one flue is covered, the lesser dimension of the highest flue shall be used.

4.6.3 Screening. Screening material attached to chimney or vent caps to prevent the entry of animals and insects shall not adversely affect the chimney or vent draft.

4.6.4 Spark Arresters.

4.6.4.1 Spark arresters, where required by the AHJ for chimneys attached to solid fuel–burning equipment, shall meet the following requirements:

(1) The net free area of the arrester shall be not less than three times the net free area of the outlet of the chimney flue it serves.
(2) The arrester screen shall have heat and corrosion resistance equivalent to 19 gauge [0.041 in. (1.04 mm)] galvanized steel or 24 gauge [0.024 in. (0.61 mm)] stainless steel.
(3) Openings shall not allow the passage of spheres having a diameter larger than ½ in. (12.7 mm) or block the passage of spheres having a diameter of less than ⅜ in. (9.5 mm).
(4) The spark screen shall be accessible for cleaning, and the screen or chimney cap shall be removable to allow cleaning of the chimney flue.

4.6.4.2 Where part of a listed chimney termination system, spark arresters shall be constructed and installed in accordance with the listing.

Chapter 5 Selection of Chimney and Vent Types

5.1 Chimney Types.

5.1.1 Selection. Chimney selection shall be limited to three basic chimney types: factory-built, masonry, and unlisted metal *[see Figure 5.1.1(a) through Figure 5.1.1(c)]*.

5.1.2 Application. Each basic chimney type is defined in Chapter 3, and the application of each is determined by Table 5.2.2.1, with specific construction or installation requirements in Chapters 6, 7, and 8.

5.2 Chimney or Vent Selection.

5.2.1 General. The selection of a chimney or vent shall be based on the following:

(1) Type of appliance connected thereto
(2) Fuel used by the appliance
(3) Temperature of the flue gases at the appliance outlet
(4) Pressure within the chimney or vent

5.2.2 Chimneys.

5.2.2.1 The chimney type shall be selected according to Table 5.2.2.1.

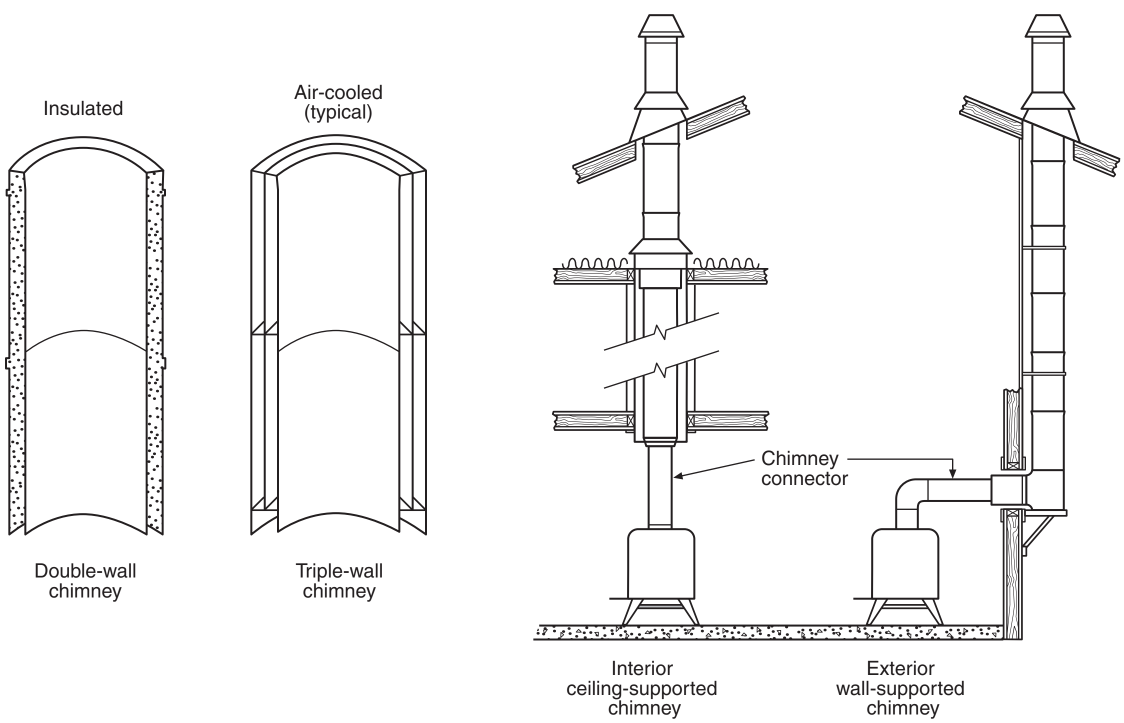


FIGURE 5.1.1(a) Typical Factory-Built Chimney Installation in a Single-Family Residence.

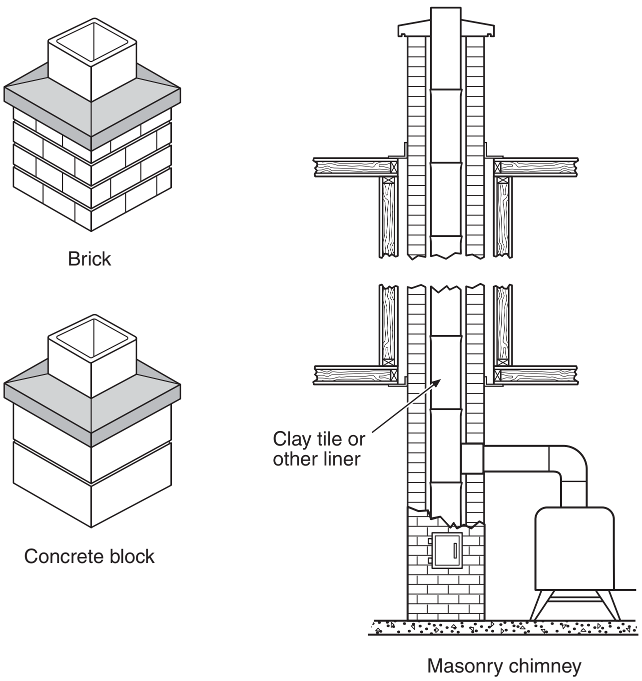


FIGURE 5.1.1(b) Masonry Chimney.

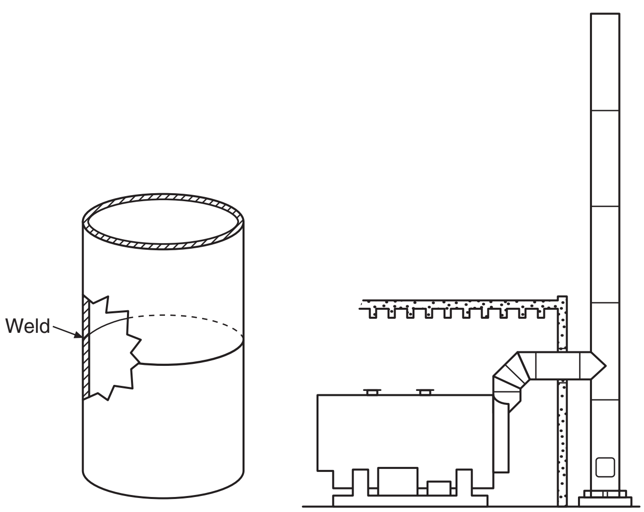


FIGURE 5.1.1(c) Typical Unlisted Metal Chimney Installation in a Commercial or Industrial Application.

5.2.2.2 Unlisted metal chimneys shall not be installed in one- and two-family dwellings.

5.2.3 Vents.

5.2.3.1 A vent shall be used only where appliances are listed for use with a vent.

5.2.3.2 The vent type shall be selected according to Table 5.2.3.2.

Chapter 6 Factory-Built Chimneys and Chimney Units

6.1 Type and Installation.

6.1.1 General. Factory-built chimneys and chimney units shall be listed and installed in accordance with the temperature and pressure conditions of the listing and the manufacturer's instructions.

6.1.2 Temperature and Pressure Limits. Flue gas temperatures and static pressures within the chimney shall not exceed the limits employed during listing tests.

6.1.3 Listing Requirements.

6.1.3.1 Factory-built chimneys shall comply with the requirements of ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*, or of ANSI/UL 959, *Standard for Medium Heat Factory-Built Appliance Chimneys*.

6.1.3.2* Factory-built chimneys for use with wood-burning appliances shall comply with the Type HT requirements of ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*.

6.1.3.3 Chimneys for factory-built fireplaces shall meet the requirements of ANSI/UL 127, *Standard for Factory-Built Fireplaces*.

6.1.3.4 Engineered appliance-venting systems that have been listed to operate without producing combustible deposits to the venting system shall be installed in accordance with the conditions of their listing and the manufacturer's instructions.

6.1.3.5 Open-front masonry fireplaces shall be permitted to use listed residential-type and building heating appliance chimneys without the Type HT designation.

6.1.4 Rated Enclosures. Factory-built chimneys that pass through floors of buildings requiring the protection of vertical openings shall be enclosed with approved walls having a fire resistance rating of not less than 1 hour where such chimneys are located in a building less than four stories in height and not less than 2 hours where such chimneys are located in a building four or more stories in height.

6.1.4.1* The enclosure shall not be constructed from any type of duct wrap or fire-rated duct wrap.

6.1.5 Decorative Shrouds. Unlisted decorative shrouds shall not be permitted at the termination of a factory-built chimney.

Table 5.2.2.1 Chimney Selection Based on Appliance Type and Flue Gas Temperature

Column I	Column II	Column III	Column IV	Column V
Types of Appliances to Be Used with Each Chimney Type				
Residential-type gas, liquid, and solid fuel–burning applications such as:	All appliances shown in Column I	All appliances shown in Columns I and II	All appliances shown in Columns I, II, and III	All appliances shown in Columns I, II, III, and IV
All appliances shown in Column I of Table 5.2.3.2	Boilers operating at not over 1000°F (538°C) flue gas temperature	1400°F (760°C) nonresidential appliances	Medium-heat nonresidential appliances	High-heat nonresidential appliances
Dual-fuel furnaces				
Fireplace inserts				
Fireplace stoves				
Fireplace stove room heaters	Low-heat nonresidential appliances			
Freestanding fireplaces				
Boilers				
Masonry fireplaces	Building heating appliance			
Pellet fuel–burning appliances[a]				
Ranges				
Residential incinerators				
Room heaters				
Stoves				
Chimney Type Based on Maximum Continuous Appliance Outlet Flue Gas Temperature Under Normal Operating Conditions				
1000°F (538°C)	**1000°F (538°C)**	**1400°F (760°C)**	**1800°F (982°C)**	**>1800°F (>982°C)**
Factory-built residential-type and building heating appliance[b] *(see Chapter 6)*	Factory-built residential-type and building heating appliance[b] *(see Chapter 6)* Factory-built building heating appliance[b] *(see Chapter 6)*	Factory-built 1400°F (760°C) *(see Chapter 6)*	Factory-built medium-heat appliance *(see Chapter 6)*	Engineered high-heat type *(see Section 6.2 and A.3.3.131.1)*
Masonry, residential type *(see Chapter 7)*	Masonry, low-heat type *(see Chapter 7)*	Masonry, low-heat type *(see Chapter 7)*	Masonry, medium-heat type *(see Chapter 7)*	Masonry, high-heat type *(see Chapter 7)*
	Unlisted metal low-heat type[c] *(see Chapter 8)*	Unlisted metal 1400°F (760°C) type[c] *(see Chapter 8)*	Unlisted metal medium-heat type[c] *(see Chapter 8)*	Unlisted metal high-heat type[c] *(see Chapter 8)*

[a]See also Table 5.2.3.2, Column VI.
[b]See 6.1.3 for requirements for factory-built chimneys used with wood-burning appliances in one- and two-family dwellings.
[c]See 8.1.1 for single-wall chimneys or unlisted metal chimneys for prohibition inside or outside one- and two-family dwellings.

Table 5.2.3.2 Vent Selection

Types of Appliances to Be Used with Each Type Vent					
Column I	**Column II**	**Column III**	**Column IV**	**Column V**	**Column VI**
All listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B vents, such as: Central furnaces Duct furnaces Floor furnaces Heating boilers Ranges, residential and low-heat gas Built-in ovens Vented wall furnaces Room heaters Water heaters Horizontal furnaces Unit heaters Decorative appliances (gas fireplaces)	Vented wall furnaces listed for use with Type BW vents only	Listed Categories II, III, and IV gas appliances and Category I appliances listed for use with Special Gas Vents	Low-temperature flue gas appliances listed for use with Type L vents Gas appliances shown under Column I	Incinerators used outdoors, in open sheds, breezeways, or carports as provided in Section 8.2 Gas appliances shown under Column I Listed residential and low-heat gas appliances without draft hoods and unlisted residential and low-heat gas appliances with or without draft hoods	Listed pellet-burning appliances listed for use with pellet vents
Vent Type					
Listed Type B Gas Vent	**Listed Type BW Gas Vent**	**Listed Special Gas Vent**	**Listed Type L Vent**	**Unlisted Single-Wall Metal Pipe***	**Listed Pellet Vent**

Note: See Chapter 10 for requirements.
*See 10.6.4 for limitations on unlisted single-wall metal pipe.

6.2 Use. Factory-built chimneys shall be permitted to be used for exhaust systems and ducting from hoods, industrial ovens, furnaces, and process equipment of any temperature classification *(see Table 5.2.2.1)*, provided the system is engineered so that gas temperatures and pressures do not exceed the applicable limit for the type of chimney.

6.3* Sizing. Factory-built chimneys shall be sized and configured in accordance with the appliance and chimney manufacturers' instructions or approved methods.

6.4 Installation. Factory-built chimneys and chimney units installed through insulation or areas to be insulated shall be separated by a physical barrier to establish and maintain the minimum air space clearance required by the chimney manufacturer.

Chapter 7 Masonry Chimneys

7.1 General Requirements.

7.1.1 Support.

7.1.1.1 Masonry chimneys shall be supported on properly designed foundations of masonry or reinforced Portland or refractory cement concrete or on noncombustible material having a fire resistance rating of not less than 3 hours.

7.1.1.2 Such supports shall be independent of the building construction, and the load shall be transferred to the ground.

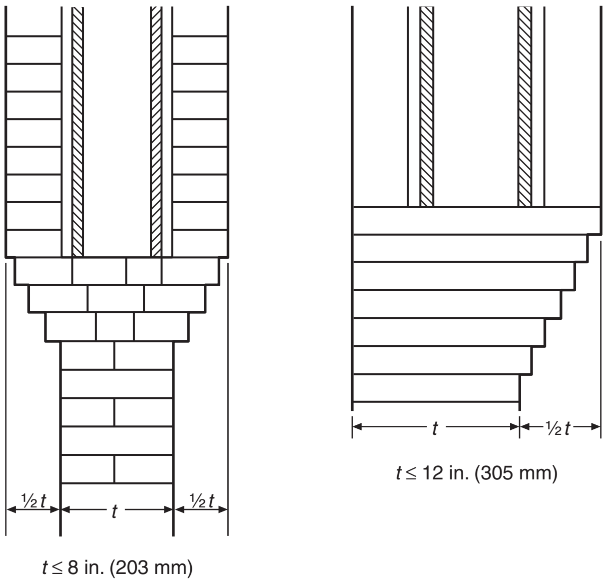
7.1.2 Corbeling. Individual and maximum projections of corbels in masonry chimneys shall comply with the requirements of this section. *[See Figure 7.1.2(a) through Figure 7.1.2(d).]*

7.1.2.1 Corbeling limitations shall be permitted to be varied for engineered, reinforced, brick masonry construction.

7.1.2.2 Individual corbels occurring at any point within a masonry chimney shall not exceed one-half the individual masonry unit height or one-third the thickness.

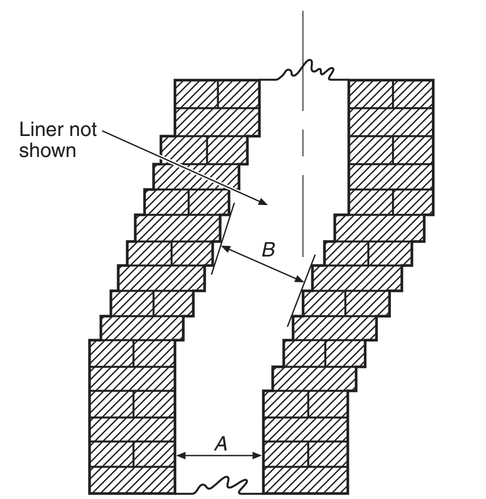
7.1.2.3 The following shall apply to masonry chimney supports:

(1) They shall be permitted to be formed by corbeling from a wall that is not less than 12 in. (305 mm) in thickness to form a maximum total projection of not more than one-half the wall thickness.
(2) Where the corbeling specified in 7.1.2.3(1) projects equally on each side of the wall, the masonry chimney support shall be permitted to be formed by corbeling



Note: t = masonry unit thickness.

FIGURE 7.1.2(a) Corbels for Supporting Chimneys.



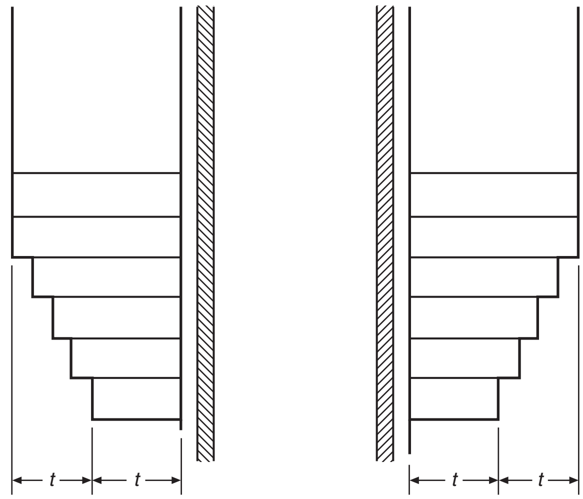
Chimney offset construction — centerline of upper flue does not fall beyond center of lower flue wall. Chimney size, A, and offset size, B, are equal.

FIGURE 7.1.2(b) Corbels to Change Chimney Direction.

from a wall that is not less than 8 in. (203 mm) in thickness to form a maximum total projection on each side of the wall that is not more than one-half the wall thickness.

7.1.2.4 Corbeling used to change the direction of a masonry chimney shall have a maximum offset so that the centerline of the upper flue does not fall beyond the center of the lower flue wall. The cross-sectional area of the flue shall not be reduced throughout the offset.

7.1.2.5 Corbeling used to increase the chimney wall thickness shall have a maximum total projection that does not exceed the thickness of the chimney wall.



Note: t = masonry unit thickness.

FIGURE 7.1.2(c) Corbels to Increase Chimney Wall Thickness.

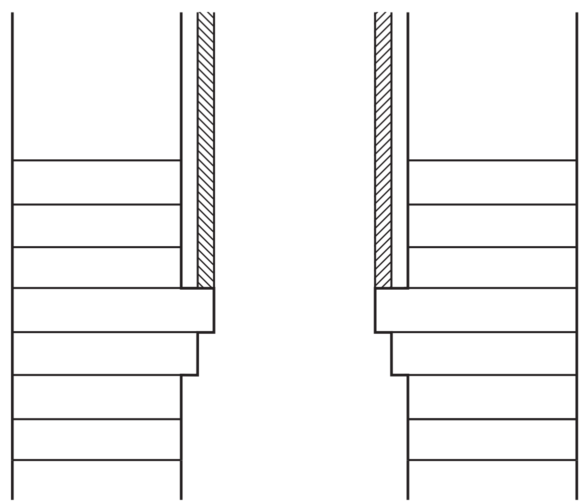


FIGURE 7.1.2(d) Corbels to Support Flue Lining.

7.1.2.6 Corbeled or solid masonry shall be provided in masonry chimneys to support the entire perimeter of flue liners.

7.1.2.7 Where a flue is constructed of two flue liners without a separation, three sides of each flue liner shall be supported entirely on corbeled masonry.

7.1.2.8 Corbels shall be made with solid units, and, where corbels are located on the walls of hollow masonry units, there shall be no fewer than three courses of solid masonry units below the corbels.

7.1.2.9 Corbeling used to incorporate wall pass-through shall be constructed in accordance with 7.1.2.

7.1.3 Change in Size or Shape of Flue at Combustible Members. A chimney flue shall not change in size or shape within 6 in. (152 mm) above or below any point where the chimney passes through combustible floor, ceiling, or roof components.

7.1.4 Cleanout Openings.

7.1.4.1 Cleanout openings shall be provided in all chimney flues serving freestanding appliances.

7.1.4.2 Cleanout openings shall be equipped with ferrous metal, stainless steel, precast cement, or other approved noncombustible doors and frames arranged to remain tightly closed and secured when not in use.

7.1.4.3 The lower edge of a cleanout opening inside a building shall be a minimum of 16 in. (406 mm) above the lowest accessible floor level.

7.1.4.4 The lower edge of a cleanout opening located outside a building shall be a minimum of 16 in. (406 mm) above grade, provided the cleanout opening is below the lowest chimney connector entrance.

7.1.4.5 Cleanout openings and doors shall not be obstructed. Combustible material located or projected beyond the face of the chimney shall be kept a minimum of 18 in. (457 mm) away from the cleanout opening.

7.1.4.6 Cleanout doors shall be permanently marked with a message equivalent to the following:

WARNING: DO NOT OBSTRUCT. KEEP COMBUSTIBLE MATERIAL AT LEAST 18 in. (457 mm) AWAY FROM THIS DOOR.

7.1.4.7 Listed cleanout doors shall be installed in accordance with the terms of their listing and the manufacturer's instructions.

7.1.5 Chimney Flue.

7.1.5.1 The base of the chimney flue shall start at a point at least 6 in. (152 mm) but not more than 12 in. (305 mm) below the bottom edge of the cleanout door opening.

7.1.5.2 Any space within the chimney below the level of the flue base shall be filled with noncombustible masonry material, mortar, concrete, or sand and topped with a wash or a cap that prevents the entry of moisture or creosote.

7.1.6 Firestopping.

7.1.6.1 Gaps between firestopping and the chimney shall not exceed $\frac{1}{16}$ in. (1.6 mm).

7.1.6.2 All spaces between chimneys and the floors and ceilings through which the chimneys pass shall remain fully open but shall be firestopped with noncombustible material.

7.1.6.3 The firestopping of spaces between chimneys and wood joists, beams, or headers shall be of galvanized steel not less than 26 gauge [0.019 in. (0.483 mm)] thick or of noncombustible sheet material not more than $\frac{1}{2}$ in. (12.7 mm) thick.

7.1.7 Smoke Test. Masonry chimneys shall be proved tight by a smoke test after construction and before being put into use.

7.1.8 Structural Design.

7.1.8.1 Chimneys shall be designed, anchored, supported, and reinforced as required in this standard.

7.1.8.2 A chimney shall not support any structural load other than its own weight, unless designed to act as a supporting member.

7.1.8.3 Seismic Reinforcing.

7.1.8.3.1 Reinforcement shall not be required in Seismic Design Category A, B, or C.

7.1.8.3.2 In structures of Seismic Design Category D, fireplaces with chimneys up to 40 in. (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete, between wythes of solid masonry or within the cells of hollow unit masonry and grouted in accordance with ASTM C476, *Standard Specification for Grout for Masonry*.

7.1.8.3.2.1 For fireplaces with chimneys greater than 40 in. (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 in. (1016 mm) in width or fraction thereof.

7.1.8.3.2.2 Vertical reinforcement shall be placed enclosed within $\frac{1}{4}$ in. (6.4 mm) ties or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 in. (457 mm) on center in concrete, or placed in the bed joints of unit masonry at a minimum of every 18 in. (457 mm) of vertical height.

7.1.8.3.2.3 Two such ties shall be provided at each bend in the vertical bars.

7.1.8.3.3 In structures of Seismic Design Category E or F, masonry and concrete chimneys shall be reinforced in accordance with the requirements of Sections 43.1 through 43.8 of *NFPA 5000*.

7.1.8.4 Seismic Anchorage.

7.1.8.4.1 Seismic anchorage shall not be required in Seismic Design Category A, B, or C.

7.1.8.4.2 In structures of Seismic Category D, masonry and concrete chimneys shall be anchored at each floor, ceiling, or roof line more than 6 ft (1.8 m) above grade except where constructed completely within the exterior walls.

7.1.8.4.3 Two $\frac{3}{16}$ in. by 1 in. (4.8 mm by 25 mm) straps shall be embedded a minimum of 12 in. (305 mm) into the chimney.

7.1.8.4.3.1 Straps shall be hooked around the outer bars and extend 6 in. (152 mm) beyond the bend.

7.1.8.4.3.2 Each strap shall be fastened to a minimum of four floor joists with two $\frac{1}{2}$ in. (12.7 mm) bolts.

7.1.8.5 Chimney design shall consider seismic and wind loading.

7.1.8.6 Masonry chimneys shall be permitted to be constructed as part of the masonry walls or reinforced concrete walls of buildings.

7.1.9 Thimbles.

7.1.9.1 Thimbles for chimneys or vent connectors shall be of fireclay *(see ASTM C315, Standard Specification for Clay Flue Liners and Chimney Pots)*, galvanized steel of a minimum thickness of 24 gauge [0.024 in. (0.61 mm)], or material of equivalent durability.

7.1.9.2 Thimbles shall be installed without damage to the liner.

7.1.9.3 The thimble shall extend through the wall to, but not beyond, the inner face of the liner and shall be cemented firmly to masonry.

7.1.9.4 Thimbles shall be located to provide pitch or rise of chimney or vent connectors.

7.1.9.5 Where the ceiling above the appliance is constructed of combustible material, the location of the thimble shall provide the minimum clearance required for the connector, as specified in Section 9.5.

7.1.9.6 The installation of thimbles through walls or partitions constructed of combustible materials shall conform with the requirements of Section 9.7.

7.1.10 Relining.

7.1.10.1 Where masonry chimneys are relined, the liner shall be listed or of approved material that resists corrosion, softening, or cracking from flue gases at temperatures appropriate to the class of chimney service.

7.1.10.2 Listed liner systems shall be installed in accordance with the listing.

7.1.10.3 Approved materials shall be installed in accordance with Section 7.2.

7.1.10.4 The relined chimney shall meet the requirements of the class of chimney service.

7.1.11* Sizing.

7.1.11.1 Masonry chimneys serving appliances shall be sized and configured in accordance with the appliance manufacturer's instructions, 13.4.4, or approved methods.

7.1.11.2 Masonry chimneys serving fireplaces shall be sized in accordance with the requirements of *ASHRAE Handbook: HVAC Systems and Equipment* or other approved methods.

7.1.11.3 Masonry chimneys serving fireplaces that are a minimum of 8 ft (2.44 m) in height above the top of the fireplace opening and are constructed with no offsets in the flue shall be permitted to be designed in accordance with 7.1.11.3.1 through 7.1.11.3.5.

7.1.11.3.1 Round chimney flues shall have a minimum net cross-sectional area of at least one-twelfth the fireplace opening.

7.1.11.3.2 Square chimney flues shall have a minimum net cross-sectional area of at least one-tenth the fireplace opening.

7.1.11.3.3 Rectangular and oval chimney flues with an aspect ratio of less than 2 to 1 shall have a minimum net cross-sectional area of at least one-tenth the fireplace opening.

7.1.11.3.4 Rectangular and oval chimney flues with an aspect ratio of 2 to 1 or more shall have a minimum net cross-sectional area of at least one-eighth the fireplace opening.

7.1.11.3.5 The aspect ratio shall be the ratio of the longer inside dimension to the shorter inside dimension.

7.1.12* Positive-Pressure Applications. Masonry chimneys used for positive internal pressure applications shall incorporate a lining system either listed for positive internal pressure applications or otherwise approved for such use.

7.2 Construction of Masonry Chimneys. Masonry chimneys shall be constructed as detailed in this section and Table 7.2.

Table 7.2 Construction, Termination, and Clearances for Masonry Chimneys

	Column															
	I		II		III	IV		V	VI		VII		VIII		IX	
	Chimney Wall Thickness				Chimney Liner (*See 7.2.2.3.*)				Termination				Minimum Air Space Clearances (*See 7.2.2.3.*)			
	Brick or Concrete		Rubble Stone			Thickness			Highest Point		Nearby Structures		Interior Chimney		Exterior Chimney	
Chimney Type	in.	mm	in.	mm	Type	in.	mm	Cement	ft	m	ft	m	in.	mm	in.	mm
Residential	4	102	12	305	Fireclay	$\frac{5}{8}$	16	Medium duty	3	0.91	2 within 10	0.61 3.05	2	51	1	25
Low-heat	8	203	12	305	Fireclay	$\frac{5}{8}$	16	Medium duty	3	0.91	2 within 10	0.61 3.05	2	51	2	51
Medium-heat	8	203	12	305	Fireclay brick	$4\frac{1}{2}$	114	Medium duty	10	3.05	10 within 25	3.05 7.6	4	102	4	102
High-heat	See 7.2.1.3.				Fireclay brick	$4\frac{1}{2}$	114	High duty	20	6.1	20 within 50	6.1 15.2	See 7.3.1.5.			

7.2.1 Construction.

7.2.1.1 Masonry chimneys shall be constructed of one of the following materials and laid with full, push-filled, head, and bed mortar joints:

(1) Solid masonry or solid, waterproofed, modular concrete blocks in nominal thicknesses not less than those specified in Table 7.2, Column I
(2) Reinforced Portland or refractory cement concrete in actual thicknesses not less than those specified in Table 7.2, Column I
(3) Rubble stone masonry in actual thicknesses not less than those specified in Table 7.2, Column II

7.2.1.2 Reinforced masonry chimneys for residential-type appliances shall be permitted to be constructed of hollow masonry units not less than 6 in. (152 mm) nominal thickness, with cells fully filled with mortar.

7.2.1.3 Masonry chimneys for high-heat appliances shall meet the following criteria:

(1) They shall be constructed with double walls of solid masonry or reinforced Portland or refractory cement concrete.
(2) Each double wall shall be not less than 8 in. (203 mm) thick with an air space of not less than 2 in. (51 mm) between walls.

7.2.2 Chimney Lining.

7.2.2.1 Masonry chimneys shall be lined.

7.2.2.2 The selection of the lining material shall be appropriate for the class of chimney service and the type of appliance connected, in accordance with the terms of the appliance listing and the manufacturer's instructions.

7.2.2.3 Listed materials used as chimney linings shall be installed in accordance with the terms of their listings and the manufacturer's instructions.

7.2.2.4 The materials specified in 7.2.3 through 7.2.8 shall be permitted for the indicated class of chimney service.

7.2.3 Low-, Medium-, and High-Heat Appliances. The following materials shall be permitted for low-, medium-, and high-heat appliances (Table 5.2.2.1, Columns II, III, IV, and V):

(1) Clay flue lining complying with the requirements of ASTM C315, *Standard Specification for Clay Flue Liners and Chimney Pots*, or the equivalent, as specified in Table 7.2, Columns III and IV
(2) Fireclay brick complying with the requirements of ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*, or the equivalent, as specified in Table 7.2, Columns III and IV

7.2.4 Residential-Type and Building Heating Appliances. The following materials shall be permitted for residential-type and building heating appliances (Table 5.2.2.1, Columns I and II):

(1) Clay flue lining or fireclay brick complying with 7.2.3, as specified in Table 7.2, Columns III and IV
(2) Listed chimney lining systems
(3) Factory-built chimneys or chimney units listed for installation within masonry chimneys
(4) Other approved materials that resist corrosion, erosion, softening, or cracking from flue gases and condensate at temperatures up to 1800°F (982°C)

7.2.5 Category I Gas Appliances. The following materials shall be permitted for Category I gas appliances (Table 5.2.3.2, Column I):

(1) Chimney liners complying with 7.2.4
(2) Chimney lining systems listed for use with listed gas appliances with draft hoods and other Category I appliances listed for use with Type B vents *(See 7.2.9 for marking.)*
(3) Type B vents listed for installation within masonry chimneys *(See 7.2.9 for marking.)*

7.2.6 Categories II, III, and IV Gas Appliances. Special gas vents listed for installation within masonry chimneys shall be permitted (Table 5.2.3.2, Column III). *(See 7.2.9 for marking.)*

7.2.7 Pellet Fuel–Burning Appliances. The following materials shall be permitted for pellet fuel–burning appliances (Table 5.2.3.2, Column VI):

(1) Chimney liners complying with 7.2.4
(2) Pellet vents listed for installation within masonry chimneys *(See 7.2.9 for marking.)*

7.2.8 Listed or Approved Materials. Other materials listed for installation within masonry chimneys for the class of chimney service and for the appliance type shall be permitted. Other approved materials that resist corrosion, erosion, softening, or cracking from flue gases and condensate at temperatures appropriate for the class of chimney service and appliance type shall be permitted.

7.2.9 Notice of Usage.

7.2.9.1 Where a Type B gas vent, special gas vent, pellet vent, or other material not suitable for use under Columns I and II of Table 5.2.2.1 is used as a liner for a masonry chimney, the chimney shall be plainly and permanently identified by a label attached to the wall or ceiling or at another conspicuous location adjacent to the point where the connector enters the chimney.

7.2.9.2 The label shall read as follows or the equivalent:

"This [*type of product*] Is for [*type or category of appliance*] Appliances That Burn [*type of fuel*] Only. Do Not Connect Other Types of Appliances."

7.2.10 Fireclay Flue Liners.

7.2.10.1 Fireclay flue liners shall be installed ahead of the construction of the chimney as it is carried up.

7.2.10.2 Liners shall be bedded one on the other in a medium-duty, non-water-soluble calcium aluminate refractory cement mixture, or its equivalent.

7.2.10.3 Joints shall be left smooth on the inside.

7.2.10.4 Portland cement–bonded mixtures shall not be used.

7.2.11 Fireclay Brick Flue Liners. Fireclay brick flue liners shall be installed laid in full-width refractory mortar as specified in Table 7.2, Column V, or the equivalent.

7.2.12 Fireclay Flue Lining for Residential and Low-Heat Masonry Chimneys.

7.2.12.1 Fireclay flue lining for residential and low-heat masonry chimneys shall be separated from the chimney wall by a minimum of ½ in. (12.7 mm) and a maximum of 4 in. (102 mm) of air space.

7.2.12.2 The air space shall not be filled, and only enough mortar to make a good joint and hold the liners in position shall be used.

7.2.12.3 Where masonry chimneys are lined with a listed chimney liner system, the system shall be installed in accordance with the listing.

7.2.13 Installation of Fireclay Flue Liners.

7.2.13.1 The fireclay flue liner shall start at or below the base of the chimney flue and shall be supported by solid masonry.

7.2.13.2 The lining shall be carried up as nearly vertically as possible, with a maximum slope no greater than 30 degrees from the vertical.

7.2.13.3 The lining shall extend for the entire height of the chimney to a level not less than 2 in. (51 mm) above the crown, splay, or wash.

7.2.13.4 The crown, splay, or wash shall be constructed to allow for unrestricted vertical movement of the flue lining due to thermal expansion without allowing the introduction of moisture into the chimney.

7.2.14 Multiple Flues.

7.2.14.1 Where a chimney contains more than one flue, a separation shall be provided between adjacent flues.

7.2.14.2 The separation shall be of solid masonry wythes (partitions) bonded or securely tied to the chimney walls and constructed according to one of the following:

(1) Not less than 4 in. (102 mm), nominal, in thickness
(2) Of reinforced Portland or refractory cement concrete not less than 4 in. (102 mm), actual, in thickness

7.2.14.3 Where two flues are used to vent a single fireplace or appliance, the provisions of 7.2.14.1 shall not be required.

7.2.14.4 Multiple flues in one chimney shall not be permitted for medium-heat appliances, high-heat appliances, or commercial and industrial incinerators.

7.2.14.5 For chimney liners that have been listed for use as multiple flues installed in accordance with the terms of the listing, the provisions of 7.2.14.1 shall not be required.

7.3 Clearance from Combustible Material.

7.3.1 Minimum Air Space.

7.3.1.1 The minimum air space clearance between interior masonry chimneys (where any portion of the chimney is located within the exterior wall of the building) and combustible materials shall be at least the distance specified in Table 7.2, Column VIII.

7.3.1.2 The minimum air space clearance between exterior masonry chimneys (where the chimney is located completely outside the exterior wall of the building, excluding the soffit or cornice area) and combustible material shall be at least the distance specified in Table 7.2, Column IX.

7.3.1.3* The air space shall not be filled.

7.3.1.4 For residential and low-heat chimneys, noncombustible trim shall be permitted to be used to prevent the entry of debris into the air space.

7.3.1.5 Masonry chimneys for high-heat appliances shall have clearance from buildings and structures based on good engineering practice and acceptable to the AHJ to avoid overheating combustible material, to allow inspection and maintenance operations on the chimney, and to avoid the danger of burns to persons.

7.3.2 Listed Chimney Liners. Chimneys constructed with listed chimney liners shall be built with clearances in conformance with the listing of the liner system.

7.4 Masonry Chimneys for Incinerators.

7.4.1 In addition to the requirements in Section 7.1 through Section 7.3, masonry chimneys for incinerators shall meet the requirements of 7.4.2 through 7.4.3.3.

7.4.2 Chute-Fed Incinerators. Chute-fed incinerators shall meet the requirements of NFPA 82.

7.4.3 Commercial and Industrial Incinerators. Masonry chimneys for commercial and industrial incinerators shall be supported on foundations of one of the following:

(1) Masonry
(2) Reinforced Portland cement concrete
(3) Refractory cement concrete
(4) Noncombustible material having a fire resistance rating of not less than 3 hours

7.4.3.1 Foundations and supports shall be independent of the building construction and transfer the load to the ground.

7.4.3.2 Chimneys shall be permitted to be supported on incinerator walls if the incinerator foundation and walls are built to support the load imposed and shall be constructed to prevent excessive stress on the roof of the combustion chamber.

7.4.3.3 The terminus of the chimney for commercial and industrial incinerators shall be equipped with an approved spark arrester if the incinerator does not include effective means for arresting sparks and fly ash. *(See NFPA 82.)*

Chapter 8 Unlisted Metal Chimneys (Smokestacks) for Nonresidential Applications

8.1 General Requirements.

8.1.1 One- and Two-Family Dwellings. Single-wall metal chimneys or unlisted metal chimneys shall not be used inside or outside one- and two-family dwellings.

8.1.2 Construction.

8.1.2.1 Unlisted metal chimneys shall be constructed of steel or cast iron.

8.1.2.2 Sheet steel shall have a thickness not less than that indicated in Table 8.1.2.2.

8.1.3 Connection and Support.

8.1.3.1 Unlisted metal chimneys shall be attached by one of the following:

(1) Rivets
(2) Welds
(3) Bolts

Table 8.1.2.2 Minimum Thickness of Sheet Steel Chimneys

	Minimum Thickness		Area		Equivalent Round Diameter	
Gauge	in.	mm	in.^{2}	m^2	in.	mm
16	0.053	1.35	≤154	≤0.0994	≤14	≤356
14	0.067	1.70	155 to 201	0.0999 to 0.1296	>14 to ≤16	>356 to ≤406
12	0.093	2.36	202 to 254	0.1303 to 0.1638	>16 to ≤18	>406 to ≤457
10	0.123	3.12	>254	>0.1638	>18	>457

Note: Regardless of minimum thicknesses specified in this table, the thickness of sheet metal must be adequate to meet the requirements of 8.1.3.

8.1.3.2 Chimneys shall be securely supported and constructed in accordance with the following:

(1) Strength to resist stresses due to steady or gusting wind loads
(2) Adequate anchoring, bracing, and inherent strength to withstand seismic and wind-induced vibrational stresses
(3) Proper material thickness for durability considering fuel analysis, gas temperature, and exposure
(4) Security against leakage of flue gases under positive pressure
(5) Allowance for thermal expansion of breeching and vertical sections

8.1.4 Prohibited Uses. Unlisted metal chimneys shall not be used inside ventilating ducts.

8.1.5 Clearances.

8.1.5.1 Unlisted metal chimneys shall have clearance from buildings and structures to avoid heating combustible material to a temperature in excess of 90°F (50°C) above ambient and to allow inspection and maintenance operations on the chimney.

8.1.5.2 Chimneys shall be located or shielded to avoid the danger of burns to persons.

8.1.6 Foundations and Supports.

8.1.6.1 Unlisted metal chimneys shall be independent of the building construction, transfer the load to the ground, and be supported on foundations of one of the following:

(1) Masonry
(2) Reinforced Portland cement concrete
(3) Refractory cement concrete
(4) Noncombustible material having a fire resistance rating of not less than 3 hours

8.1.6.2 An unlisted metal chimney also can be supported at intervals by the building structure, in which case expansion joints shall be provided at each support level.

8.1.6.3 All joints shall be liquidtight or of a design that allows liquid to drain to the interior of the chimney.

8.1.7 Flue Gases Below 350°F (177°C). Unlisted metal chimneys serving appliances producing flue gases having a temperature below 350°F (177°C) at the entrance to the chimney at full load or partial load shall be one of the following:

(1) Constructed of or lined with acid- and condensate-resistant stainless steel
(2) Lined with acid- and condensate-resistant refractory material or other approved materials

8.1.8* Sizing. Unlisted metal chimneys shall be sized and configured in accordance with the appliance manufacturer's instructions or approved methods.

8.2 Unlisted Metal Chimneys for Residential-Type or Low-Heat Appliances.

8.2.1 Termination (Height).

8.2.1.1 Unlisted metal chimneys for residential-type or low-heat appliances shall extend to the following:

(1) At least 3 ft (0.92 m) above the highest point at which they pass through the roof of a building
(2) At least 2 ft (0.61 m) higher than any portion of a building within 10 ft (3.1 m) *[See Figure 4.2(a).]*

8.2.1.2 The outlet of an unlisted metal chimney for residential-type and low-heat appliances equipped with a mechanical exhaust system shall be permitted to terminate at a location that meets the following stipulations:

(1) Not less than 3 ft (0.92 m) from an adjacent building or building opening
(2) At least 10 ft (3.1 m) abovegrade or above walkways

8.2.1.3 The outlet shall be arranged such that the flue gases are not directed so that they jeopardize people, overheat combustible structures, or enter building openings in the vicinity of the outlet.

8.2.2 Clearances.

8.2.2.1 Exterior.

8.2.2.1.1 Exterior unlisted metal chimneys used only for residential-type or low-heat appliances shall have a clearance of not less than 18 in. (457 mm) from a wall of wood frame construction and from any combustible material.

8.2.2.1.2 Exterior unlisted metal chimneys over 18 in. (457 mm) in diameter shall have a clearance of not less than 4 in. (102 mm) from a building wall of noncombustible construction.

8.2.2.1.3 Exterior unlisted metal chimneys 18 in. (457 mm) or less in diameter shall have a clearance of not less than 2 in. (51 mm) from a building wall of noncombustible construction.

8.2.2.1.4 An unshielded, unlisted metal chimney erected on the exterior of a building shall not be installed less than 2 ft (0.61 m) from any door, window, or walkway.

8.2.2.2 Interior.

8.2.2.2.1 Where an unlisted metal chimney extends through any story(ies) of a building above that in which the appliances connected to the chimney are installed, it shall be enclosed in those upper stories within a continuous enclosure constructed of noncombustible materials complying with the following:

(1) The enclosure shall extend from the ceiling of the appliance room to or through the roof so that it maintains the integrity of the fire separations required by the applicable building code provisions.
(2) Where the building is less than four stories in height, the enclosure walls shall have a fire resistance rating of not less than 1 hour.
(3) Where the building is four stories or more in height, the enclosure walls shall have a fire resistance rating of not less than 2 hours.
(4) The enclosure walls shall provide a space not less than 12 in. (305 mm) on all sides of the chimney sufficient to allow inspection and repair.
(5) Only doorways for inspection purposes equipped with approved self-closing fire doors shall be permitted.

8.2.2.2.2 Where an unlisted metal chimney serving only residential-type or low-heat appliances is located in the same story of a building as that story in which the appliances connected thereto are located, it shall have a clearance of not less than 18 in. (457 mm) from a wall of wood frame construction and from any combustible material.

8.2.2.2.3 Interior unlisted metal chimneys over 18 in. (457 mm) in diameter shall have a clearance of not less than 4 in. (102 mm) from a building wall of noncombustible construction.

8.2.2.2.4 Interior unlisted metal chimneys 18 in. (457 mm) or less in diameter shall have a clearance of not less than 2 in. (51 mm) from a building wall of noncombustible construction.

8.2.2.2.5 Where an unlisted metal chimney serving only residential-type or low-heat appliances passes through a roof constructed of combustible material, it shall be guarded by a ventilating thimble of galvanized steel or approved corrosion-resistant metal that adheres to the following criteria:

(1) Is not less than 0.024 in. (0.61 mm) in thickness
(2) Extends not less than 9 in. (229 mm) below and 9 in. (229 mm) above the roof construction

8.2.2.2.6 Where combustible material in the roof construction is cut away to provide not less than 18 in. (457 mm) clearance on all sides of the chimney, using entirely noncombustible material to close such an opening, the requirements of 8.2.2.2.5 shall not apply.

8.2.2.2.7 The ventilating thimble shall be constructed of galvanized steel not less than 24 gauge [0.024 in. (0.61 mm)] in thickness and provide the following:

(1) A clearance of not less than 9 in. (229 mm) from the chimney surface to the nearest combustibles
(2) A minimum 1 in. (25 mm) air space between the thimble wall and combustible material
(3) A ventilated space between the chimney and the thimble wall *(See Figure 8.2.2.2.7.)*

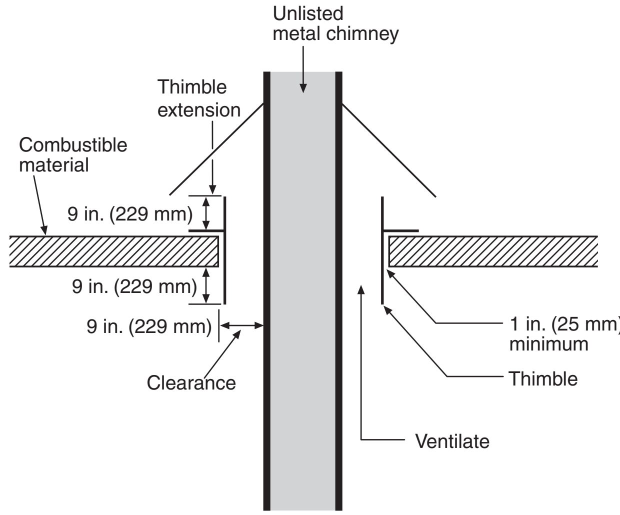


FIGURE 8.2.2.2.7 Ventilating Thimble.

8.3 Unlisted Metal Chimneys for Medium-Heat Appliances.

8.3.1 Construction. Unlisted metal chimneys serving medium-heat appliances shall be constructed as follows:

(1) Lined with medium-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*) or its equivalent
(2) Laid in medium-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*) or its equivalent

8.3.1.1 The lining shall be at least 2 in. (51 mm) thick for chimneys having a diameter or greatest cross-sectional dimension of 18 in. (457 mm) or less.

8.3.1.2 The lining shall have a thickness of not less than 4 in. (102 mm) laid on a full-width bed for chimneys having a diameter or greatest cross-sectional dimension greater than 18 in. (457 mm), and the following criteria also shall be met:

(1) The lining shall start 2 ft (0.61 m) or more below the lowest chimney connector entrance.
(2) The lining shall extend to a height of at least 25 ft (7.6 m) above the highest chimney connector entrance.
(3) Chimneys terminating 25 ft (7.6 m) or less above a chimney connector entrance shall be lined to the top.

8.3.2 Termination (Height). Unlisted metal chimneys for medium-heat appliances shall extend not less than 10 ft (3.1 m) higher than any portion of any building within 25 ft (7.6 m).

8.3.3 Clearances.

8.3.3.1 Exterior.

8.3.3.1.1 Exterior unlisted metal chimneys used for medium-heat appliances shall have a clearance of not less than 24 in. (0.61 m) from a wall of wood frame construction and from any combustible material.

8.3.3.1.2 Exterior unlisted metal chimneys over 18 in. (457 mm) in diameter shall have a clearance of not less than 4 in. (102 mm) from a building wall of noncombustible construction.

8.3.3.1.3 Exterior unlisted metal chimneys 18 in. (457 mm) or less in diameter shall have a clearance of not less than 2 in. (51 mm) from a building wall of noncombustible construction.

8.3.3.1.4 An uninsulated, unlisted metal chimney erected on the exterior of a building shall not be installed less than 24 in. (0.61 m) from any door or window or from any walkway.

8.3.3.2 Interior.

8.3.3.2.1 Where an unlisted metal chimney extends through any story(ies) of a building above that story in which the appliances connected to the chimney are installed, it shall be enclosed in those upper stories within a continuous enclosure constructed of noncombustible materials complying with the following:

(1) The enclosure shall extend from the ceiling of the appliance room to or through the roof so that it maintains the integrity of the fire separations required by the applicable building code provisions.
(2) Where the building is less than four stories in height, the enclosure walls shall have a fire resistance rating of not less than 1 hour.
(3) Where the building is four stories or more in height, the enclosure walls shall have a fire resistance rating of not less than 2 hours.
(4) The enclosure walls shall provide a space not less than 12 in. (305 mm) on all sides of the chimney to allow inspection and repair.
(5) Only doorways for inspection purposes equipped with approved self-closing 1-hour fire doors shall be permitted.

8.3.3.2.2 Where an unlisted metal chimney serving a medium-heat appliance passes through a roof constructed of combustible material, it shall be as follows:

(1) Guarded by a ventilating thimble of galvanized steel or approved corrosion-resistant metal extending not less than 9 in. (229 mm) below and 9 in. (229 mm) above the roof construction
(2) Of a size that allows a minimum clearance of 18 in. (457 mm) on all sides of the chimney

8.3.3.2.3 Where an unlisted metal chimney serving medium-heat appliances is located in the same story of a building as that story in which the appliances connected thereto are located, it shall have a clearance of not less than 36 in. (0.92 m) from a wall of wood frame construction and from any combustible material.

8.3.3.2.4 Interior unlisted metal chimneys over 18 in. (457 mm) in diameter shall have a clearance of not less than 4 in. (102 mm) from a building wall of noncombustible construction.

8.3.3.2.5 Interior unlisted metal chimneys 18 in. (457 mm) or less in diameter shall have a clearance of not less than 2 in. (51 mm) from a building wall of noncombustible construction.

8.4 Unlisted Metal Chimneys for High-Heat Appliances.

8.4.1 Construction.

8.4.1.1 Unlisted metal chimneys for high-heat appliances shall be lined with high-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*) or its equivalent, not less than 4 in. (102 mm) thick, laid on a full-width bed in high-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*) or its equivalent.

8.4.1.2 The lining shall start 2 ft (0.61 m) or more below the lowest chimney connector entrance, and the following criteria also shall be met:

(1) The lining shall extend to a height of at least 25 ft (7.6 m) above the highest chimney connector entrance.
(2) Chimneys terminating 25 ft (7.6 m) or less above a chimney connector entrance shall be lined to the top.

8.4.2 Termination (Height). Unlisted metal chimneys for high-heat appliances shall extend not less than 20 ft (6.1 m) higher than any portion of any building within 50 ft (15.3 m).

Chapter 9 Chimney Connectors and Vent Connectors

9.1 Connectors Required. Connectors shall be used to connect appliances to the vertical chimney or vent unless the chimney or vent is attached directly to the appliance.

9.2 Materials.

9.2.1 Connectors shall be as follows:

(1) Made of noncombustible, corrosion-resistant material
(2) Capable of withstanding the flue gas condensate, pressures, and temperatures produced by the appliances
(3) Of sufficient thickness to withstand physical damage

9.2.2 Connectors for residential-type appliances shall conform to the requirements of this chapter.

9.2.2.1 Vent connectors for listed gas appliances and appliances listed for use with Type B gas vents that are installed in attics shall be one of the following:

(1) Type B or Type L vent material
(2) Listed vent connector material having at least an equivalent insulating value

9.2.2.2 Vent connectors for appliances that are listed for use with Type B gas vents and for appliances with draft hoods and equipped with listed conversion burners and that are not installed in attics shall be of Type B or Type L material or other material listed for use as connectors or shall be smooth interior-wall metal pipe having strength and resistance to heat and corrosion equivalent to that of galvanized sheet steel not less than 0.018 in. (0.46 mm) thick, aluminum (1100 or 3003 alloy or the equivalent) not less than 0.027 in. (0.69 mm) thick, or stainless steel not less than 0.012 in. (0.31 mm) thick.

9.2.2.2.1 Where reduced clearance is necessary, listed reduced clearance connectors shall be permitted to be used if they are installed in accordance with the manufacturer's installation instructions.

9.2.2.3 Connectors for oil appliances, solid fuel–burning appliances, domestic-type incinerators, and gas appliances other than those specified in 9.2.2.1 and 9.2.2.2 shall be constructed of one of the following:

(1) Factory-built chimney material
(2) Type L vent material
(3) Steel pipe having resistance to corrosion and heat not less than that of pipe specified in Table 9.2.2.3

9.2.3 Connectors for low-heat appliances shall be constructed of one of the following:

(1) Listed factory-built chimney material
(2) Steel pipe having resistance to corrosion and heat and not less than the thickness of steel pipe specified in Table 9.2.2.3

9.2.4 Connectors for medium-heat appliances and commercial and industrial incinerators shall conform to the requirements

Table 9.2.2.3 Metal Thickness for Steel Pipe Connectors

Diameter of Connector		Sheet Gauge No.	Minimum Thickness	
in.	mm		in.	mm
<6	<152	26	0.019	0.48
≥6 to ≤10	≥152 to ≤254	24	0.024	0.61
>10 to ≤16	>254 to ≤406	22	0.029	0.74
>16	>406	16	0.056	1.42

of 9.2.4.1 through 9.2.4.2.2 and shall be constructed of one of the following:

(1) Listed medium-heat chimney sections
(2) Steel not lighter than that designated for unlisted metal chimneys in Table 8.1.2.2

9.2.4.1 Connector sections of listed medium-heat chimneys shall be joined using one of the following:

(1) Continuous welds
(2) Flanges
(3) Couplings

9.2.4.2 Steel connectors shall be lined with medium-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*) laid in medium-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*) or the equivalent.

9.2.4.2.1 The lining shall be at least 2 in. (51 mm) thick for connectors having an inside diameter or greatest inside cross-sectional dimension of 18 in. (457 mm) or less.

9.2.4.2.2 The lining shall be at least 4 in. (102 mm) thick laid on the 4 in. (102 mm) bed for connectors having an inside diameter or greatest inside cross-sectional dimension greater than 18 in. (457 mm).

9.2.5 Metal connectors for high-heat appliances shall conform to the requirements of 9.2.5.1 and 9.2.5.2.

9.2.5.1 Metal connectors for high-heat appliances shall be made of steel not lighter than that designated for chimneys in Table 8.1.2.2.

9.2.5.2 The connectors shall be lined with high-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*) or its equivalent having a thickness of not less than 4 in. (102 mm) laid on the 4 in. (102 mm) bed in high-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*) or its equivalent.

9.2.6 Masonry connectors or breeching shall be made of refractory material equivalent in resistance to heat and corrosion to high-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*) not less than 4 in. (102 mm) thick.

9.3 Length. A connector shall be as short and straight as practicable. The appliance shall be located as close as practicable to the chimney or vent.

9.3.1 The horizontal length of a connector to a natural draft chimney or vent serving a single appliance shall be in accordance with one of the following:

(1) Not more than 50 percent of the height of the vertical portion of the chimney above the connector for a connector serving a solid fuel–burning appliance
(2) Not in excess of the design specifications for a connector that is part of an engineered venting system
(3)* In accordance with NFPA 54 for Category I or draft hood–equipped gas appliances
(4) Not more than 75 percent of the height of the vertical portion of the chimney or vent above the connector for all other fuels

9.3.2 The horizontal length, design, and construction of combined connectors or connectors to a manifold joining two or more appliances to a chimney or vent shall be determined in accordance with approved engineering methods.

9.4 Size.

9.4.1 The connector shall be sized for its entire length in accordance with 9.4.2 and 9.4.3.

9.4.2 The effective area of a connector for a single appliance shall be not less than the area of the appliance flue collar, unless it is part of an engineered venting system.

9.4.3 A connector or manifold serving two or more appliances shall have an effective area equivalent to the combined areas of the appliance flue collars or individual connectors, unless it is part of an engineered venting system.

9.5 Clearance.

9.5.1 Clearances from connectors to combustible material shall be in accordance with the requirements of 9.5.1.1 through 9.5.5.3 for both unprotected and protected installations.

9.5.1.1 Clearances from connectors to unprotected combustible material shall be in accordance with Table 9.5.1.1 and Figure 9.5.1.1.

9.5.1.2 Clearances from connectors to combustible material shall be permitted to be reduced, provided the combustible material is protected by an engineered protection system acceptable to the AHJ, using materials or products listed for protection purposes, or is in accordance with Table 9.5.1.2 and Figure 9.5.1.1 chimney or vent connectors.

9.5.1.2.1 Where the required clearance with no protection is 18 in. (457 mm), clearances shall be permitted to be reduced to the distances in the Minimum Clearance column of Table 9.5.1.2.

9.5.1.2.2 For other required clearances, calculate the allowable clearance from the Maximum Allowable Reduction in Clearance column of Table 9.5.1.2.

9.5.1.2.3 Spacers and ties shall meet the following criteria:

(1) Spacers and ties shall be of noncombustible material.
(2) No spacers or ties shall be used directly behind an appliance or a connector.

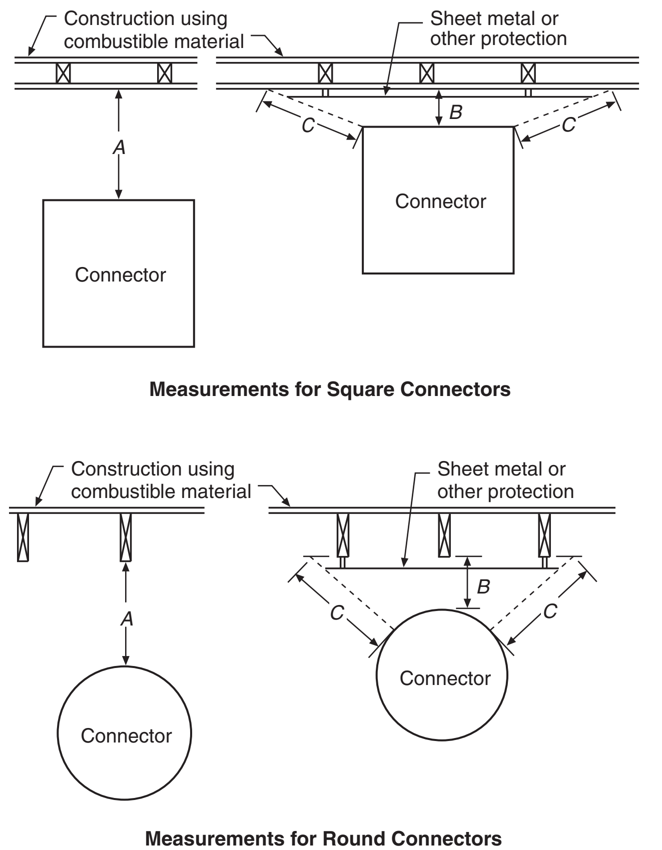
9.5.1.2.4 Mineral wool batts (blanket or board) shall have a minimum density of 8 lb/ft^3 (128 kg/m^3) and have a minimum melting point of 1500°F (816°C).

9.5.1.2.5 Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu-in./hr-ft^2-°F (0.14 W/m-K) or less. Insulation board shall be formed of noncombustible material.

Table 9.5.1.1 Chimney Connector and Vent Connector Clearances from Combustible Materials

Description of Appliance	Minimum Clearance[a] in.	Minimum Clearance[a] mm
Residential-Type Appliances		
Single-Wall Metal Pipe Connectors		
Gas appliances without draft hoods	18	457
Electric, gas, and oil incinerators	18	457
Oil and solid-fuel appliances	18	457
Unlisted gas appliances with draft hoods	9	229
Boilers and furnaces equipped with listed gas burners and with draft hoods	9	229
Oil appliances listed as suitable for use with Type L vents	9	229
Listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B vents[c]	6	152
Type L Vent Piping Connectors		
Gas appliances without draft hoods	9	229
Electric, gas, and oil incinerators	9	229
Oil and solid-fuel appliances	9	229
Unlisted gas appliances with draft hoods	6	152
Boilers and furnaces equipped with listed gas burners and with draft hoods	6	152
Oil appliances listed as suitable for use with Type L vents[b]		
Listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B vents[c]		
Type B Gas Vent Piping Connectors		
Listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B vents[c]		
Low-Heat Appliances		
Single-Wall Metal Pipe Connectors		
Gas, oil, and solid-fuel boilers, furnaces, and water heaters	18	457
Restaurant-type ranges	18	457
Oil unit heaters	18	457
Unlisted gas unit heaters	18	457
Listed gas unit heaters with draft hoods	6	152
Other low-heat nonresidential appliances	18	457
Medium-Heat Appliances		
Single-Wall Metal Pipe Connectors		
All gas, oil, and solid-fuel appliances	36	914
High-Heat Appliances		
Masonry or Metal Connectors		
All gas, oil, and solid-fuel appliances[d]		

[a]If the listing of an appliance specifies a different clearance, the listed clearance takes precedence.
[b]If listed Type L vent piping is used, the clearance is permitted to be in accordance with the vent listing.
[c] If listed Type B or Type L vent piping is used, the clearance is permitted to be in accordance with the appliance and vent listing.
[d]See 9.5.1.2.



Notes:
(1) *A* equals the required clearance with no protection.
(2) *B* equals the reduced clearance permitted.
(3) The protection applied to the construction using combustible material shall extend far enough in each direction to make *C* equal to *A*.

FIGURE 9.5.1.1 Extent of Protection Required to Reduce Clearances from Chimney or Vent Connectors.

9.5.1.2.6 If a single-wall connector passes through a masonry wall used as a wall shield, there shall be at least ½ in. (12.7 mm) of open, ventilated air space between the connector and the masonry.

9.5.1.2.7 There shall be at least 1 in. (25 mm) between the connector and the protector.

9.5.1.2.8 In no case shall the clearance between the connector and the wall surface be reduced below that allowed in Table 9.5.1.2.

9.5.2* Engineered systems installed for the protection of combustible materials shall reduce the temperature rise of such materials to 90°F (50°C) above ambient.

9.5.3 The following shall apply to clearance protection material:

(1) All clearances shall be measured from the outer surface of the connector to the combustible material, disregarding any intervening protection applied to the combustible material.
(2) The clearance protection material shall not interfere with the accessibility of the connector.

Table 9.5.1.2 Reduction of Connector Clearance with Specified Forms of Protection

Clearance Reduction Applied to and Covering All Combustible Surfaces Within the Distance Specified as Required Clearance with No Protection*	Maximum Allowable Reduction in Clearance (%)		Minimum Clearance			
			As Wall Protector		As Ceiling Protector	
	As Wall Protector	As Ceiling Protector	in.	mm	in.	mm
3½ in. (90 mm) thick masonry wall without ventilated air space	33	—	12	305	—	—
½ in. (12.7 mm) thick noncombustible insulation board over 1 in. (25 mm) glass fiber or mineral wool batts without ventilated air space	50	33	9	229	12	305
0.024 in. (0.61 mm), 24 gauge sheet metal over 1 in. (25 mm) glass fiber or mineral wool batts reinforced with wire, or equivalent, on rear face with ventilated air space	66	50	6	152	9	229
3½ in. (90 mm) thick masonry wall with ventilated air space	66	—	6	152	—	—
0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space	66	50	6	152	9	229
½ in. (12.7 mm) thick noncombustible insulation board with ventilated air space	66	50	6	152	9	229
0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space over 0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space	66	50	6	152	9	229
1 in. (25 mm) glass fiber or mineral wool batts sandwiched between two sheets 0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space	66	50	6	152	9	229

Notes:
(1) All clearances and thicknesses are minimum; larger clearances and thicknesses may be permitted.
(2) To calculate the minimum allowable clearance, the following formula can be used: $C_{pr} = C_{un}\ (1 - R/100)$, where C_{pr} is the minimum allowable clearance, C_{un} is the required clearance with no protection, and R is the maximum allowable reduction in clearance.
*See 9.5.1 and Table 9.5.1.1.

9.5.4 Materials and products listed for the purpose of reducing clearance to combustibles shall be installed in accordance with the conditions of the listings and the manufacturers' instructions.

9.5.5 For clearance reduction systems using an air space between the combustible wall and the wall protector, air circulation shall be provided by one of the methods specified in 9.5.5.1 through 9.5.5.3.

9.5.5.1 Air circulation shall be provided by leaving all edges of the wall protector open with at least a 1 in. (25 mm) air gap.

9.5.5.2 Where wall protectors are installed on a single flat wall away from corners, air circulation shall be provided by leaving only the bottom and top edges or only the side and top edges open with at least a 1 in. (25 mm) air gap.

9.5.5.3 Wall protectors that cover two walls in a corner shall be open at the bottom and top edges with at least a 1 in. (25 mm) air gap.

9.6 Location. Where the connector used for a gas appliance having a draft hood or for Category I appliances is located in or passes through an attic, crawl space, or other cold area, that portion of the connector shall be one of the following:

(1) Listed Type B or Type L vent material
(2) Listed vent connector material having at least an equivalent insulating value

9.7 Installation.

9.7.1 The following criteria shall apply to a connector to a masonry chimney:

(1) It shall extend through the wall to the inner face or liner but not beyond.
(2) It shall be firmly cemented to masonry.
(3) If a thimble is used to facilitate removal of the chimney connector for cleaning, the thimble shall be permanently cemented in place with high-temperature cement.

9.7.2 A chimney connector or vent connector shall not pass through any floor or ceiling or through a fire wall or fire partition.

9.7.3 Connectors for listed gas appliances with draft hoods, other listed Category I gas appliances (Table 5.2.3.2, Column I), and oil appliances listed for Type L vents (Table 5.2.3.2, Column III) shall be permitted to pass through walls or partitions constructed of combustible material, provided one of the following conditions is met:

(1) They are made of listed Type B or Type L vent material for gas appliances or of listed Type L vent material for oil

appliances and are installed with not less than listed clearances to combustible material.
(2) They are made of single-wall metal pipe and guarded by a ventilated metal thimble not less than 4 in. (102 mm) larger in diameter than the vent connector.

9.7.4 Connectors for residential-type appliances (Table 5.2.2.1, Column I) shall be permitted to pass through walls or partitions constructed of combustible material if one of the following is true of the connector:

(1) It is listed for wall pass-through and is installed in accordance with the conditions of the listing.
(2) It is incorporated into the chimney construction in accordance with 7.1.2.9.
(3) It is installed in accordance with one of the methods described in Figure 9.7.4.

9.7.5 A connector for a medium- or high-heat appliance (Table 5.2.2.1, Columns IV and V) shall not pass through walls or partitions constructed of combustible material.

9.7.6 Connectors shall maintain a pitch or rise of at least $\frac{1}{4}$ in./ft (6.4 mm/305 mm) of horizontal length of pipe from the appliance to the chimney.

9.7.7 Connectors shall be installed without sharp turns or other construction features that would create excessive resistance to the flow of flue gases.

9.7.8* The following shall apply to a device, other than a damper, that obstructs the free flow of flue gas:

(1) It shall not be installed in a connector, chimney, or vent unless listed for such use. *(For requirements regarding dampers, see Section 9.9.)*
(2) Approved economizers, heat reclaimers, and recuperators shall be permitted in venting systems of equipment that are not required to be equipped with draft hoods in accordance with the fuel-burning appliance listing, provided performance is in accordance with Section 4.1.

9.7.9 Connectors shall be supported and joints fastened using sheet metal screws, rivets, or other approved means.

9.7.10 The entire length of a connector shall be accessible for inspection, cleaning, and replacement.

9.7.11 A connector serving a gas or oil appliance shall not be connected to a chimney flue serving a factory-built fireplace unless specifically listed for such installation.

9.7.12 The following shall apply to gas or oil appliances:

(1) A connector serving a gas or oil appliance shall be permitted to be connected to a masonry fireplace flue if one of the following conditions is met:
    (a) The fireplace opening is sealed.
    (b) The fireplace is abandoned and the chimney flue that vents the fireplace is permanently sealed below the connection.
(2) Listed gas or oil appliances shall be installed in accordance with the listing.

9.7.13 The following shall apply to vent and chimney connectors:

(1) They shall not be covered with insulation.
(2) Listed insulated vent and chimney connectors shall be installed in accordance with the terms of their listing.

9.8 Interconnection.

9.8.1 Connectors serving appliances operating under natural draft shall not be connected into any portion of a mechanical draft system operating under positive pressure.

9.8.2 Unless listed for such connection, solid fuel–burning appliances shall not be connected to a chimney flue serving another appliance.

9.8.3 Gas appliances and appliances burning liquid fuel shall be permitted to be connected to one chimney flue through separate openings or to be connected through a single opening, provided they are joined by a suitable fitting located as close as practicable to the chimney and provided both of the following apply:

(1) Sufficient draft is available for the safe combustion of each appliance and for the removal of all products of combustion.
(2) The appliances so connected are equipped with primary safety controls and all appliances are located in the same room.

9.8.4 If two or more openings are provided into one chimney flue, the following stipulations shall apply:

(1) They shall be at different levels.
(2) The smaller connector shall enter at the highest level consistent with available head room or clearance to combustible material.

9.9 Dampers.

9.9.1 Manually operated dampers shall not be placed in chimneys, vents, or connectors of stoker-fired, liquid fuel–burning, or gas-burning appliances.

9.9.2 Fixed baffles on the appliance side of draft hoods and draft regulators shall not be classified as dampers.

9.9.3 Manually operated dampers shall be permitted to be installed in the chimney connector of hand-fired solid fuel–burning appliances, provided such dampers do not obstruct more than 80 percent of the connector area.

9.9.4 Automatically operated dampers shall meet the following criteria:

(1) They shall be listed.
(2) They shall be installed by a qualified installer in accordance with the terms of the damper and appliance listings.

9.9.5 The installation of dampers on gas appliances shall be in accordance with NFPA 54.

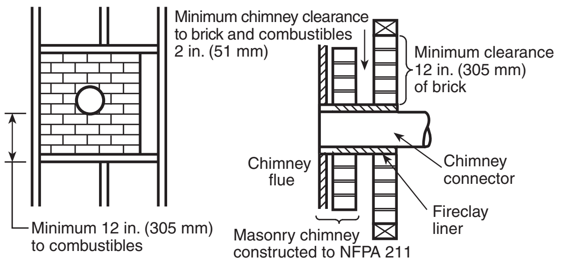
9.10 Draft Hoods. See NFPA 54.

9.11* Draft Regulators.

9.11.1 Gas appliances connected to chimneys, other than those required to be installed with draft hoods by NFPA 54 shall be permitted to be installed with draft regulators in accordance with the appliance manufacturer's instructions.

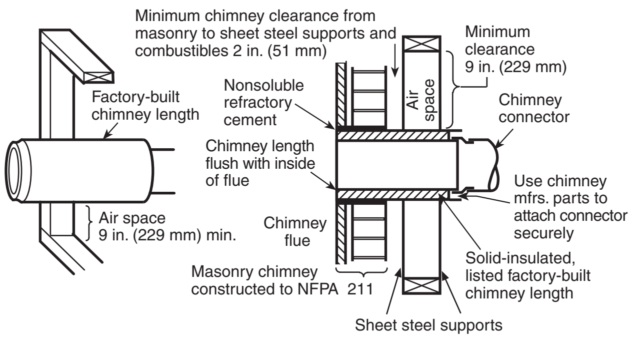
9.11.2 The following shall apply to solid fuel–burning appliances:

(1) They shall be permitted to be installed with draft regulators.
(2) The draft regulators shall be installed and set in accordance with the instructions furnished with the appliance or the draft regulator.



System A. Minimum 3.5 in. (90 mm) thick brick masonry wall framed into combustible wall with a minimum of 12 in. (305 mm) brick separation from clay liner to combustibles. Fireclay liner (ASTM C 315, *Standard Specification for Clay Flue Liners and Chimney Pots*, or equivalent), minimum ⅝ in. (16 mm) wall thickness, shall run from outer surface of brick wall to, but not beyond, the inner surface of chimney flue liner and shall be firmly cemented in place.

Clearance: 12 in. (305 mm)

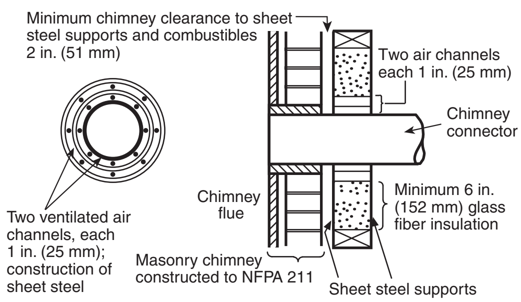


System B. Solid-insulated, listed factory-built chimney length of the same inside diameter as the chimney connector and having 1 in. (25 mm) or more of insulation with a minimum 9 in. (229 mm) air space between the outer wall of the chimney length and combustibles.

The inner end of the chimney length shall be flush with the inside of the masonry chimney flue and shall be sealed to the flue and to the brick masonry penetration with non-water-soluble refractory cement. Supports shall be securely fastened to wall surfaces on all sides.

Fasteners between supports and the chimney length shall not penetrate the chimney liner.

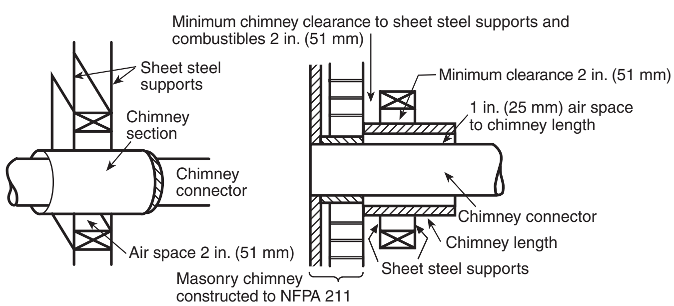
Clearance: 9 in. (229 mm)



System C. Sheet steel chimney connector, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness, with a ventilated thimble, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness, having two 1 in. (25 mm) air channels, separated from combustibles by a minimum of 6 in. (152 mm) of glass fiber insulation. Opening shall be covered, and thimble supported with a sheet steel support, minimum 24 gauge [0.024 in. (0.61 mm)] in thickness.

Supports shall be securely fastened to wall surfaces on all sides and shall be sized to fit and hold chimney section. Fasteners used to secure chimney section shall not penetrate chimney flue liner.

Clearance: 6 in. (152 mm)



System D. Solid-insulated, listed factory-built chimney length with an inside diameter 2 in. (51 mm) larger than the chimney connector and having 1 in. (25 mm) or more of insulation, serving as a pass-through for a single wall sheet steel chimney connector of minimum 24 gauge [0.024 in. (0.61 mm)] thickness, with a minimum 2 in. (51 mm) air space between the outer wall of chimney section and combustibles.

Minimum length of chimney section shall be 12 in. (305 mm). Chimney section concentric with and spaced 1 in. (25 mm) away from connector by means of sheet steel support plates on both ends of chimney section. Opening shall be covered, and chimney section supported on both sides with sheet steel supports of minimum 24 gauge [0.024 in. (0.61 mm)] thickness.

Supports shall be securely fastened to wall surfaces on all sides and shall be sized to fit and hold chimney section. Fasteners used to secure chimney section shall not penetrate chimney flue liner.

Clearance: 2 in. (51 mm)

Note: All clearances and thicknesses are minimums; larger clearances and thicknesses are permitted.

FIGURE 9.7.4 Chimney Connector Systems and Clearances from Combustible Walls for Residential Heating Appliances.

9.11.3 A barometric draft regulator, if used, shall be installed in the same room or enclosure as the appliance in such a manner that no difference in pressure between the air in the vicinity of the regulator and the combustion air supply will be permitted.

Chapter 10 Vents

10.1 Types and Uses. See 5.2.3.2.

10.1.1 Type B gas vents shall be used to vent only listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B gas vents.

10.1.2 Type B gas vents shall not be used for venting the following:

(1) Vented wall furnaces listed for use with Type BW gas vents only
(2) Incinerators
(3) Appliances that can be converted readily to the use of solid or liquid fuels
(4) Combination gas/oil-burning appliances
(5) Appliances listed for use with chimneys only
(6) Listed Categories II, III, and IV gas appliances

10.1.3 Type BW vents shall be used only with listed vented gas wall furnaces having a capacity not greater than that of the listed Type BW gas vent.

10.1.4* A Special Gas Vent shall be listed and used in accordance with the terms of its listing and the appliance and vent manufacturers' instructions.

10.1.5 Type L vents shall be used only with appliances listed as suitable for such use and with gas appliances listed as suitable for use with Type B gas vents.

10.1.6 Single-wall metal pipe other than Special Gas Vents used to vent Categories II, III, and IV gas appliances shall conform to the requirements of 10.1.6.1 through 10.1.6.4.

10.1.6.1 Single-wall metal pipe shall not be used to vent incinerators.

10.1.6.2 The pipe shall be of sheet copper with a thickness not less than 24 B & S gauge [0.0201 in. (0.51 mm)] or of galvanized steel with a thickness not less than 20 gauge [0.036 in. (0.914 mm)].

10.1.6.3 Single-wall metal pipe shall be used only for runs directly from the space in which the appliance is located, through the roof or exterior wall to the outer air.

10.1.6.4 Single-wall metal pipe shall not originate in any unoccupied attic or concealed space and shall not pass through any attic, inside wall, concealed space, floor, or ceiling.

10.2 Size.

10.2.1 General. Vents shall be sized and configured in accordance with approved methods and the appliance and vent manufacturers' instructions.

10.2.2 Gas Vents. Gas vents shall be sized in accordance with NFPA 54 or other approved methods, and the appliance and vent manufacturers' instructions.

10.3 Location. Single-wall outside vents for appliances used in cold climates shall not be permitted.

10.4 Termination (Height).

10.4.1 All vents shall terminate above the roof surface.

Exception: Pellet vents and other vents as provided in 10.4.5 and Section 10.7.

10.4.1.1 Vents installed with mechanical exhausters shall terminate not less than 12 in. (305 mm) above the highest point where they pass through the roof surface.

10.4.1.2 Vents installed with a listed cap shall terminate in accordance with the terms of the cap's listing.

10.4.1.3 Vents installed without listed caps or mechanical exhausters shall extend 2 ft (0.61 m) above the highest point where they pass through the roof surface of a building and at least 2 ft (0.61 m) higher than any portion of a building within 10 ft (3.1 m). *[See Figure 4.2(a).]*

10.4.2 Natural draft vents for gas appliances shall terminate at an elevation not less than 5 ft (1.52 m) above the highest connected appliance outlet.

Exception: As provided in 10.4.3 and 10.7.2.

10.4.3 Natural draft gas vents serving vented wall furnaces shall terminate at an elevation not less than 12 ft (3.7 m) above the bottom of the furnace.

10.4.4 Vents passing through roofs shall extend through the roof flashing.

10.4.5 Mechanical draft systems shall not be required to comply with 10.4.1 and 10.4.3, provided they comply with the following:

(1) The exit terminal of a mechanical draft system other than a gas-, oil-, or pellet-fired direct vent appliance shall be located in accordance with the following:
    (a) Not less than 3 ft (0.92 m) above any forced air inlet located within 10 ft (3.1 m)
    (b) Not less than 4 ft (1.2 m) below, 4 ft (1.2 m) horizontally from, or 1 ft (305 mm) above any door, window, or gravity air inlet into any building
    (c) Not less than 2 ft (0.61 m) from an adjacent building and not less than 7 ft (2.1 m) above grade where located adjacent to public walkways
(2) The exit terminal shall be arranged such that flue gases are not directed so they jeopardize people, overheat combustible structures, or enter buildings.
(3) Forced draft systems and all portions of induced draft systems under positive pressure during operation shall be designed and installed to be gastight or to prevent leakage of combustion products into a building.
(4) Through-the-wall vents for gas appliances shall not terminate over public walkways or over an area where condensate or vapor could create a nuisance or hazard or could be detrimental to the operation of regulators, relief valves, or other equipment.

10.4.6 Unlisted decorative shrouds shall not be permitted at the termination of a listed Type B gas vent.

10.5 Notice of Usage.

10.5.1 In those localities where solid and liquid fuels are used, gas vents shall be plainly and permanently identified by a label attached to the wall or ceiling at a point where the vent connector enters the gas vent. The label shall read as follows:

"This Gas Vent Is for Appliances That Burn Gas. Do Not Connect to Solid or Liquid Fuel–Burning Appliances or Incinerators."

10.5.2 Where a Type B gas vent, Special Gas Vent, or pellet vent is used as the liner for a masonry chimney, the chimney shall be plainly and permanently identified by a label attached to the wall or ceiling adjacent to the point where the connector enters the chimney and that reads as follows:

"This Chimney Liner Is for [*type, category of appliance*] Appliances That Burn [*type of fuel*] Only. Do Not Connect Other Types of Appliances."

10.6* Installation.

10.6.1 Type B, Type BW, and Type L vents shall be listed and installed in full compliance with the terms of their listing and the manufacturers' installation instructions.

10.6.2 Vents installed through insulation or areas to be insulated shall be separated by a physical barrier to establish and maintain the minimum air space clearance required by the vent manufacturer.

10.6.3 Vents that pass through the floors of buildings requiring the protection of vertical openings shall be enclosed within an approved enclosure.

10.6.3.1 The enclosure walls shall have a fire resistance rating of not less than 1 hour where a vent as described in 10.6.3 is located in a building less than four stories in height.

10.6.3.2 The enclosure walls shall have a fire resistance rating of not less than 2 hours where a vent as described in 10.6.3 is located in a building four or more stories in height.

10.6.4 Unlisted single-wall metal pipe shall be installed as specified in 10.6.4.1 through 10.6.4.3.

10.6.4.1 Unlisted single-wall metal pipe shall be installed with minimum clearances from combustible material as follows:

(1) Unlisted gas appliances without draft hoods — 18 in. (457 mm)
(2) Unlisted gas appliances equipped with draft hoods — 9 in. (229 mm)
(3) Boilers and furnaces equipped with listed conversion gas burners and with draft hoods — 9 in. (229 mm)
(4) Listed gas appliances with draft hoods and other Category I gas appliances listed for use with Type B vents — 6 in. (152 mm)

Exception: Residential incinerators.

10.6.4.2 Where a single-wall metal pipe passes through an exterior wall constructed of combustible material, it shall be guarded at the point of passage by a ventilating metal thimble not smaller than the following:

(1) For listed gas-burning appliances with draft hoods and other Category I gas appliances listed for use with Type B vents, the thimble shall be 4 in. (102 mm) larger in diameter than the pipe.
(2) For unlisted gas-burning appliances with draft hoods, the thimble shall be 6 in. (152 mm) larger in diameter than the pipe.
(3) For unlisted gas appliances without draft hoods, the thimble shall be 12 in. (305 mm) larger in diameter than the pipe.

10.6.4.2.1 The requirement of 10.6.4.2 shall not apply where all combustible material in the wall is cut away from the pipe a sufficient distance to provide the clearance required by 10.6.4.1 from such pipe to combustible material, with entirely noncombustible material used to close such an opening.

10.6.4.2.2 The requirement of 10.6.4.2(1) shall not apply to residential incinerators.

10.6.4.2.3 Where there is a run of not less than 6 ft (1.8 m) of pipe in the opening between the draft hood outlet or flue collar and the thimble, the thimble required by 10.6.4.2(1) shall be permitted to be 2 in. (51 mm) larger in diameter than the pipe.

10.6.4.3 Where an unlisted single-wall metal pipe passes through a roof constructed of combustible material, it shall be guarded at the point of passage according to one of the following:

(1) As specified for passage through a combustible exterior wall by 10.6.4.2
(2) With listed gas appliances that can be connected to Type B gas vents by a noncombustible, nonventilating thimble not less than 4 in. (102 mm) larger in diameter than the vent pipe and extending not less than 18 in. (457 mm) above and 6 in. (152 mm) below the roof with the annular space open at the bottom and closed only at the top

10.7 Special Venting Arrangements.

10.7.1 Direct Vent Appliances Fired with Gas, Oil, or Pellet Fuels.

10.7.1.1 Direct vent appliances shall be listed and installed in accordance with their listing and the manufacturer's instructions.

10.7.1.2 The vent terminal of a direct vent appliance with an input of 10,000 Btu/hr (2930 W) or less shall be located at least 6 in. (152 mm) from any opening into a building, and such an appliance with an input of over 10,000 Btu/hr (2930 W) but not over 50,000 Btu/hr (14,650 W) shall be located not less than 9 in. (229 mm) from any opening through which vent gases could enter a building, and the vent terminal of such appliance having an input over 50,000 Btu/hr (14,650 W) shall be located not less than 12 in. (305 mm) from the opening.

10.7.1.3 The bottom of the vent terminal and the air intake shall be located at least 12 in. (305 mm) above grade.

10.7.2 Ventilating Hoods and Exhaust Systems.

10.7.2.1* Where ventilating hoods and exhaust systems serving commercial cooking appliances are used to vent gas-burning appliances installed in commercial applications, the connector from the appliance shall terminate under the hood not less than 18 in. (457 mm) from any grease filter or screen installed in the hood.

10.7.2.2 Where automatically operated appliances, such as water heaters, are vented through natural draft ventilating hoods, dampers shall not be installed in the ventilating system.

10.7.2.3 Where automatically operated appliances, such as water heaters, are vented through a ventilating hood or exhaust system equipped with a mechanical exhaust system, the appliance control system shall be interlocked to allow appliance operation only when the mechanical exhaust system is in operation. *[See 10.4.5(3).]*

10.7.2.4 A ventilating hood shall be installed above an open-top broiler in a residence.

10.7.2.4.1 The hood shall be made with tight joints and shall be constructed of copper with a thickness not less than 24 B & S gauge [0.0201 in (0.51 mm)] or of galvanized steel with a thickness not less than 28 gauge [0.016 in. (0.406 mm)].

10.7.2.4.2 A clearance of not less than ¼ in. (6.4 mm) between the hood and the underside of combustible material or metal cabinets shall be provided.

10.7.2.4.3 The vertical clearance above the broiler to the underside of combustible material or a metal cabinet protected by the hood shall be not less than 24 in. (610 mm).

10.7.2.4.4 The width and breadth of the hood shall be not less than that of the open-top broiler unit.

10.7.2.4.5 The hood shall be centered over the unit.

10.7.2.4.6 The hood shall be exhausted directly through an outside wall to the outside or connected to a suitable chimney flue used for no other purpose. The connecting duct shall conform to the following:

(1) Connecting ducts shall be made of galvanized steel not less than 28 gauge [0.016 in. (0.406 mm)].
(2) A clearance of not less than 6 in. (152 mm) shall be provided between the exhaust duct and unprotected combustible material.

Exception: This clearance shall be permitted to be reduced where the combustible material is protected in accordance with Table 9.5.1.2.

10.7.3 Clothes Dryers.

10.7.3.1 All ducts expelling lint shall be provided with a lint collector.

10.7.3.2 Requirements for gas-fired clothes dryer exhaust shall be in accordance with NFPA 54.

10.7.3.3 All clothes dryers shall be exhausted to the outside air.

10.7.3.4 Maximum Run. Clothes dryer exhaust ducts shall have a maximum length not exceeding 35 ft (10.7 m) as measured from the dryer terminal to the outlet.

10.7.3.4.1 Reductions of 2½ ft (0.76 m) shall be made in the maximum length of the duct for each 45-degree bend and 5 ft (1.5 m) in the maximum length of the duct for each 90-degree bend.

10.7.3.4.2 The transition duct shall not be included in the maximum length of the duct.

10.7.3.4.3 Where the dryer manufacturer's installation instructions regarding maximum length of exhaust ducts is different from the maximum length specified in 10.7.3.4, the exhaust duct shall be installed in accordance with the dryer manufacturer's installation instructions.

10.7.3.5 A clothes dryer exhaust duct shall not be connected into any chimney connector, vent connector, chimney, or vent.

10.7.3.6 Ducts for exhausting clothes dryers shall not be put together with sheet metal screws or other fastening means that extend into the duct.

10.7.3.7 Supporting Dryer Exhaust Ducts. Dryer exhausts shall be supported with metal straps where additional support is needed.

10.7.3.8 Exhaust ducts for clothes dryers shall meet the following criteria:

(1) They shall be constructed of rigid sheet metal or other noncombustible material and shall have a smooth interior surface.
(2) They shall have a minimum thickness equivalent to No. 24 galvanized steel gauge [0.024 in. (0.61 mm)] for Type 2 ducts and No. 28 gauge [0.016 in. (0.406 mm)] for Type 1 ducts.

10.7.3.9 Electrical wires shall maintain a minimum 1 in. (25 mm) clearance from exhaust ducts for Type 1 clothes dryers.

10.7.3.10 Transition ducts used to connect the dryer to the exhaust duct shall be listed for that application or installed in accordance with the clothes dryer manufacturer's installation instructions.

10.7.3.11 Exhaust ducts for Type 2 clothes dryers shall have a clearance of at least 6 in. (152 mm) to combustible material.

10.7.3.11.1 If such a duct passes through a wall, floor, or partition constructed of combustible material, all such material in the wall, floor, or partition shall be cut away from the duct to provide a clearance of at least 6 in. (152 mm), and the opening shall be closed in accordance with 10.7.3.12.

10.7.3.11.2 Exhaust ducts for Type 2 clothes dryers shall be permitted to be installed with reduced clearances to combustible material, provided the combustible material is protected as described in Table 9.5.1.2.

10.7.3.12 Where ducts pass through walls, floors, or partitions, the space around the duct shall be sealed with noncombustible material.

10.7.3.13 The following shall apply to multiple installations of Type 1 and Type 2 clothes dryers:

(1) The installations shall be made in a manner to prevent adverse operation due to backpressures that might be created in the exhaust.
(2) Common exhaust vents that pass through floors of buildings requiring the protection of vertical openings shall be enclosed with approved walls having a fire resistance rating of not less than the following:
    (a) 1 hour, where such chimneys are located in a building less than four stories in height
    (b) 2 hours, where such chimneys are located in a building four or more stories in height

10.7.4 Appliances with Integral Vents. Gas appliances incorporating integral venting means shall be installed in accordance with the manufacturer's installation instructions and 10.4.5. [**54:**12.3.6]

Chapter 11 Fireplaces

11.1 Factory-Built Fireplaces.

11.1.1 Factory-built fireplaces shall be listed and installed in accordance with the terms of the listing.

11.1.2 Hearth extensions shall be provided in accordance with the manufacturers' instructions or be of masonry on noncombustible construction in accordance with Section 11.3.

11.1.3 Factory-built fireplaces shall be secured to the floor or structural framing of the building in order to prevent shifting.

11.1.4 Only listed decorative shrouds at the termination of a factory-built fireplace chimney shall be permitted.

11.2* Masonry Fireplaces.

11.2.1 Construction.

11.2.1.1 Fireplaces shall be constructed of solid masonry units or of reinforced Portland or refractory cement concrete.

11.2.1.2 Masonry fireplaces shall be supported on foundations of one of the following:

(1) Masonry
(2) Reinforced Portland cement concrete
(3) Refractory cement concrete
(4) Other noncombustible construction having a fire resistance rating of not less than 3 hours, provided such supports are adequate for the load

11.2.1.2.1 Footings for masonry fireplaces and their chimneys shall be constructed of concrete or solid masonry at least 12 in. (305 mm) thick and shall extend at least 6 in. (152 mm) beyond the face of the fireplace or foundation wall on all sides.

11.2.1.2.2 Footings shall be founded on natural undisturbed earth or engineered fill below frost depth.

11.2.1.2.3 In areas not subject to freezing, footings shall be at least 12 in. (305 mm) below finished grade.

11.2.1.3 The firebox of a concrete or masonry fireplace shall have a minimum depth of 20 in. (508 mm).

11.2.1.3.1 The throat shall not be less than 8 in. (203 mm) above the fireplace opening.

11.2.1.3.2 The throat opening shall not be less than 4 in. (102 mm) in depth.

11.2.1.3.3 The cross-sectional area of the passageway above the firebox, including the throat, damper, and smoke chamber, shall not be less than the cross-sectional area of the flue.

11.2.1.3.4 Rumford fireplaces shall be permitted, provided that the depth of the fireplace is at least 12 in. (305 mm) and at least one-third the width of the fireplace opening, and the throat is at least 12 in. (305 mm) above the lintel and at least one-twentieth the cross-sectional area of the fireplace opening.

11.2.1.4 Where a lining of low-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*), firebox brick (ASTM C1261, *Standard Specification for Firebox Brick for Residential Fireplaces*), or the equivalent, at least 2 in. (51 mm) thick laid in medium-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*), or the equivalent, or other approved lining is provided, the total thickness of back and sides, including the lining, shall be not less than 8 in. (203 mm).

11.2.1.5 All joints and intersections between the hearth extension/fireplace facing and the fire chamber (firebox) shall be fully sealed with medium-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*). Gaps or voids at supporting lintels and joints between steel fireplace units and the fireplace face or between the frames of dampers and the fireplace face shall be sealed with the same material or with a high-temperature [2000°F (1093°C) service rating] insulating mortar.

11.2.1.6 Where the lining described in 11.2.1.4 is not provided, the thickness of the back and sides of the fireplace shall be not less than 12 in. (305 mm).

11.2.1.7 Where the masonry supporting a fireplace is designed to support vertical loads from the building and corbels are used to support beams or girders, corbeling shall be in accordance with 7.1.2 for masonry chimneys.

11.2.1.8 Masonry over a fireplace opening shall be supported by a lintel of noncombustible material.

11.2.1.8.1 The minimum required bearing length on each end of the fireplace opening shall be a nominal 4 in. (102 mm).

11.2.1.8.2 The fireplace throat or damper shall be located a minimum of 8 in. (203 mm) above the top of the fireplace opening.

11.2.1.9 Where a lining of low-duty fireclay brick (ASTM C27, *Standard Classification of Fireclay and High-Alumina Refractory Brick*), firebox brick (ASTM C1261, *Standard Specification for Firebox Brick for Residential Fireplaces*), or the equivalent, at least 2 in. (51 mm) thick laid in medium-duty refractory mortar (ASTM C199, *Standard Test Method for Pier Test for Refractory Mortars*), or the equivalent, or other approved lining is provided, the total thickness of the smoke chamber walls, including the lining, shall be not less than 6 in. (152 mm).

11.2.1.10 Where unlined, the smoke chamber wall thickness shall be not less than 8 in. (203 mm).

11.2.1.11 The smoke chamber height shall not be greater than the inside width of the fireplace room opening.

11.2.1.12 The smoke chamber depth shall not be greater than the depth of the fireplace fire chamber. *(See Figure 11.2.1.12.)*

11.2.1.13 The inner surfaces of the smoke chamber shall be parge coated smooth, with an insulating refractory mortar, and not inclined more than 45 degrees from vertical.

11.2.1.14 Masonry fireplaces shall be provided with chimneys designed and constructed in compliance with one of the following:

(1) In accordance with the requirements for construction of masonry chimneys *(See Section 7.2.)*
(2) Where permitted by the individual listing, with approved factory-built chimneys having approved adapters in accordance with the requirements for factory-built chimneys *(See Chapter 5.)*

11.2.1.15 Hearth Thickness. The minimum thickness of fireplace hearths shall be 4 in. (102 mm).

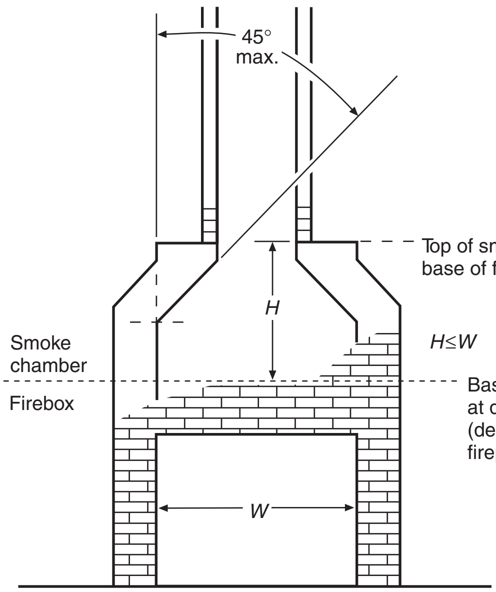


FIGURE 11.2.1.12 Sectional View of Fireplace Showing Smoke Chamber.

11.2.2 Seismic Reinforcing.

11.2.2.1 Reinforcement shall not be required in Seismic Design Category A, B, or C.

11.2.2.2 In structures of Seismic Design Category D, fireplaces with chimneys up to 40 in. (1016 mm) wide, four No. 4 continuous vertical bars, anchored in the foundation, shall be placed in the concrete, between wythes of solid masonry or within the cells of hollow unit masonry and grouted in accordance with ASTM C476, *Standard Specification for Grout for Masonry*.

11.2.2.2.1 For fireplaces with chimneys greater than 40 in. (1016 mm) wide, two additional No. 4 vertical bars shall be provided for each additional 40 in. (1016 mm) in width or fraction thereof.

11.2.2.2.2 Vertical reinforcement shall be placed enclosed within ¼ in. (6.4 mm) ties or other reinforcing of equivalent net cross-sectional area, spaced not to exceed 18 in. (457 mm) on center in concrete, or placed in the bed joints of unit masonry at a minimum of every 18 in. (457 mm) of vertical height.

11.2.2.2.3 Two such ties shall be provided at each bend in the vertical bars.

11.2.2.2.4 In structures of Seismic Design Category E or F, masonry and concrete chimneys shall be reinforced in accordance with the requirements of Sections 43.1 through 43.8 of *NFPA 5000*.

11.2.3 Seismic Anchorage.

11.2.3.1 Seismic anchorage shall not be required in Seismic Design Category A, B, or C.

11.2.3.2 In structures of Seismic Category D, masonry and concrete chimneys shall be anchored at each floor, ceiling, or roof line more than 6 ft (1.8 m) above grade except where constructed completely within the exterior walls.

11.2.3.3 Two 3⁄16 in. by 1 in. (4.8 mm by 25 mm) straps shall be embedded a minimum of 12 in. (305 mm) into the chimney.

11.2.3.3.1 Straps shall be hooked around the outer bars and extend 6 in. (152 mm) beyond the bend.

11.2.3.3.2 Each strap shall be fastened to a minimum of four floor joists with two ½ in. (12.7 mm) bolts.

11.2.4 Steel Fireplace Units.

11.2.4.1 Steel fireplace units incorporating a firebox liner of not less than ¼ in. (6.4 mm) thick steel and an air chamber shall be installed with masonry to provide a total thickness at the back and sides of not less than 8 in. (203 mm), not less than 4 in. (102 mm) of which shall be solid masonry.

11.2.4.2 Listed firebox liners shall be installed in accordance with the terms of the listing.

11.2.4.3 Warm-air ducts employed with steel fireplace units of the circulating air type shall be constructed of metal or masonry.

11.2.5 Clearance.

11.2.5.1 All wood beams, joists, studs, and other combustible material shall have a clearance to masonry fireplaces as follows:

(1) Not less than 2 in. (51 mm) from the front faces and sides
(2) Not less than 4 in. (102 mm) from the back faces of masonry fireplaces *(See Figure 11.2.5.1.)*

11.2.5.2 Spaces between headers or trimmers of combustible material and masonry fireplaces shall be firestopped with one of the following noncombustible materials:

(1) Galvanized steel not less than 26 gauge [0.019 in. (0.483 mm)] in thickness
(2) Noncombustible sheet material not more than ½ in. (12.7 mm) thick

11.2.5.3 Woodwork, such as wood trim, mantels, and other combustible material, shall not be placed within 6 in. (152 mm) of a fireplace opening.

11.2.5.4 Combustible material above and projecting more than 1½ in. (38 mm) from a fireplace opening shall not be placed less than 12 in. (305 mm) from the top of the fireplace opening. *(See Figure 11.2.5.4.)*

11.2.6 Accessibility. For cleaning purposes, means shall be provided for access to the venting area above and immediately behind any movable damper valve plate in masonry fireplaces and steel fireplace units by one of the following methods:

(1) A damper plate that can be removed with common hand tools
(2) A cleanout opening located to provide access to the smoke chamber area

11.2.7 Cleanout Openings. Cleanout openings shall be equipped with ferrous metal, stainless steel, precast cement, or other approved noncombustible doors and frames arranged to remain tightly closed and secured when not in use.

11.2.8 Ash Dumps. Cleanouts, if provided, shall be accessible and located so that ash removal will not create a hazard to combustible materials.

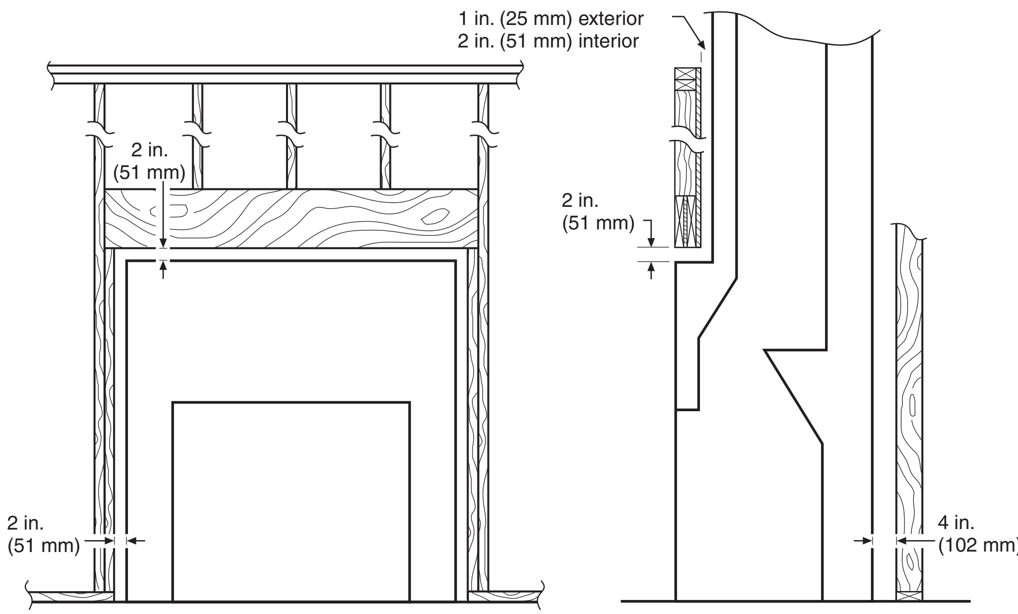


FIGURE 11.2.5.1 Fireplace Clearance to Combustible Material.

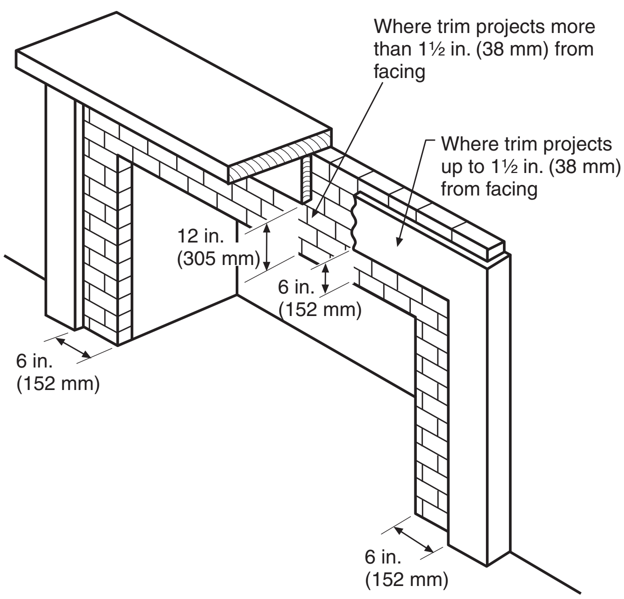


FIGURE 11.2.5.4 Fireplace Clearance to Combustible Material.

11.2.9 Dampers.

11.2.9.1 Masonry fireplaces shall be equipped with a ferrous metal damper located at least 8 in. (203 mm) above the top of the fireplace opening.

11.2.9.2 Dampers shall be installed in the fireplace or at the top of the flue venting the fireplace and shall be operable from the room containing the fireplace.

11.2.9.3 A nonferrous metal damper shall be permitted to be installed at the top of the flue specified in 11.2.9.2.

11.2.9.4 Damper controls shall be permitted to be located in the fireplace.

11.2.10* Masonry Fireplace Accessories. Fireplace accessories shall be one of the following:

(1) Installed by a qualified agency
(2) Listed and installed in accordance with the terms of their listing
(3) Installed in accordance with the accessory manufacturer's installation instructions

11.3 Hearth Extensions.

11.3.1 Masonry fireplaces shall have hearth extensions of brick, concrete, stone, tile, or other approved noncombustible material wholly supported by and integral with the chimney structure, and a minimum 4 in. (102 mm) clearance shall be maintained directly below the underside.

11.3.1.1 Support for the hearth shall be provided by a structural slab or corbeled brickwork.

11.3.1.2 Wooden forms used during the construction of the hearth and hearth extension shall be removed when the construction is completed.

11.3.2 The minimum thickness of the hearth extension shall be 2 in. (51 mm).

11.3.3 Where the fireplace opening is less than 6 ft^2 (0.56 m^2), the hearth extension shall extend as follows:

(1) At least 16 in. (406 mm) in front of the facing material
(2) At least 8 in. (203 mm) beyond each side of the fireplace opening *(See Figure 11.3.3.)*

11.3.4 Where the fireplace opening is 6 ft^2 (0.56 m^2) or larger, the hearth extension shall extend as follows:

(1) At least 20 in. (508 mm) in front of the facing material
(2) At least 12 in. (305 mm) beyond each side of the fireplace opening *(See Figure 11.3.3.)*

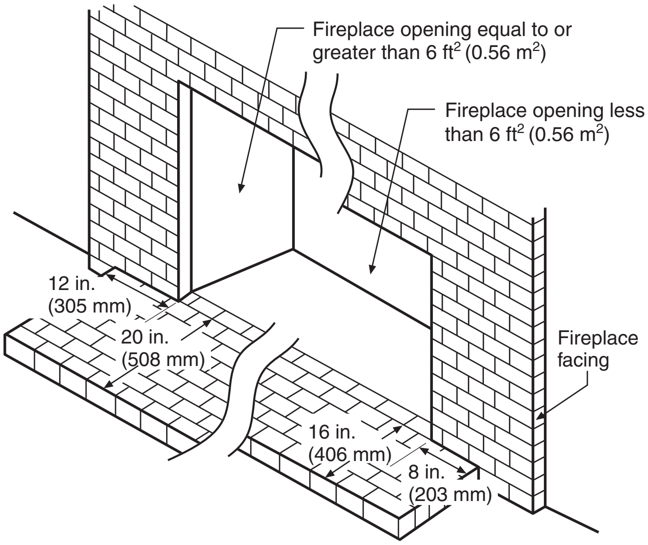


FIGURE 11.3.3 Fireplace Hearth Extension Requirements.

11.3.5 Where a fireplace is elevated above or overhangs a floor, the hearth extension also shall extend over the area under the fireplace.

11.4 Combustion Air Ducts.

11.4.1 Where installed, combustion air ducts shall be installed in accordance with this section.

11.4.1.1 Combustion air ducts for factory-built fireplaces shall be a listed component of the fireplace and installed according to the manufacturer's instructions.

11.4.1.2 Listed combustion air duct systems for masonry fireplaces shall be installed according to the terms of their listing and the manufacturers' instructions.

11.4.2 Combustion air ducts shall extend as directly as practicable from the outdoors (inlet) to a termination outside the fire chamber (outlet).

11.4.3 Combustion air ducts shall be constructed of one of the following:

(1) Masonry
(2) Galvanized steel with a thickness not less than 26 gauge [0.019 in. (0.483 mm)]
(3) Other approved noncombustible material

11.4.4 Combustion air ducts shall be equipped with a damper that is capable of being fully closed.

11.4.5 Combustion air ducts that terminate outside the fire chamber but within 6 in. (152 mm) of the fire chamber shall be designed and installed to prevent the direct entry of flame, embers, or ashes from the fire chamber into the duct.

11.4.6 Unlisted combustion air ducts shall be installed with a minimum 1 in. (25 mm) clearance to combustibles for all parts of the duct construction within 5 ft (1.53 m) of the duct outlet.

11.4.7 The exterior inlet of the combustion air duct shall be screened.

11.4.8 Combustion air ducts shall not originate in any of the following:

(1) Attic
(2) Basement
(3) Garage
(4) Other interior space

Chapter 12 Masonry Heaters

12.1 Listed Masonry Heaters. Listed masonry heaters shall be installed in accordance with the manufacturer's installation instructions.

12.2 Unlisted Masonry Heaters. Unlisted masonry heaters shall be constructed in accordance with ASTM E1602, *Standard Guide for Construction of Solid Fuel Burning Masonry Heaters.*

12.3 Clearances to Combustibles.

12.3.1 Listed masonry heaters shall be installed with clearances according to their listing.

12.3.2 Unlisted masonry heaters shall be installed with clearances in accordance with ASTM E1602, *Standard Guide for Construction of Solid Fuel Burning Masonry Heaters.*

Chapter 13 Solid Fuel–Burning Appliances

13.1 Appliances. Solid fuel–burning appliances shall be one of the following:

(1) Listed and installed in accordance with the terms of their listing and this chapter
(2) Approved by the AHJ

13.1.1 Unlisted appliances approved by the AHJ shall be installed as follows:

(1) In accordance with the manufacturer's instructions
(2) As specified in this chapter

13.1.2 The requirements in 13.1.1 shall not apply to mobile home installations.

13.2 Location of Appliances.

13.2.1* Every appliance shall be located with respect to building construction and other equipment to allow access to the appliance.

13.2.2 Solid fuel–burning appliances shall not be installed in alcoves or enclosed spaces less than 512 ft^3 (14.5 m^3) unless specifically listed for such use.

13.2.2.1 Solid fuel–burning appliances listed for installation in enclosed spaces or alcoves less than 512 ft^3 (14.5 m^3) shall be installed in accordance with the requirements of the listing and the manufacturer's instructions.

13.2.2.2 The space or room shall be sized to allow circulation of heated air.

13.2.2.3 Appliances shall be so located as not to interfere with the circulation of air within the heated space.

13.2.3 Solid fuel–burning appliances shall not be installed in any location where gasoline or any other flammable vapors or gases are present.

13.2.4 Solid fuel–burning appliances shall not be installed in any garage.

13.3 Air for Combustion and Ventilation.

13.3.1 Solid fuel–burning appliances shall be installed in a location and manner so as to provide ventilation and combustion air supply to allow proper combustion of fuel, chimney draft, and maintenance of safe temperatures.

13.3.2 Where buildings are so tight that normal infiltration does not provide the necessary air, outside air shall be introduced.

13.4 Chimney Connections and Usage.

13.4.1 Chimney Connection. All solid fuel–burning appliances shall be connected to chimneys in accordance with Chapter 9.

13.4.1.1 The chimney provided shall be in accordance with Table 5.2.2.1.

13.4.1.2 Galvanized steel pipe shall not be used for solid fuel–burning appliances.

13.4.2 Clearance. The clearance of chimney connectors to combustible material shall be in accordance with Table 9.5.1.1.

13.4.3 Inspection and Cleaning Access. Connectors and chimneys for solid fuel–burning appliances shall be designed, located, and installed to allow access for internal inspection and cleaning.

13.4.4* Flue Cross-Sectional Area. For residential-type, natural draft solid fuel–burning appliances, the flue shall meet the following conditions:

(1) The cross-sectional area of the flue shall not be less than the cross-sectional area of the appliance flue collar, unless specified by the appliance manufacturer.
(2) The cross-sectional area of the flue of a chimney with no walls exposed to the outside below the roofline shall not be more than three times the cross-sectional area of the appliance flue collar.
(3) The cross-sectional area of the flue of a chimney with one or more walls exposed to the outside below the roofline shall not be more than two times the cross-sectional area of the appliance flue collar.

13.4.5 Connection to Masonry Fireplaces.

13.4.5.1 A natural draft solid fuel–burning appliance such as a stove or insert shall be permitted to use a masonry fireplace flue where the following conditions are met:

(1) There is a connector that extends from the appliance to the flue liner.
(2) Any unexposed metal that is used as a connector and is exposed to flue gases is constructed of stainless steel or other equivalent material that resists corrosion, softening, or cracking from flue gases at temperatures up to 1800°F (982°C).
(3) The cross-sectional area of the flue is no smaller than the cross-sectional area of the flue collar of the appliance, unless otherwise specified by the appliance manufacturer.
(4)* The cross-sectional area of the flue of a chimney with no walls exposed to the outside below the roofline is no more than three times the cross-sectional area of the appliance flue collar.
(5) The cross-sectional area of the flue of a chimney with one or more walls exposed to the outside below the roofline is no more than two times the cross-sectional area of the appliance flue collar.
(6) If the appliance vents directly through the chimney wall above the smoke chamber, there is a noncombustible seal below the entry point of the connector.
(7) The installation is such that the chimney system can be inspected and cleaned.
(8) Means are provided to prevent dilution of combustion products in the chimney flue with air from the habitable space.

13.4.5.2 Listed fireplace accessories shall be permitted to use a masonry fireplace flue in accordance with their listing.

13.4.6 Existing Flue Use. Another solid fuel–burning appliance shall not be installed using an existing flue serving a factory-built fireplace unless the appliance is specifically listed for such installation.

13.5 Installation of Residential-Type Appliances

13.5.1 General Requirements.

13.5.1.1 Residential-type solid fuel–burning appliances that are tested and listed by a recognized testing laboratory for installation on floors constructed of combustible materials shall be placed on floors in accordance with the requirements of the listing and the conditions of approval.

13.5.1.2 Appliances that are not listed by a recognized testing laboratory shall be provided with floor protection in accordance with the provisions of 13.5.2 or 13.5.3.

13.5.1.3 Residential-type solid fuel–burning appliances shall be permitted to be placed without floor protection in any of the following manners:

(1) On concrete bases adequately supported on compacted soil, crushed rock, or gravel
(2) On concrete slabs or masonry arches that do not have combustible materials attached to the underside
(3) On approved assemblies constructed of only noncombustible materials and having a fire resistance rating of not less than 2 hours, with floors constructed of noncombustible material
(4) On properly stabilized ground that can support the load of the appliance

13.5.1.4 Any floor assembly, slab, or arch shall extend not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.1.5 In lieu of the requirements for floor protection specified herein, a floor protector listed by a recognized testing laboratory and installed in accordance with the installation instructions shall be permitted to be employed.

13.5.1.6 Concrete bases, concrete slabs, masonry arches, and floor–ceiling assemblies and their supports shall be designed and constructed to support the appliances.

13.5.2 Room Heaters, Fireplace Stoves, Room Heater/Fireplace Stove Combinations, and Ranges.

13.5.2.1 Room heaters, fireplace stoves, room heater/fireplace stove combinations, or ranges that are set on legs or pedestals that provide not less than 6 in. (152 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the following conditions exist:

(1) The floor under the appliance is protected with closely spaced solid masonry units not less than 2 in. (51 mm) in thickness.
(2) The top surface of the masonry is covered with sheet metal not less than 24 gauge [0.024 in. (0.61 mm)].
(3) The floor protection extends not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.2.2 Room heaters, fireplace stoves, room heater/fireplace stove combinations, or ranges that are set on legs or pedestals providing 2 in. to 6 in. (51 mm to 152 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the following conditions exist:

(1) The floor under the appliance is protected with one course of hollow masonry units not less than 4 in. (102 mm) in nominal thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with sheet metal not less than 24 gauge [0.024 in. (0.61 mm)].
(4) The floor protection extends not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.2.3 Room heaters, fireplace stoves, room heater/fireplace stove combinations, or ranges with legs or pedestals that provide less than 2 in. (51 mm) of ventilated open space beneath the fire chamber or base of the appliance shall not be placed on floors of combustible construction.

13.5.3 Furnaces and Boilers.

13.5.3.1 Furnaces or boilers with legs or pedestals that provide not less than 6 in. (152 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the floor under the appliance has the following characteristics:

(1) It is protected with one course of hollow masonry units not less than 4 in. (102 mm) in thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with a steel plate not less than $\frac{3}{16}$ in. (4.8 mm) in thickness.
(4) The floor protection extends not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.3.2 Furnaces or boilers that are set on legs or pedestals that provide 2 in. to 6 in. (51 mm to 152 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the floor under the appliance has the following characteristics:

(1) It is protected with two courses of hollow masonry units, each not less than 4 in. (102 mm) in thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with a steel plate not less than $\frac{3}{16}$ in. (4.8 mm) in thickness.
(4) The floor protection extends not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.3.3 Furnaces or boilers with legs or pedestals that provide less than 2 in. (51 mm) of ventilated open space beneath the fire chamber or base of the appliance shall not be placed on floors of combustible construction.

13.5.4 Installation of Low-Heat Nonresidential Appliances.

13.5.4.1 Low-heat nonresidential solid fuel–burning appliances that have been tested and listed by a recognized testing laboratory for placement on floors constructed with a combustible material shall be placed on floors in accordance with the requirements of the listing and conditions of approval.

13.5.4.1.1 Appliances that are not listed by a recognized testing laboratory shall be provided with floor protection in accordance with the provisions of 13.5.4.3 or 13.5.4.4.

13.5.4.1.2 Low-heat nonresidential solid fuel–burning appliances shall be permitted to be placed without floor protection in any of the following manners:

(1) On floors constructed of noncombustible materials that have a fire resistance rating of not less than 2 hours and that extend not less than 18 in. (457 mm) beyond the appliance on all sides
(2) On concrete bases adequately supported on compacted soil, crushed rock, or gravel
(3) On properly stabilized ground that can support the load of the appliance

13.5.4.2 Concrete bases, concrete slabs, and floors shall be designed and constructed to support the appliances.

13.5.4.3 Low-heat nonresidential solid fuel–burning appliances that are set on legs or pedestals that provide not less than 18 in. (457 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the following conditions exist:

(1) The floor under the appliance is protected with one course of hollow masonry units not less than 4 in. (102 mm) in thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with a steel plate not less than $\frac{3}{16}$ in. (4.8 mm) in thickness.
(4) The floor protection extends not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.4.4 Low-heat nonresidential solid fuel–burning appliances that are set on legs or pedestals that provide 6 in. to 18 in. (152 mm to 457 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the following conditions exist:

(1) The floor under the appliance is protected with two courses of hollow masonry units, each not less than 4 in. (102 mm) in thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with a steel plate not less than $\frac{3}{16}$ in. (4.8 mm) in thickness.
(4) The floor protection extends not less than 18 in. (457 mm) beyond the appliance on all sides.

13.5.4.5 Low-heat nonresidential solid fuel–burning appliances with legs or pedestals that provide less than 6 in. (152 mm) of ventilated open space beneath the fire chamber or base of the appliance shall not be placed on floors of combustible construction.

13.5.5 Installation of Medium-Heat Nonresidential Appliances.

13.5.5.1 Medium-heat nonresidential solid fuel–burning appliances that have been tested and listed by a recognized testing laboratory for placement on floors constructed with a combustible material shall be placed on floors in accordance with the requirements of the listing and conditions of approval.

13.5.5.1.1 Appliances that are not listed by a recognized testing laboratory shall be provided with floor protection in accordance with the provisions of 13.5.5.3 or 13.5.5.4.

13.5.5.1.2 Medium-heat nonresidential solid fuel–burning appliances shall be permitted to be placed without floor protection in any of the following manners:

(1) On concrete bases adequately supported on compacted soil, crushed rock, or gravel
(2) On floors constructed of noncombustible materials that have a fire resistance rating of not less than 2 hours and that extend not less than 3 ft (0.92 m) beyond the appliance on all sides and 8 ft (2.45 m) beyond the front or side where ashes are removed
(3) On properly stabilized ground that can support the load of the appliance

13.5.5.2 Concrete bases, concrete slabs, and floors shall be designed and constructed to support the appliances.

13.5.5.3 Medium-heat nonresidential solid fuel–burning appliances that are set on legs or pedestals that provide not less than 24 in. (610 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the floor under the appliance has the following characteristics:

(1) It is protected with one course of hollow masonry units not less than 4 in. (102 mm) in thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with a steel plate not less than $\frac{3}{16}$ in. (4.8 mm) in thickness.
(4) The floor protection extends not less than 3 ft (0.92 m) beyond the appliance on all sides and 8 ft (2.45 m) beyond the front or side where ashes are removed.

13.5.5.4 Medium-heat nonresidential solid fuel–burning appliances that are set on legs or pedestals that provide 18 in. to 24 in. (457 mm to 610 mm) of ventilated open space beneath the fire chamber or base of the appliance shall be permitted to be placed on floors of combustible construction, provided the floor under the appliance has the following characteristics:

(1) It is protected with two courses of hollow masonry units, each not less than 4 in. (102 mm) in thickness.
(2) The masonry units are laid with ends unsealed and joints matched in such a way as to provide free circulation of air through the core spaces of the masonry.
(3) The top surface of the masonry is covered with a steel plate not less than $\frac{3}{16}$ in. (4.8 mm) in thickness.
(4) The floor protection extends not less than 3 ft (0.92 m) beyond the appliance on all sides and 8 ft (2.45 m) beyond the front or side where ashes are removed.

13.5.5.5 Medium-heat nonresidential solid fuel–burning appliances with legs or pedestals that provide less than 18 in. (457 mm) of ventilated open space beneath the fire chamber or base of the appliance shall not be placed on floors of combustible construction.

13.5.6 Installation of High-Heat Nonresidential Appliances.

13.5.6.1 High-heat nonresidential solid fuel–burning appliances shall be placed in one of the following manners:

(1) On concrete bases adequately supported on compacted soil, crushed rock, or gravel
(2) On floors constructed of noncombustible materials that have a fire resistance rating of not less than 2 hours and that extend not less than 10 ft (3.1 m) beyond the appliance on all sides and not less than 30 ft (9.2 m) beyond the front or side where hot products are removed
(3) On properly stabilized ground that can support the load of the appliance

13.5.6.2 Concrete bases and floors shall be designed and constructed to support the appliances.

13.5.6.3 High-heat nonresidential solid fuel–burning appliances shall not be placed on floors of combustible construction.

13.6 Clearances from Solid Fuel–Burning Appliances.

13.6.1 The clearance shall be not less than specified in Table 13.6.1.

13.6.1.1 Appliances listed for installation with clearances less than specified in Table 13.6.1 shall be permitted to be installed in accordance with the terms of their listing and the manufacturer's instructions.

13.6.1.2 Heating furnaces and boilers and water heaters specifically listed for installation in spaces such as alcoves shall be permitted to be so installed in accordance with the terms of their listing, provided the specified clearance is maintained regardless of whether the enclosure is of combustible or noncombustible material.

13.6.1.3 These clearances shall apply to appliances installed in rooms that are large in comparison with the size of the appliances.

13.6.2 Clearance Reduction.

13.6.2.1 Clearances from listed and unlisted solid fuel–burning appliances to combustible material shall be permitted to be reduced if the combustible material is protected as described in Table 13.6.2.1 and in Figure 13.6.2.1(a) through Figure 13.6.2.1(f).

13.6.2.2 Where the required clearance with no protection is 36 in. (914 mm), the clearances in Table 13.6.2.1 shall be the minimum allowable clearances. For other required clearances with no protection, minimum allowable clearance shall be calculated from maximum allowable reduction.

13.6.2.3 Unless the appliance is specifically listed for lesser clearance, the clearance after reduction shall be not less than the following:

(1) 12 in. (305 mm) to combustible walls
(2) 18 in. (457 mm) to combustible ceilings

13.6.2.4 Spacers and ties shall be of noncombustible material. No spacers or ties shall be used directly behind the appliance or the conductor.

Table 13.6.1 Standard Clearances for Solid Fuel–Burning Appliances

Type of Appliance	Above Top of Casing or Appliance; Above Top and Sides of Furnace Plenum or Bonnet		From Front		From Back[a]		From Sides[a]	
	in.	mm	in.	mm	in.	mm	in.	mm
Residential Appliances	6	152	48	1219	6[b]	152[b]	6[b]	152[b]
Steam boilers — 15 psi (103 kPa)								
Water boilers — 250°F (121°C) max.								
Water boilers — 200°F (93°C) max.								
All water walled or jacketed appliances								
Furnaces								
Gravity and forced air[c]	18	457	48	1219	18	457	18	457
Room Heaters, Fireplace Stoves,	36	914	36	914	36	914	36	914
Room Heater/Fireplace Stove Combinations,								
Ranges					**Firing Side**		**Opposite Side**	
Lined fire chamber	30[d]	762[d]	36	914	24	610	18	457
Unlined fire chamber	30[d]	762[d]	36	914	36	914	18	457

[a]Provisions for fuel storage must be located at least 36 in. (914 mm) from any side of the appliance.
[b]Adequate clearance for cleaning and maintenance must be provided.
[c]For clearances from air ducts, see NFPA 90B.
[d]Clearance to combustible material or metal cabinets. If the underside of such combustible material or metal cabinet is protected with sheet metal of not less than 24 gauge [0.024 in. (0.61 mm)], spaced out 1 in. (25 mm), the distance is permitted to be reduced to not less than 24 in. (610 mm).

13.6.2.5 With all clearance reduction systems using a ventilated air space, adequate air circulation shall be provided as described in 13.6.2.15. There shall be at least 1 in. (25 mm) between the clearance reduction system and combustible walls and ceilings for clearance reduction systems using a ventilated air space.

13.6.2.6 Mineral wool batts (blanket or board) shall have a minimum density of 8 lb/ft^3 (128.7 kg/m^3) and have a minimum melting point of 1500°F (816°C).

13.6.2.7 Insulation material used as part of a clearance reduction system shall have a thermal conductivity of 1.0 Btu-in./hr-ft^2-°F (0.14 W/m-K) or less. Insulation board shall be formed of noncombustible material.

13.6.2.8 If a single-wall connector passes through a masonry wall used as a wall shield, there shall be at least ½ in. (13 mm) of open, ventilated air space between the connector and the masonry.

13.6.2.9 There shall be at least 1 in. (25 mm) between the appliance and the protector. In no case shall the clearance between the appliance and the wall surface be reduced below that allowed in Table 13.6.2.1.

13.6.2.10 Clearances in front of the loading door, ash removal door, or both of the appliance shall not be reduced from those in Section 13.5.

13.6.2.11 Clearances from solid fuel–burning appliances to combustible material shall be permitted to be reduced, provided the combustible material is protected by an engineered protection system acceptable to the AHJ.

13.6.2.12 Engineered systems installed for the protection of combustible material shall reduce the temperature of such materials to 90°F (50°C) rise above ambient.

13.6.2.13 System design shall be based on applicable heat transfer principles, taking into account the following:

(1) The geometry of the system
(2) The heat loss characteristics of the structure behind the combustible material
(3) The possible abnormal operating conditions of the heat-producing sources

13.6.2.14 The following shall apply to clearances from solid fuel–burning appliances to combustible material:

(1) They shall be permitted to be reduced by the use of materials or products listed for protection purposes.
(2) Materials and products listed for the purpose of reducing clearance to combustibles shall be installed in accordance with the conditions of the listing and the manufacturer's instructions.

13.6.2.15 For clearance reduction systems using an air space between the combustible wall and the wall protector, adequate

Table 13.6.2.1 Reduction of Appliance Clearance with Specified Forms of Protection

Clearance Reduction Applied to and Covering All Combustible Surfaces Within the Distance Specified as Required Clearance with No Protection*	Maximum Allowable Reduction in Clearance (%)		Minimum Clearance			
			As Wall Protector		As Ceiling Protector	
	As Wall Protector	As Ceiling Protector	in.	mm	in.	mm
(a) 3½ in. (90 mm) thick masonry wall without ventilated air space	33	—	24	610	—	—
(b) ½ in. (13 mm) thick noncombustible insulation board over 1 in. (25 mm) glass fiber or mineral wool batts without ventilated air space	50	33	18	457	24	610
(c) 0.024 in. (0.61 mm), 24 gauge sheet metal over 1 in. (25 mm) glass fiber or mineral wool batts reinforced with wire or equivalent on rear face with ventilated air space	66	50	12	305	18	457
(d) 3½ in. (90 mm) thick masonry wall with ventilated air space	66	—	12	305	—	—
(e) 0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space	66	50	12	305	18	457
(f) ½ in. (13 mm) thick noncombustible insulation board with ventilated air space	66	50	12	305	18	457
(g) 0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space over 0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space	66	50	12	305	18	457
(h) 1 in. (25 mm) glass fiber or mineral wool batts sandwiched between two sheets 0.024 in. (0.61 mm), 24 gauge sheet metal with ventilated air space	66	50	12	305	18	457

Notes:

(1) All clearances and thicknesses are minimums; larger clearances and thicknesses are permitted.

(2) To calculate the minimum allowable clearance, the following formula can be used: $C_{pr} = C_{un} \times [1 - (R/100)]$, where C_{pr} is the minimum allowable clearance, C_{un} is the required clearance with no protection, and R is the maximum allowable reduction in clearance.

(3) Refer to Figure 13.6.2.1(e) and Figure 13.6.2.1(f) for other reduced clearances using materials found in this table.

*See 13.6.1 through 13.6.1.3.

air circulation shall be provided by one of the methods following and illustrated in Figure 13.6.2.15.

(1) Air circulation shall be permitted to be provided by leaving all edges of the wall protector open with at least a 1 in. (25 mm) air gap.
(2) If the wall protector is installed on a single flat wall away from corners, air circulation shall be permitted to be provided by leaving only the bottom and top edges or only the side and top edges open with at least a 1 in. (25 mm) air gap.
(3) Wall protectors that cover two walls in a corner shall be open at the bottom and top edges with at least a 1 in. (25 mm) air gap.

13.6.2.16 All clearances shall be measured from the outer surface of the combustible material to the nearest point on the surface of the solid fuel–burning appliance, disregarding any intervening protection applied to the combustible material.

13.6.2.17 All clearances provided between solid fuel–burning appliances and combustible materials shall be large enough to maintain sufficient clearances between chimney connectors and combustible material as required in Section 9.5.

13.7 Accessories.

13.7.1 Factory-built accessories for solid fuel–burning appliances such as heat exchangers, stove mats, floor pads, and protection shields shall be listed and shall be installed in accordance with the terms of their listing.

13.7.2 Unlisted accessories that are acceptable to the AHJ shall be permitted to be installed in accordance with the approval of the AHJ and the appliance and accessory manufacturers' installation instructions.

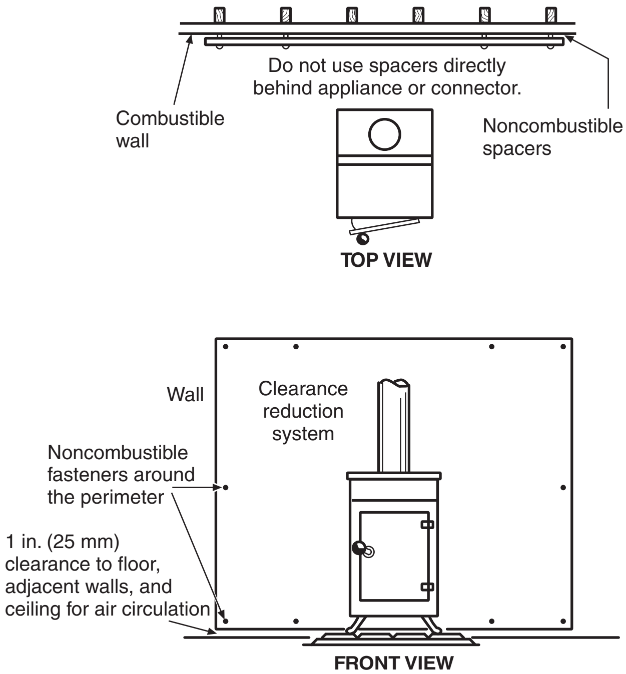


FIGURE 13.6.2.1(a) Clearance Reduction System — Fastener Location.

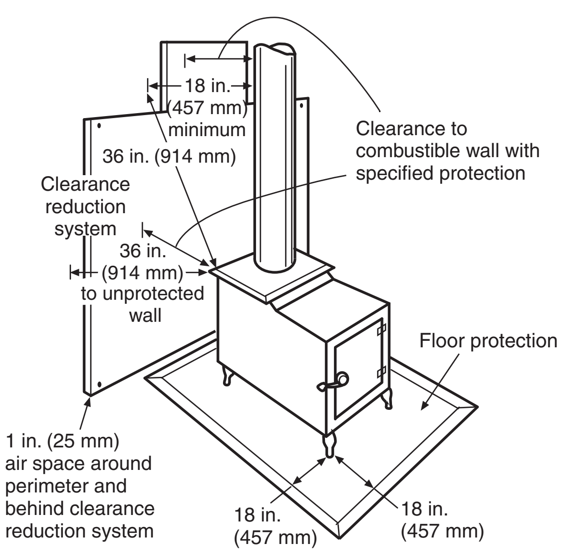


FIGURE 13.6.2.1(b) Distance to Combustible Wall/Floor.

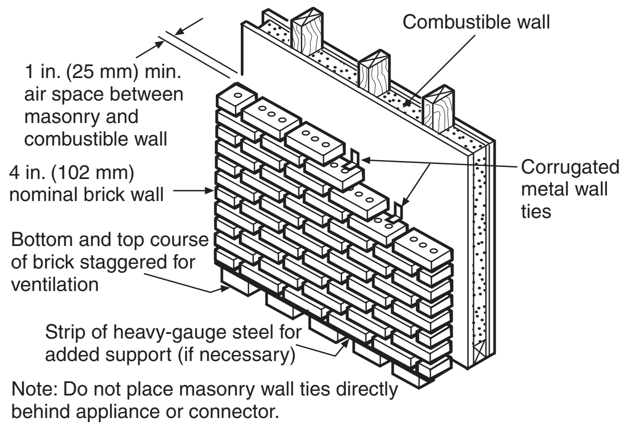
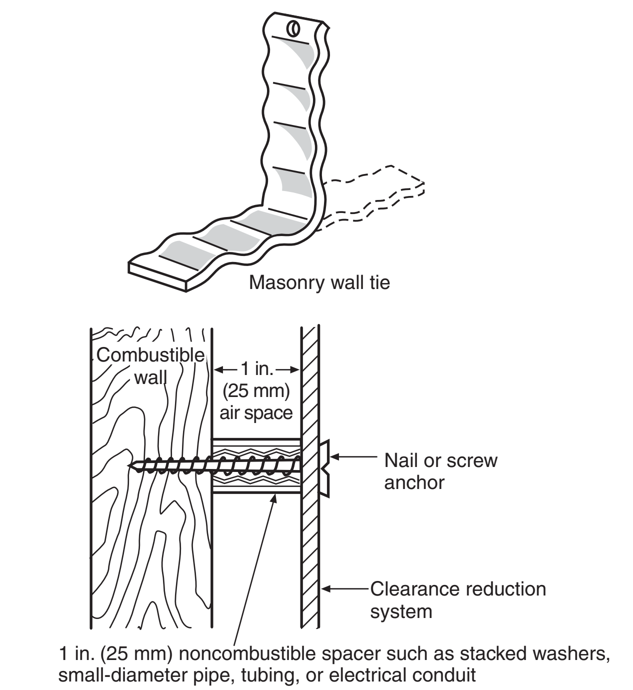


FIGURE 13.6.2.1(c) Masonry Clearance Reduction System.

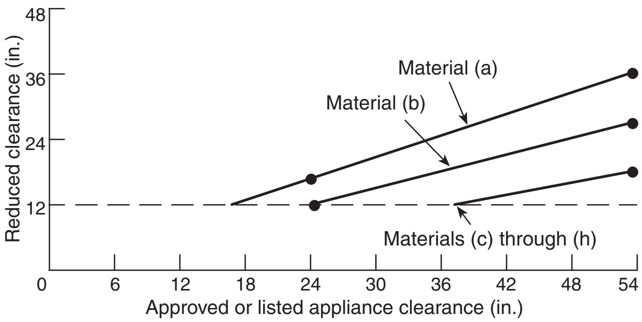


Notes:

(1) Masonry walls can be attached to combustible walls using wall ties.

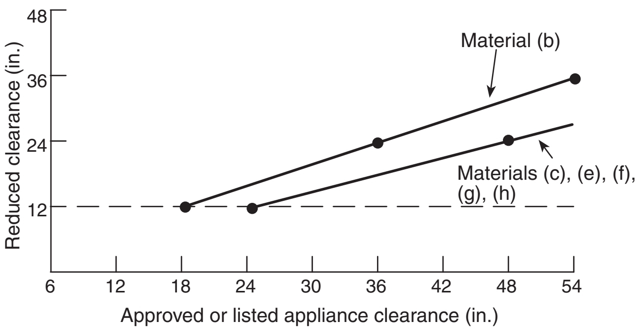
(2) Do not use spacers directly behind appliance or connector.

FIGURE 13.6.2.1(d) Fastener Detail.



For SI units: 1 in. = 25.4 mm.

FIGURE 13.6.2.1(e) Wall Protection Using Materials in Table 13.6.2.1.



Notes:

(1) Materials (a) and (d) are not expected to be used as ceiling protection.

(2) For SI units: 1 in. = 25.4 mm.

FIGURE 13.6.2.1(f) Ceiling Protection Using Materials in Table 13.6.2.1.

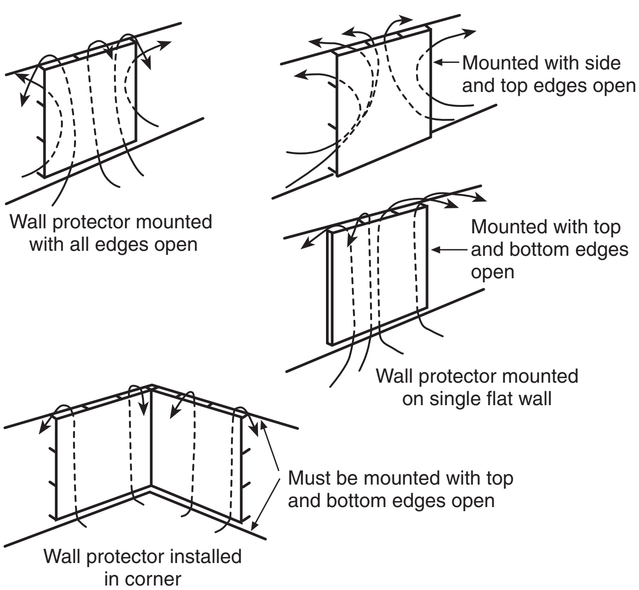


FIGURE 13.6.2.15 Air Circulation Methods.

Chapter 14 Maintenance

14.1 Initial Installation. Initial installation of chimneys, fireplaces, and vents shall allow inspection of the surroundings to determine that the required clearances have been maintained and that correct provisions for support, stabilization, future inspection, and maintenance are in place.

14.2 Annual Inspection. Chimneys, fireplaces, and vents shall be inspected at least once a year in accordance with the requirements of Section 15.2.

Exception: Type B and Type BW gas venting systems.

14.2.1 Cleaning, maintenance, and repairs shall be done if necessary.

14.3 Inspection — Connections. Connectors, spark arresters, cleanouts, and tee fittings for chimneys and for oil and pellet venting systems shall be inspected at least once a year for soundness and deposits.

Exception: Connectors for Type B gas venting systems.

14.4 Appliance or Connector Replacement.

14.4.1 When an existing appliance or connector is replaced or a new appliance is connected to a chimney, the chimney flue shall be inspected in accordance with Chapter 15.

14.4.2 The chimney shall be cleaned, lined or relined, or repaired as necessary.

14.5 Cleanout Doors. After any inspection or maintenance operation, cleanout doors and caps or plugs for cleanout tee fittings shall be closed tightly or secured in place.

14.6 Cleaning Methods. Cleaning of chimneys, if necessary, shall be done by methods that do not impair structural or thermal performance.

14.7 Evidence of Damage.

14.7.1 Chimneys, vents, and fireplaces shall be inspected, cleaned, and repaired if there is any evidence of damage to the chimney, fireplace, or vent or to the surroundings.

14.7.1.1 Factory-built chimney components or accessories shall be listed or approved for use with the specific model of factory-built chimney system if the components or accessories are available.

14.7.1.1.1 If original manufacturer's listed components or accessories are unavailable, components or accessories acceptable to and installed by a qualified agency shall be installed in accordance with the component or accessory manufacturer's installation instructions.

14.7.1.2 Factory-built fireplace components or accessories shall be listed or approved for use with the specific model of factory-built fireplace system if the components or accessories are available.

14.7.1.2.1 If original manufacturer's listed components or accessories are unavailable, components or accessories acceptable to and installed by a qualified agency shall be installed in accordance with the component or accessory manufacturer's installation instructions.

14.7.2 Inspections required by 14.7.1 shall comply with the requirements for a Level II inspection in accordance with Section 15.4.

14.8 Operating Malfunction. When inspection or an operating malfunction shows that an existing chimney, fireplace, or vent is damaged, unsuitable, or improperly sized, it shall be repaired, rebuilt, or resized to the construction and functional requirements of this standard.

14.9* Damaged or Deteriorated Liners. If the flue liner in a chimney has softened, cracked, or otherwise deteriorated so that it no longer has the continued ability to contain the products of combustion (i.e., heat, moisture, creosote, and flue gases), the liner shall be either removed and replaced, repaired, or relined with a listed liner system or other approved material that will resist corrosion, softening, or cracking from flue gases at temperatures appropriate to the class of chimney service. *(See Table 5.2.2.1.)*

14.10 Unused Openings. Unused openings in chimney flues and chimney walls shall be sealed by solid masonry with a minimum thickness equal to that of the chimney flue and wall thickness or with a listed sealing device.

Chapter 15 Inspection of Existing Chimneys

15.1* General. Inspections shall be conducted by a qualified agency.

15.1.1* Observations that are incidental to a chimney maintenance or repair task not shown in Table 15.2.1 shall not be required to comply with the minimum levels of inspection set forth in this chapter.

15.1.2 Defects that are observed during the course of such work shall be reported to the property owner, occupant, or responsible party.

15.2 Type of Inspection. The scope of the inspection, the areas of the chimney examined, and the degree of invasiveness of the inspection shall be appropriate for the conditions giving rise to the inspection.

15.2.1 The type of inspection shall be determined in accordance with Table 15.2.1.

15.2.2 The type of inspection performed shall be based on the circumstances that give rise to the inspection.

15.2.3 For situations shown in the Circumstances row of Table 15.2.1, the minimum level of inspection shall be that indicated by the column in which the situation is found.

15.2.4 For situations not shown in the Circumstances row, the type of inspection shall be based on the descriptions in the Indications row.

15.2.5 The following shall apply to examination of the chimney at a level higher than that indicated by Table 15.2.1:

(1) Nothing shall prevent the examination of all or part of the chimney at a higher level than the minimum indicated by Table 15.2.1.
(2) Partial examination of the chimney at a higher level shall not require that the entire inspection be conducted at that higher level.

15.3* Level I Inspections. A Level I inspection shall be utilized when verification of the suitability of the chimney or flue for continued service, under the same conditions and with the same or similar appliance or appliances, is needed.

15.3.1 Circumstances. A Level I inspection shall be conducted under the following circumstances:

(1) During annual inspections in accordance with Section 14.2
(2) During routine cleaning of a flue or flues within the chimney
(3) At the time of replacement of one or more connected appliances with an equal number of appliances of similar type, input rating, and efficiency, in accordance with Section 14.4
(4) At other times as indicated in Section 15.3

15.3.2 Scope and Access. Level I inspections shall include examination of readily accessible portions of the chimney and accessible portions of the connected appliance and chimney connection.

15.3.2.1 The following shall apply to the inspection of locations with panels, doors, or coverings:

(1) The chimney exterior and surroundings shall be inspected at locations that can be accessed without removal of panels, doors, or coverings.
(2) Where panels, doors, or coverings are opened as part of the performance of another task, such as chimney cleaning, such locations shall be examined as part of a Level I inspection.

15.3.2.2 Readily accessible areas of the chimney flue that can be observed through existing openings, such as a thimble, cleanout opening, or flue termination, shall be examined for the presence of a continuous flue liner, proper installation, and no damage or deterioration.

15.3.2.3 The following shall apply to inspection of flues:

(1) Where an inspection is conducted in accordance with Section 14.2, the inspection shall include all flues within the chimney and connected appliances.
(2) An inspection conducted during cleaning or appliance replacement shall include the flue or flues being cleaned and the appliance or appliances connected to each.

15.3.2.4 The inspection shall include verification that the flue or flues being inspected are free of combustible deposits and blockage or obstruction.

15.3.2.5 The connected appliance or appliances, their chimney connectors, and surroundings shall be examined for proper clearances, protection, damage or deterioration, and observable evidence of operating malfunction.

15.3.2.6 Chimney connector inspection shall meet the following criteria:

(1) Connectors shall be examined for proper support and fastening of joints, pitch, and securement to the chimney.
(2) Connectors shall be examined for damage, deterioration, internal blockage or obstruction, and freedom from combustible deposits.

15.3.2.7 Internal surfaces of fireplaces and smoke chambers shall be examined for damage and deterioration, combustible deposits, and evidence of operating malfunction.

Table 15.2.1 Selection of Inspection Type

	Inspection Types		
Criteria	**Level I**	**Level II**	**Level III**
Scope	Readily accessible areas of chimney, structure, and flue; lack of obstruction or combustible deposits in flue; basic appliance installation and connection	All subjects of a Level I inspection; proper construction and condition of accessible portions of the chimney structure and all enclosed flues; proper clearances from combustibles in accessible locations; size and suitability of flues for connected appliances	All subjects of Level I and Level II inspections; proper construction and condition of concealed portions of chimney structure and enclosed flues; proper clearances from combustibles
Degree of access required	Readily accessible portions of chimney exterior and interior; accessible portions of appliance and chimney connection	All accessible portions of the chimney exterior and interior, including areas within accessible attics, crawl spaces, and basements, and accessible portions of the appliance and chimney connection; includes inspection by video scanning or other means	External and internal portions of chimney structure, including concealed areas of the building or chimney; includes removal of components of building or chimney where necessary, but only as necessary to gain access to areas that are the subject of the inspection
Circumstances	Annual inspection as required by Section 14.2; during routine cleaning of chimney flue; upon direct replacement of connected appliance with one of similar type, input rating, and efficiency	Upon addition or removal of one or more connected appliances or replacement of appliance with one of dissimilar type, input rating, or efficiency; prior to relining or replacement of flue lining; upon sale or transfer of the property; after operating malfunction or external event likely to have caused damage to the chimney	Where necessary for the investigation of an incident that has caused damage to the chimney or building; where a hazard detected or suspected as the result of a Level I or II inspection cannot be fully evaluated without access to concealed areas
Indications	For verification of suitability of the chimney for continued service, under the same conditions and with the same appliance or appliances	For verification of suitability of the chimney for new or changed conditions of service; Level I inspection not sufficient to determine serviceability of the chimney	When construction of all or part of chimney is deemed critical to its renewed or continued use; required only for those areas that cannot be properly evaluated by a Level I or Level II inspection

Note: The inspection is not required when the last connected appliance is removed and chimney use is discontinued.

15.3.2.7.1 Fireplace inserts, stoves, or accessories shall be removed from the fireplace as necessary to permit such examination.

15.3.2.7.2 The means of connecting a fireplace insert or stove to the chimney flue shall be examined for compliance with 13.4.5.

15.3.2.7.3* Fireplace inserts, stoves, or accessories shall not be required to be removed when the venting system can be thoroughly cleaned without such removal.

15.4* Level II Inspections. A Level II inspection is indicated when verification of the suitability of the chimney for new or changed conditions of service is needed or when a Level I inspection is not sufficient to determine the serviceability of the chimney.

15.4.1 Circumstances. A Level II inspection shall be conducted under the following circumstances:

(1)* Upon addition or removal of one or more connected appliances or upon replacement of an appliance with one or more of dissimilar type, input rating, or efficiency, unless the last connected appliance is removed and chimney use will be discontinued
(2) Prior to relining of a flue or replacement of flue lining, in accordance with 7.1.10
(3) Upon sale or transfer of the property

(4) After a building or chimney fire, weather or seismic event, or other incident likely to have caused damage to the chimney
(5) At other times as indicated in Section 15.3

15.4.2 Scope and Access. Level II inspections shall include all accessible portions of the chimney exterior and interior, including the following:

(1) Areas within accessible attics, crawl spaces, and basements
(2) Accessible portions of the appliance and chimney connection

15.4.2.1 The inspection shall include examination of all areas covered in 15.3.2 for Level I inspections.

15.4.2.2 All areas of the chimney and its surroundings that can be accessed without the removal or destruction of permanently attached portions of the chimney or building structure shall be inspected, including examination of the following:

(1) Locations within attics
(2) Crawl spaces
(3) Basements that can be accessed through doors, hatches, or other openings that do not require removal of permanently attached parts of the building

15.4.2.3 The inspection shall include examination of accessible areas of all chimney flues and the internal surfaces of all flue liners incorporated within the chimney with video scanning equipment or other means used as necessary to observe those areas.

15.4.2.4 The inspection shall include verification of proper clearances from the chimney to combustibles at all locations that can be accessed as described in 15.3.2.2.

15.4.2.5 The inspection shall include evaluation of the proper type of flue lining material and flue sizing for the type and input rating of the connected appliances.

15.4.2.5.1 Sizing of flues for solid fuel–burning and pellet fuel–burning equipment shall be in accordance with this standard.

15.4.2.5.2 Sizing of flues for gas appliances shall be in accordance with NFPA 54.

15.4.2.5.3 Sizing of flues for liquid fuel appliances shall be in accordance with NFPA 31.

15.5* Level III Inspections. A Level III inspection shall be utilized for concealed areas.

15.5.1 Areas Required. A Level III inspection shall be required only for those areas suspected of malfunction or damage that cannot be properly evaluated by a Level I or Level II inspection.

15.5.2 Circumstances. A Level III inspection shall be conducted under the following circumstances:

(1) Where necessary for the investigation of a building or chimney fire, weather or seismic event, or other incident known to have caused damage to the chimney or building
(2) Where a hazard detected or suspected as the result of Level I or II inspection cannot be fully evaluated without access to concealed areas
(3) At other times as indicated in Section 15.5

15.5.3 Scope and Access. A Level III inspection shall include examination of concealed areas of the chimney suspected of damage or malfunction.

15.5.3.1 The inspection shall include examination of all areas covered in 15.3.2 for Level I inspections and in 15.4.2 for Level II inspections.

15.5.3.2 Examination of the chimney shall include concealed areas that can be accessed only by removal or destruction of permanently attached portions of the chimney or building structure, as necessary to determine compliance with this standard.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.1 Accessible (for Inspections). Access can be described as the capability of being reached for the purpose of inspection, maintenance, or repair. Access could first require the movement or removal of a panel, door, or other covering, the use of ladders, or the use of a common tool, such as a screwdriver or wrench. Access does not require any destructive actions to the building or property.

A.3.3.1.1 Readily Accessible (for Inspections). Readily accessible can be described as being quickly or easily reached for inspection, maintenance, or repair. Readily accessible would not require the use of tools for opening or removal of any panel, door, or other covering, nor would it require the use of ladders.

A.3.3.2.1 Factory-Built Fireplace Accessories. These accessories include, but are not limited to, such items as decorative shrouds, glass or screen door assemblies, grates, blowers, log lighters intended for the ignition of solid fuel, gas log decorative appliances, spark arrestors, and chimney caps.

A.3.3.2.2 Masonry Fireplace Accessories. These accessories include, but are not limited to, such items as heat exchangers, glass or screen door assemblies, grates, andirons, blowers, log lighters intended for the ignition of solid fuel, fire backs intended to reflect heat or reduce heat exposure, dampers, gas log decorative appliances, spark arrestors, chimney caps, and ash receptacle doors.

A.3.3.4.2 Direct Vent Appliance. Direct vent appliances are sometimes called sealed combustion system applicances.

A.3.3.29.1.3 Type HT Factory-Built, Residential-Type and/or Building Heating Appliance–Type Chimney. Chimneys designated as Type HT are listed for venting flue products not exceeding 1000°F (538°C) continuous. In addition, they comply with the 10-minute 2100°F (1149°C) temperature test requirements of ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*. Such test requirements were developed to simulate the effects of a chimney fire. Type HT chimneys are required on certain controlled-combustion solid fuel–burning appliances because such appliances are often associated with a higher likelihood of creosote buildup and associated occurrence of chimney fires.

A.3.3.51 Crown. Masonry chimney termination includes considerations of weather protection for the chimney and thermal expansion of the flue liner.

A chimney crown offers the advantages of extension beyond the sides of the chimney to direct water away from both the flue and the chimney. A properly sealed space between the liner and the crown to allow vertical movement of the flue should be a design feature of prefabricated or site-constructed masonry or metal crowns.

A site-applied wash or splay may require frequent maintenance to ensure that it remains impervious to water penetration. Because a splay or a wash does not extend out past the chimney, it allows water to run down the sides of a chimney, which can result in chimney deterioration. Care must be taken to provide for vertical movement of the flue liner as required in 7.2.13.4.

See Figure A.3.3.51.

A.3.3.56.1 Mechanical Draft. When a fan is located so as to push the flue gases through the chimney or vent, a forced mechanical draft is created. When a fan is located so as to pull the flue gases through the chimney or vent, an induced mechanical draft is created.

A.3.3.80 Gas Appliance Categories. For additional information on appliance categorization, see the appropriate Z21 and Z83 American National Standards.

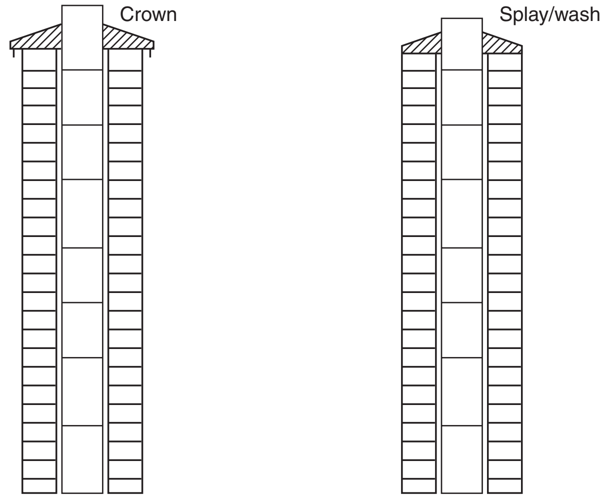


FIGURE A.3.3.51 Chimney Crown and Splay/Wash.

A.3.3.131.1 Engineered Venting or Chimney System. Approved engineering methods can include the following:

(1) The vent capacity tables in NFPA 54
(2) The fuel-burning equipment manufacturers' venting instructions
(3) Drawings, calculations, and specifications provided by the venting equipment manufacturer or a professional engineer
(4) Use of calculations from *ASHRAE Handbook: HVAC Systems and Equipment*, Chapter 31
(5) Application of the VENTII (version 4.1 or more current) computer program, developed under Gas Research Institute sponsorship for vent design and analysis
(6) The listed metal liner sizing and listed cast-in-place liner sizing tables in NFPA 31

A.3.3.142 Vent. Type B gas vents are tested with flue gases at 400°F (204°C) above ambient. Type BW gas vents are tested with flue gases at 480°F (249°C) above ambient and are limited to use only with certain gas-fired wall furnaces. Special Gas Vents may be certified at a variety of flue gas temperature rises up to 480°F (249°C) above ambient. Pellet vents are tested with flue gases at 500°F (260°C) above ambient. Type L vents are tested with flue gases at 500°F (260°C) above ambient.

A.4.1 See 3.3.131.1.

A.4.1.2.5(3) Documents that provide listing requirements include ANSI/UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Alarms*, and IAS 6-96, *IAS-US Requirements for Carbon Monoxide Alarms for Residential Use*. Additionally, NFPA 720 provides guidance for the installation of carbon monoxide warning equipment.

A.6.1.3.2 See 3.3.131.1.

A.6.1.4.1 Duct wrap systems, such as those listed to ASTM E2336, *Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems*, are generally used with commercial kitchen vent systems and are not appropriate for preventing heat transfer from the chimney to nearby combustibles. In addition, factory-built chimneys are listed products that have not been tested in conjunction with duct wrap. Therefore, there is no way of determining if the duct wrap/chimney combination will provide the necessary fire resistance. If duct wrap is used within a rated enclosure, it should be properly secured and should not violate the chimney air space requirements.

A.6.3 See 3.3.131.1.

A.7.1.11 See 3.3.131.1.

A.7.1.12 Many residential appliances, including pellet stoves, Category I gas appliances, and most residential oil-fired appliances, do not create sustained positive pressure inside masonry chimneys even though they are equipped with combustion blowers.

A.7.3.1.3 However, this does not eliminate the firestopping requirements in 7.1.6.

A.8.1.8 See 3.3.131.1.

A.9.3.1(3) See 3.3.131.1.

A.9.5.2 The system design should be based on applicable heat transfer principles, taking into account the geometry of the system, the heat loss characteristics of the structure behind the combustible material, and the possible abnormal operating conditions of heat-producing sources.

A.9.7.8 Listed equipment includes components such as heat reclaimers, draft regulators, and safety controls.

A.9.11 For information concerning the use and installation of draft regulators with oil-burning appliances, see NFPA 31.

A.10.1.4 ANSI/UL 1738, *Standard for Venting Systems for Gas-Burning Appliances, Categories II, III, IV*, covers the construction of special gas vents.

A.10.6 Additional requirements for the installation of venting systems serving gas appliances appear in NFPA 54.

A.10.7.2.1 For information on ventilation of restaurant cooking equipment, see NFPA 96.

A.11.2 See Figure A.11.2(a) and Figure A.11.2(b).

A.11.2.10 Factory-built accessories for fireplaces include devices that could alter the combustion or heating characteristics of the fireplace. These products should meet the requirements of ANSI/UL 907, *Fireplace Accessories*; ANSI Z21.11.2, *Gas-Fired Room Heaters — Volume II, Unvented Room Heaters*; Z21.60/CSA 2.26, *Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces*; or ANSI Z21.84, *Manually Lighted, Natural Gas, Decorative Gas Appliances for Installation in Solid-Fuel Burning Appliances*.

In developing the 2013 edition, the committee received reports that some building and energy codes indicate that gasketed or tight-fitting doors should be used on masonry fireplaces to minimize heat loss through the fireplace opening when not in operation. Many existing masonry fireplaces were not designed to be operated with such doors in the closed position. Operation with closed gasketed or tight-fitting doors has the risk of causing an increase in temperature of the masonry material. If operation continues for an extended period, the masonry material could be capable of transferring enough heat to ignite nearby combustibles, even if the minimum separation distance specified in 11.2.5 is provided. In addition, operation of a masonry fireplace with gasketed or tight-fitting doors in the closed position can result in incomplete combustion.

A.13.2.1 Sufficient clearance should be maintained to allow cleaning of surfaces; the replacement of air filters, blowers, motors, controls, and chimney connectors; the lubrication and servicing of moving parts; and the adjustment and servicing of stokers, if provided.

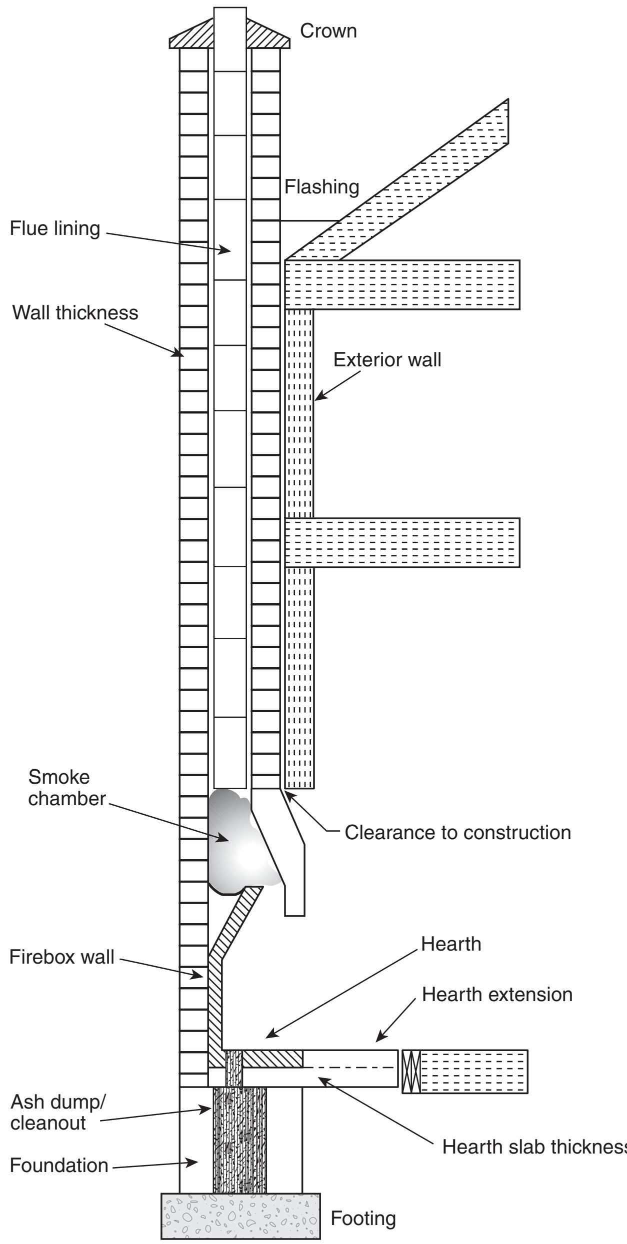


FIGURE A.11.2(a) Fireplace and Chimney Details.

A.13.4.4 Some appliances could perform incorrectly with the "three times" rule. In some cases, smaller cross-sectional areas could be needed to ensure proper performance. The appliance manufacturer's instructions should be consulted for each installation. Natural draft residential-type appliances are designed with a combustion system that relies on natural draft created within the appliance or by the venting system to maintain the combustion process.

A.13.4.5.1(4) Some appliances could perform incorrectly with the "three times" rule. In some cases, smaller cross-sectional areas could be needed to ensure proper performance. The

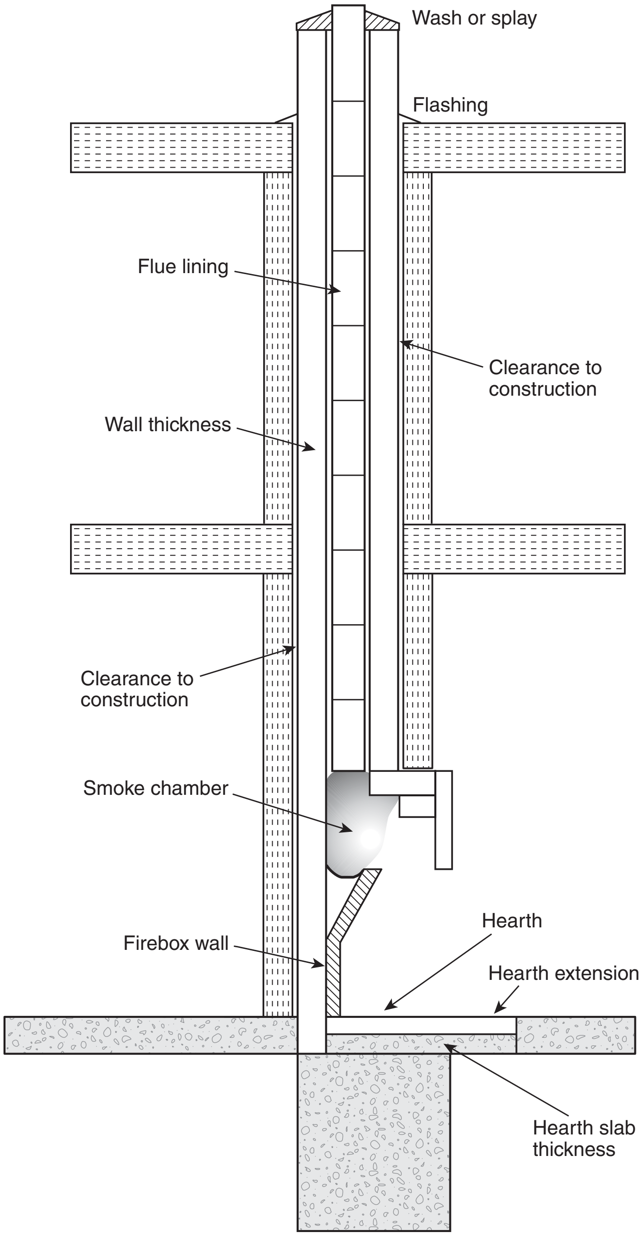


FIGURE A.11.2(b) Interior Block Chimney.

appliance manufacturer's instructions should be consulted for each installation.

A.14.9 Deterioration of the interior surface of a liner that results in softening or corrosion of liner materials (e.g., powdering or crumbling of liner materials or attack on metal surfaces resulting in perforation) indicates an inability of the liner to continue to perform its intended function.

Damage to liners that is from either structural or thermal causes and results in cracks that would allow moisture to penetrate the liner or would preclude the liner from containing flames or the products of combustion, or both, indicates an inability of the liner to continue to perform its intended function.

A.15.1 This chapter covers the inspection of chimneys and is intended primarily for the inspection of residential chimneys, but at the discretion of the inspector, it could apply to industrial or commercial chimneys serving certain appliances.

There are different types of inspections, ranging from superficial observation to an in-depth inspection in which portions of the chimney or building structure are removed, or other destructive methods are used to check hidden portions of a system. Inspections can be triggered by many circumstances, ranging from routine maintenance activities to a complete re-evaluation following a destructive event such as an earthquake. This chapter is intended to delineate, as precisely as possible, the inspection activities appropriate for different circumstances. The application of these requirements to specific situations requires judgment on the part of the inspector and should be in accordance with the Indications row of Table 15.2.1.

Although this chapter is concerned with the inspection of chimneys, the chimney cannot be considered apart from the appliance connected to it. Any defects or potential hazards encountered during such work should not be ignored and should be brought to the attention of the owner, occupant, or responsible party.

A.15.1.1 Certain minor tasks, such as installation of a chimney cap or flashing repair, are so limited in scope that they do not trigger a full inspection of the chimney. However, any defects or potential hazards encountered during such work should not be ignored and should be brought to the attention of the responsible party.

A.15.3 A Level I inspection is required to ensure the minimum acceptable levels of safety for a chimney. Unless otherwise stated, a Level I inspection is limited to readily accessible areas. The following list indicates some of the items to be included in a Level I inspection, to the extent that they are readily accessible and included in the installation being inspected. The following list should not be considered all-inclusive:

(1) Level of cleanliness of venting system
(2) Verification that the flue is not blocked or significantly restricted or obstructed
(3) Appliance clearance
(4) General condition of appliance
(5) Chimney or vent and its connector for general suitability for appliance
(6) Chimney or vent and its connector for type, material, and condition
(7) Chimney or vent and its connector clearance
(8) Chimney or vent and its connector joint security
(9) Chimney or vent and its connector for support and stability
(10) Chimney or vent and its connector for offset, rise, or slope
(11) Chimney connector or vent connector accessories (barometric damper, damper, draft hood, heat reclaimer)
(12) Chimney liner for proper support
(13) Appropriateness of the chimney liner type for appliance
(14) That the chimney liner is present and free of readily visible defects, distortion, and spalling
(15) That flue cleanouts are present and properly installed
(16) Condition of wash when readily accessible
(17) That the chimney cap, if present, does not contribute to flue blockage/restriction
(18) That the spark arrester, if present, is not obstructed

(19) That the top installed damper, if present, does not obstruct the flue
(20) Wall pass-through general condition
(21) That the connector is secure where it meets the wall pass-through, chimney, or vent
(22) General condition of hearth and hearth extension
(23) Hearth extension sizing
(24) General condition of the hearth extension, fireplace facing, fire chamber, and smoke chamber, with special emphasis on tight-fitting joints between assemblies
(25) Type and condition of fire chamber lining
(26) Clearance to combustible trim and mantels around fireplace opening
(27) Operation and closure of damper assembly
(28) Smoke chamber general condition
(29) Smoke chamber accessibility
(30) Smoke chamber transition to flue
(31) That air circulation grilles (openings) around factory-built fireplace are not blocked or restricted
(32) Freedom from rust or corrosion of readily accessible metal parts in factory-built fireplaces and chimneys
(33) That mechanical draft systems are operable and free from rust and corrosion

A.15.3.2.7.3 This paragraph is provided for cases where removing the device is not necessary to gain access to flue passageways needing inspection. It covers devices such as grates or heat exchangers that do not fill or block the fireplace opening. It also covers fireplace inserts or stoves that are directly connected to the chimney flue, where combustion products are contained in the connection and do not contact the fireplace surfaces.

A.15.4 A Level II inspection is limited to accessible parts of the chimney to include attic, basement, and crawl spaces. The following list (which is in addition to the list in A.15.3 for Level I inspection and which should not be considered all-inclusive) indicates some of the items to be included in a Level II inspection, to the extent that they are readily accessible and included in the installation being inspected:

(1) Chimney wall material
(2) Condition of chimney walls
(3) Attic insulation shield for factory-built chimneys and factory-built fireplace chimneys
(4) Housing and shrouds for factory-built chimneys and factory-built fireplace chimneys
(5) Factory-built chimney support type
(6) Factory-built chimney and factory-built fireplace chimney assembled with appropriate parts
(7) Factory-built chimney and factory-built fireplace chimney clearances
(8) Factory-built chimney and factory-built fireplace chimney attachment to appliance
(9) That the venting system is properly sized for the appliance
(10) Height and dimensions of liner
(11) Installation and condition of offsets in flue
(12) That unused openings (into flue) are properly sealed
(13) Construction of wash
(14) Expansion joint between flue and wash
(15) Condition of flashing
(16) Condition of crickets, when present
(17) Chimney connector or vent connector gauge (material thickness)
(18) That the chimney and vent connector diameter is proper for appliance(s) connected
(19) That the wall pass-through is properly installed with adequate clearance and installation details
(20) Chimney or vent connector configuration (appropriate dimensions for sizing and compared with vent or chimney)
(21) Manifold sizing
(22) Combustion air supplied for fireplaces in accordance with Section 11.4
(23) Condition of outside air inlets, outlets, and ducting in accordance with Section 11.4
(24) Ash dump
(25) Combustible framing/forms under hearth or hearth extension of masonry fireplaces
(26) Fireplace opening size (ratio with flue) of masonry fireplaces
(27) Size of throat of masonry fireplaces
(28) Smoke chamber dimensions (angle/height) of masonry fireplaces
(29) Smoke chamber lining (parged, firebrick, etc.) of masonry fireplaces
(30) Smoke shelf area of masonry fireplaces
(31) Factory-built fireplace brand, model, and listing
(32) That factory-built fireplace glass doors and accessories (inserted items) are approved
(33) Factory-built fireplace hearth platform and covering

When conducting a Level II inspection on any type of factory-built chimney or appliance, the inspector should request the product installation instructions from the building owner or occupant for review prior to completing the inspection.

A.15.4.1(1) This item should not be interpreted to include the removal or disconnection of an appliance and subsequent replacement or reconnection that occurs during the course of routine cleaning and maintenance activities.

A.15.5 A Level III inspection encompasses a complete evaluation of the chimney, including verification of proper materials and clearances to combustibles.

The following list (which is in addition to the lists in A.15.3 and A.15.4 for Level I and Level II inspections and which should not be considered all-inclusive) indicates some of the items to be included in a Level III inspection, to the extent that they are readily accessible and included in the installation being inspected:

(1) Firestopping
(2) Debris in annular space of factory-built chimney and factory-built fireplace chimney
(3) Clearances inside the chase housing of factory-built chimneys and factory-built fireplace chimneys
(4) Masonry foundation
(5) Masonry foundation depth and dimension
(6) Masonry foundation soil conditions
(7) That the space around the chimney liner is adequate
(8) That seismic requirements, where required, have been met
(9) Thickness of fireplace walls
(10) Clearance around fireplace walls
(11) Smoke chamber wall thickness
(12) Smoke chamber clearance
(13) Factory-built fireplace clearance

(14) That the factory-built fireplace hearth strip is properly installed
(15) That the factory-built fireplace installation is stable
(16) Connection between factory-built fireplace and its chimney
(17) Factory-built fireplace hearth extensions per manufacturer's instructions, including U values

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 31, *Standard for the Installation of Oil-Burning Equipment*, 2016 edition.

NFPA 54, *National Fuel Gas Code*, 2015 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2014 edition.

NFPA 720, *Standard for the Installation of Carbon Monoxide (CO) Detection and Warning Equipment*, 2015 edition.

B.1.2 Other Publications.

B.1.2.1 ANSI Publications. American National Standards Institute, Inc., 25 West 43rd Street, 4th Floor, New York, NY 10036.

ANSI Z21.11.2, *Gas-Fired Room Heaters — Volume II, "Unvented Room Heaters,"* 2007.

ANSI Z21.60/CSA 2.26, *Decorative Gas Appliances for Installation in Solid-Fuel Burning Fireplaces,* 2003 (2009).

ANSI Z21.84, *Manually Lighted, Natural Gas, Decorative Gas Appliances for Installation in Solid-Fuel Burning Appliances,* 2002.

B.1.2.2 ASHRAE Publications. ASHRAE, Inc., 1791 Tullie Circle, NE, Atlanta, GA 30329-2305.

ASHRAE Handbook: HVAC Systems and Equipment, 2012.

B.1.2.3 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohacken, PA 19428-2959.

ASTM E2336, *Standard Test Methods for Fire Resistive Grease Duct Enclosure Systems,* 2004 (2009).

B.1.2.4 CSA America Publications. Canadian Standards Association, 8501 East Pleasant Valley Road, Cleveland, OH 44131-5575.

IAS 6-96, *IAS-US Requirements for Carbon Monoxide Alarms for Residential Use*, 1998.

B.1.2.5 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 103, *Standard for Factory-Built Chimneys for Residential Type and Building Heating Appliances*, 2010.

ANSI/UL 907, *Fireplace Accessories,* 2010.

ANSI/UL 1738, *Standard for Venting Systems for Gas-Burning Appliances, Categories II, III and IV*, 2010, Revised 2011.

ANSI/UL 2034, *Standard for Single and Multiple Station Carbon Monoxide Alarms*, 2008, Revised 2009.

B.2 Informational References. The following documents or portions thereof are listed here as informational resources only. They are not a part of the requirements of this document.

B.2.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 220, *Standard on Types of Building Construction*, 2015 edition.

B.3 References for Extracts in Informational Sections. (Reserved)

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NFPA®214

Standard on

Water-Cooling Towers

2016 Edition

This edition of NFPA 214, *Standard on Water-Cooling Towers*, was prepared by the Committee on Water-Cooling Towers. It was issued by the Standards Council on November 14, 2015, with an effective date of December 4, 2015, and supersedes all previous editions.

This edition of NFPA 214 was approved as an American National Standard on December 4, 2015.

Origin and Development of NFPA 214

The subject of the protection of water-cooling towers was first considered by the NFPA Committee on Building Construction in 1957, and a progress report on the subject was published in the Advance Reports of that year. In 1958, a new Committee on Water-Cooling Towers was appointed, and a Tentative Standard on Fire Protection of Water-Cooling Towers proposed by the Committee was adopted by the Association. Final adoption of NFPA 214, *Standard on Water-Cooling Towers*, was secured in 1959. Revised editions were published in 1961, 1966, 1968, 1971, 1976, 1977, 1983, 1988, and 1992. The 1996 edition of the standard reinforced a performance-based approach to fire protection for water-cooling towers. The scope was also changed to include protection of field-erected water-cooling towers.

The changes in the 2000 edition reflected the new *Manual of Style for NFPA Technical Committee Documents*. The 2005 edition added requirements for pilot line detectors.

The 2011 edition made several clarifications to improve NFPA 214's functionality for the user and to coordinate with other documents.

The 2016 edition has better aligned the sprinkler requirements within the Standard with the types of systems defined in NFPA 13, *Standard for the Installation of Sprinkler Systems*.

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NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This Committee shall have primary responsibility for documents on the design, construction, protection, and maintenance of water-cooling towers.

NFPA 214

Standard on

Water-Cooling Towers

2016 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex C. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex C.

Chapter 1 Administration

1.1* Scope. This standard applies to fire protection for field-erected and factory-assembled water-cooling towers of combustible construction or those in which the fill is of combustible material.

1.2 Purpose. The purpose of this standard is to provide a reasonable degree of protection for life and property from fire where water-cooling towers are located.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.
NFPA 14, *Standard for the Installation of Standpipe and Hose Systems,* 2016 edition.
NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems,* 2014 edition.
NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines,* 2015 edition.
NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work,* 2014 edition.
NFPA 70®, National Electrical Code®, 2014 edition.
NFPA 72®, National Fire Alarm and Signaling Code, 2016 edition.
NFPA 780, *Standard for the Installation of Lightning Protection Systems,* 2014 edition.

2.3 Other Publications.

2.3.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A153/A153M, *Standard Specification for Zinc Coating (Hot Dip) on Iron and Steel Hardware*, 2009.

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C*, 2012.

2.3.2 UL Publications. Underwriters Laboratory Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 263, *Fire Tests of Building Construction and Materials*, 2011.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2016 edition.

Chapter 3 Definitions

3.1 General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3 Labeled. Equipment or materials to which has been attached a label, symbol, or other identifying mark of an organization that is acceptable to the authority having jurisdiction and concerned with product evaluation, that maintains periodic inspection of production of labeled equipment or materials, and by whose labeling the manufacturer indicates compliance with appropriate standards or performance in a specified manner.

3.2.4* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.5 Shall. Indicates a mandatory requirement.

3.2.6 Should. Indicates a recommendation or that which is advised but not required.

3.3 General Definitions.

3.3.1 Air Travel. The distance that air travels through the cooling tower fill by tower type, measured horizontally in crossflow towers (as the fill packing width), or vertically in counterflow towers (as the fill packing depth).

3.3.2* Cell. The smallest tower subdivision that can function as an independent unit with regard to air and water flow.

3.3.3 Combustible Material. A material that, in the form in which it is used and under the conditions anticipated, will ignite and burn; a material that does not meet the definition of noncombustible.

3.3.4* Cooling Tower.

3.3.4.1* ***Counterflow.*** A cooling tower classification in which the water flows countercurrent to the airflow.

3.3.4.2* ***Crossflow.*** A cooling tower classification in which the airflow is essentially perpendicular to the flow of water.

3.3.4.3 ***Deluge Sprinkler System.*** A sprinkler system employing open sprinklers or nozzles that are attached to a piping system that is connected to a water supply through a valve that is opened by the operation of a detection system installed in the same areas as the sprinklers or the nozzles. When this valve opens, water flows into the piping system and discharges from all sprinklers or nozzles attached thereto. [**13,** 2016]

3.3.4.4 ***Dry Pipe Sprinkler System.*** A sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinklers. [**13,** 2016]

3.3.4.5* ***Mechanical-Draft.*** A cooling tower classification in which air movement depends on fans or blowers.

3.3.4.6* ***Natural-Draft.*** A cooling tower containing no fans or blowers, in which air movement depends on the difference in densities of the heated air inside the tower and the cooler air outside.

3.3.5 Film Fill. Water-cooling media made of formed plastic sheets and placed parallel to tower air travel at evenly spaced intervals.

3.3.6* Fire-Resistant Partition. A tight, continuous partition suitable for use in a cooling tower environment that has a fire resistance rating of 20 minutes or more in accordance with Section 4.9.

3.3.7 Noncombustible Material. A material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to a fire or heat. Materials that are reported as passing ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* shall be considered noncombustible materials. [**13,** 2016]

3.3.8 Pilot Line Detector. An automatic sprinkler or thermostatic fixed temperature release device used as a detector to pneumatically or hydraulically release the system actuation valve.

3.3.9 Preaction Sprinkler System. A sprinkler system employing automatic sprinklers that are attached to a piping system that contains air that might or might not be under pressure, with a supplemental detection system installed in the same areas as the sprinklers. [**13,** 2016]

3.3.10 System Actuation Valve. The main valve that controls the flow of water into the fire protection system.

3.3.11 Wet Pipe Sprinkler System. A sprinkler system employing automatic sprinklers attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by heat from a fire. [**13,** 2016]

Chapter 4 General Requirements

4.1 Construction Materials of Water-Cooling Towers.

4.1.1 Where the cooling tower's structure, fan, distribution system, louvers, and fill and drift eliminator materials are all of noncombustible materials, a fire protection system shall not be required.

4.1.2 If any of the construction materials are combustible and the factors in Section 4.2 necessitate it, fire protection shall be provided in accordance with Chapter 5, and towers shall be located in accordance with Chapter 4.

4.2* Fire Risk Analysis. A fire risk analysis shall be conducted. The following are some of the factors that shall be considered in determining the extent and method of fire protection required for induced-draft and natural-draft water-cooling towers:

(1) Importance to continuity of operation
(2)* Size and construction of tower
(3) Type of tower
(4) Location of tower
(5) Water supply
(6) Value of tower
(7) Climate
(8)* Water delivery time
(9) Environment

(10) Rooftop towers
(11) Limited access
(12) Materials of construction *(see Section 4.1)*

4.3 Combustible Exterior Surfaces. Water-cooling towers with combustible exterior surfaces, including the deck, distribution basins, and so forth, shall be located at least 100 ft (30.5 m) from the following hazards:

(1) Structures or processes that emit sparks or flying brands under ordinary circumstances, such as chimneys, incinerators, flare stacks, or cob burners
(2) Materials or processes of severe fire hazard, such as petroleum processing and storage tanks, explosives manufacturing or storage, and petroleum product pipelines and pumping stations

4.4 Combustible Surfaces with Fixed Protection. Towers with combustible exterior surfaces that are provided with fixed exposure protection in accordance with 5.2.10 shall be permitted to be located closer than 100 ft (30.5 m) from the hazards listed in Section 4.3.

4.5 Noncombustible Exterior Surfaces. Towers with noncombustible exterior surfaces shall be located 40 ft (12 m) or more from the hazards listed in Section 4.3.

4.6 Noncombustible Surfaces with Fixed Protection. Towers with noncombustible exterior surfaces that are provided with fixed interior fire protection installed in accordance with Chapter 5 shall be permitted to be located closer than 40 ft (12 m) from the hazards listed in Section 4.3.

4.7 Combustible Towers on Building Roofs. Combustible water-cooling towers located on building roofs or other locations to which access for manual fire fighting is restricted or difficult shall be provided with a protection system in accordance with Chapter 5.

4.8 Screening.

4.8.1 Open areas or space between a combustible cold-water basin and the ground or roof of a building upon which it is located shall be effectively screened to prevent the accumulation of waste combustible material under the tower and to prevent the use of such areas or space under the tower for the storage of combustible material.

4.8.2 Fire protection shall be permitted to be installed in lieu of screening.

4.9 Fire-Resistant Partition.

4.9.1* A fire-resistant partition for water-cooling towers shall be tested in accordance with ASTM E119 or UL 263.

4.9.2 The partition shall extend from 1 ft (0.3 m) below the operating water level of the cold-water basin to the underside of the fan deck (counterflow towers) or distribution basin (crossflow towers).

Chapter 5 Fire Protection

5.1 General.

5.1.1* Types of Fire Protection Systems. If the fire risk analysis results in Section 4.2, or the conditions of Section 4.7 exist, requiring a fire protection system, that system shall be in accordance with 5.2.2.

5.1.2 Complete Plans and Data Required. A complete plan showing piping arrangement, location of sprinklers, fixed detectors, and operating equipment such as valves and deluge valves, together with hydraulic calculations, water requirements, and water supply information, shall be submitted to the authority having jurisdiction for approval before installation.

5.1.2.1 Plans shall be drawn to scale and shall include the details necessary to indicate clearly all of the equipment and its arrangement.

5.1.2.2 Plans shall show location of new work with relation to existing structures, water-cooling towers, and water supplies.

5.1.2.3 Plans shall include a note listing the types of materials used in the system.

5.2 Fire Protection System Design.

5.2.1 General. Fire protection systems shall be designed, installed, and tested in accordance with NFPA 13.

5.2.2 Types of Systems.

5.2.2.1* The following fire protection systems shall be permitted to be used in counterflow cooling towers:

(1) Wet pipe sprinkler system
(2) Dry pipe sprinkler system
(3) Preaction sprinkler system
(4) Deluge sprinkler system

5.2.2.2* A deluge sprinkler system shall be used in crossflow towers.

5.2.3 Minimum Rate of Application.

5.2.3.1 Under the fan decks of counterflow towers, the rate of application of water shall be 0.5 gpm/ft^2 (20.4 mm/min), including fan opening.

5.2.3.2 Under the fan decks of crossflow towers, the rate of application of water shall be 0.33 gpm/ft^2 (13.45 mm/min), including fan opening.

5.2.3.3 Over the fill areas of crossflow towers, the rate of application of water shall be 0.5 gpm/ft^2 (20.4 mm/min).

5.2.4 Types and Locations of Discharge Outlets.

5.2.4.1* Counterflow Towers.

5.2.4.1.1 The discharge outlets shall be located under the fan deck and fan opening.

5.2.4.1.2 Except under the fan opening, all discharge outlets shall have deflector distances installed in accordance with NFPA 13.

5.2.4.1.3 Closed-head discharge outlets for dry-pipe and preaction systems shall be installed in the upright position only.

5.2.4.2* Crossflow Towers.

5.2.4.2.1 The discharge outlets protecting the plenum area shall be located under the fan deck and in the fan opening.

5.2.4.2.2 Discharge outlets protecting the fill shall be located under the distribution basin on either the louver or drift eliminator side, discharging horizontally through the joist channels.

5.2.4.2.3 Placement and Pressure of Discharge Devices.

5.2.4.2.3.1 Towers with an air travel dimension longer than the maximum allowable for the discharge device being used shall have discharge devices placed on both sides of the fill area in each joist channel.

5.2.4.2.3.2 The pressure at each discharge device shall be adequate to provide protection for half of the length of the fill measured along the air travel.

5.2.4.2.4 Number of Discharge Devices.

5.2.4.2.4.1 Where joist channels are wider than 2 ft (0.6 m), more than one discharge device shall be required per joist channel.

5.2.4.2.4.2 If the discharge device being used is listed for the width of the joist channel being protected, one discharge device per joist channel shall be permitted to be used.

5.2.4.3* Extended Fan Decks. On towers having extended fan decks that completely enclose the distribution basin, the discharge outlets protecting the fill area shall be located over the basin, under the extension of the fan deck.

5.2.4.3.1 These discharge outlets shall be open directional spray nozzles or other approved spray devices arranged to discharge 0.35 gpm/ft^2 (14.26 mm/min) directly on the distribution basin and 0.15 gpm/ft^2 (6.11 mm/min) on the underside of the fan deck extension.

5.2.4.3.2 On towers having extended fan decks that do not completely enclose the hot-water basin, outlets protecting the fill shall be located under the distribution basin in accordance with 5.2.4.2.2.

5.2.4.4 Combustible Fan Decks. For deluge systems using directional spray nozzles in the pendant position, provisions shall be made to protect the underside of a combustible fan deck at a minimum rate of 0.15 gpm/ft^2 (6.11 mm/min), which shall be included as part of the application rate specified in 5.2.3.

5.2.4.5* Water Basin Covers. On film-filled towers that have solid, hot-water basin covers over the complete basin, the discharge outlets protecting the fill area shall be permitted to be located under the basin covers.

5.2.4.5.1 These discharge outlets shall be open directional spray nozzles or other approved devices arranged to discharge 0.50 gpm/ft^2 (20.4 mm/min) into the distribution basin horizontally, with some of the spray splashing up and on the underside of the water basin covers.

5.2.4.5.2 On towers having basin covers that do not completely enclose the hot-water basin, outlets protecting the fill shall be located under the distribution basin in accordance with 5.2.4.2.2.

5.2.5 Pipe, Fittings, and Hangers.

5.2.5.1* Piping shall be installed in accordance with the requirements of NFPA 13.

5.2.5.2* Piping or tubing used within the cooling tower shall be metallic and approved for fire protection use, except as outlined in 5.2.5.2.1.

5.2.5.2.1 Piping or tubing used for pneumatic detection systems shall be permitted to be of other materials suitable for use in a cooling tower environment.

5.2.5.3 Hydraulic calculations shall be made in accordance with NFPA 13.

5.2.5.4 All fittings shall be of a type specifically approved for fire protection use.

5.2.5.4.1 In dry sections of the system piping, which can be exposed to possible fire conditions, ferrous fittings shall be of steel, malleable iron, or ductile iron, except as outlined in 5.2.5.4.2.

5.2.5.4.2 Cast-iron fittings shall be permitted to be used in pneumatic detection piping.

5.2.5.5 Approved, gasketed, groove-type fittings shall be permitted to connect pipe in fire-exposed areas where the fire protection system is operated automatically.

5.2.5.6 Where piping is supported from structural members of a cooling tower, the attachment shall be made so that the structural member is not split or otherwise damaged.

5.2.6 Valves.

5.2.6.1 General.

5.2.6.1.1 Valves shall be installed in accordance with NFPA 13.

5.2.6.1.2 Shutoff valves and automatically operated water control valves, if provided, shall be located as follows:

(1) Outside the fire-exposed area
(2) As close to the cooling tower as possible to minimize the amount of pipe to the discharge device
(3) Where they will be accessible during a fire emergency

5.2.6.2 Manual Release Valve.

5.2.6.2.1 Remote manual release valves, where required, shall be conspicuously located and accessible during a fire emergency.

5.2.6.2.2 Where remote manual release valves are not required, an inspector's test valve shall be provided for each pilot-head-operated system.

5.2.7* Strainers. Strainers shall be required for systems utilizing discharge devices with waterways of less than ⅜ in. (9.5 mm) diameter.

5.2.8* Heat Detectors. Where deluge or preaction systems are used, heat detectors shall be installed and shall be selected from either of the types in 5.2.8.1 or 5.2.8.2.

5.2.8.1 Pilot Line Detection Systems. Where pilot line detection systems are installed for actuation of deluge or preaction systems, heat detectors shall be installed in accordance with 5.2.8.1.1 through 5.2.8.1.4.

5.2.8.1.1 Protection.

5.2.8.1.1.1 Corrosion Protection. Detection equipment shall be protected from corrosion in accordance with Section 5.3.

5.2.8.1.1.2 Protective Canopy. Detection equipment requiring protection from the weather shall be provided with a canopy, hood, or other protection.

5.2.8.1.1.3* Mechanical Damage. Detection equipment shall be located so as to be protected from mechanical damage.

5.2.8.1.1.4 Mounting. Pilot line detectors shall be permitted to be supported by their piping or tubing.

5.2.8.1.2 Selection, Location, and Spacing of Pilot Line Detectors.

5.2.8.1.2.1 The selection, location, and spacing of pilot line detectors for the actuation of fire protection systems shall be in accordance with 5.2.8.1.2.1(A) through 5.2.8.1.2.1(E).

(A) In mechanical-draft towers, pilot line detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening where necessary to comply with the spacing requirements in 5.2.8.1.2.1(B). *(For extended fan decks, see 5.2.8.2.3.)*

(B) Pilot line detectors shall be spaced not more than 8 ft (2.4 m) apart in any direction including the fan opening. Temperature ratings shall be selected in accordance with operating conditions, but shall be no less than intermediate.

(C) Pilot line detectors shall not be required to be installed under the fan deck area in the fill area of crossflow towers with unenclosed distribution basins.

(D) A pilot line detector shall be provided over each fan drive motor where the motor is located so that it is not within the protected area of the tower.

(E) Specially listed pilot line detection devices specific to water-cooling towers shall be permitted to be used at spacings that have been evaluated and listed in accordance with the following:

(1) Data obtained from field experience
(2) Tests
(3) Engineering surveys
(4) Manufacturer's recommendations
(5) Detectors' listing criteria for water cooling towers
(6) Nature of the hazard being protected
(7) Both normal and abnormal air velocities
(8) Range of anticipated temperatures
(9) Maximum expected rates of temperature change under non-fire conditions
(10) Number and height of structural levels
(11) Effects of environment, including humidity
(12) Presence and magnitude of electromagnetic interference
(13) Presence of obstructions that might retard or mitigate timely detection
(14) Other conditions that might affect the efficacy of the fire detection employed

5.2.8.1.2.2 Detectors shall be located so as to promptly respond to a fire, flammable gas release, or other design condition.

5.2.8.1.2.3 The detection system shall be capable of detecting a fire up to the elevation of the highest level of protected equipment surface.

5.2.8.1.3 Pilot Line Detectors.

5.2.8.1.3.1 Pilot line detectors shall be standard response type unless specifically listed for water-cooling tower applications.

5.2.8.1.3.2 The temperature rating of pilot line detectors shall be selected in accordance with NFPA 13.

5.2.8.1.3.3 Where located under a fan deck or fan deck enclosure, the deflector of a pilot line detector shall be positioned 1 in. (2.54 cm) to 12 in. (30 cm) below an unobstructed fan deck or 1 in. (2.54 cm) to 6 in. (15.24 cm) below the structural members of an obstructed fan deck, but not more than a total of 22 in. (56 cm) below the fan deck.

5.2.8.1.3.4 The obstruction-to-water-distribution rules for automatic sprinklers in NFPA 13 shall not be required to be followed where pilot line detectors are used.

5.2.8.1.3.5 Two or More Systems. Where there are two or more adjacent water spray systems in one area controlled by separate detection systems, the pilot line detectors on each system shall be spaced independently.

5.2.8.1.4 Arrangement and Supervision of Pneumatic and Hydraulic Systems. Pneumatically and hydraulically operated systems shall be supervised in a manner such that failure will result in positive notification of the abnormal condition, unless the failure results in operation of the water spray system.

5.2.8.2 Electrical Heat Detection Systems. Where electrical detection systems are installed for actuation of deluge or preaction systems, heat detectors shall be installed in accordance with the applicable sections of *NFPA 72*.

5.2.8.2.1 In mechanical-draft towers, electrical heat detectors shall be located under the fan deck at the circumference of the fan opening and under the fan opening where necessary to comply with the spacing requirements of 5.2.8.2.2 through 5.2.8.2.2.2. *(For extended fan decks, see 5.2.8.3.)*

5.2.8.2.2* Electrical fixed-temperature detectors shall be spaced not more than 8 ft (2.4 m) apart in any direction including the fan opening.

5.2.8.2.2.1 Temperature ratings shall be selected in accordance with operating conditions, but shall be no less than intermediate.

5.2.8.2.2.2 Electrical fixed-temperature detectors shall not be required to be installed under the fan deck area of crossflow towers with unenclosed distribution basins.

5.2.8.2.3 On towers having extended fan decks that completely enclose the distribution basin, electrical heat detectors shall be located under the fan deck extension in accordance with standard, indoor-spacing rules for the type detectors used in accordance with *NFPA 72*.

5.2.8.2.3.1 Where the fan deck extension is 16 ft (4.9 m) or less and this dimension is the length of the joist channel, then only one row of detectors centered on and at right angles to the joist channels shall be required. Spacing between detectors shall be in accordance with *NFPA 72*.

5.2.8.2.3.2 On towers having extended fan decks that do not completely enclose the hot-water basin, electrical heat detectors shall not be required under the fan deck extension.

5.2.8.3 Where electrical heat detectors are inaccessible during tower operation, an accessible test detector shall be provided for each detection zone.

5.2.8.4 Electrical heat detector components exposed to corrosive vapors or liquids shall be protected by materials of construction or by protective coatings applied by the equipment manufacturer.

5.2.9 Protection for Fan Drive Motor.

5.2.9.1 A sprinkler or spray nozzle shall be provided over each fan drive motor where the motor is located so that it is not within the protected area of the tower.

5.2.9.2 Where a preaction or deluge system is used, the detection system shall be extended to cover the motor.

5.2.9.3 Provision shall be made to interlock the fan motors with the fire protection system so that the cooling tower fan motors are stopped in the cell(s) for which the system is actuated.

5.2.9.4 Where the continued operation of the fans is vital to the process, a manual override switch shall be permitted to be provided to reactivate the fan when it is determined that there is no fire.

5.2.10 Exposure Protection.

5.2.10.1 Where any combustible exterior surfaces of a tower, including the fan deck and distribution basins, are less than 100 ft (30.5 m) from significant concentrations of combustibles such as structures or piled material, the combustible exposed surfaces of the tower shall be protected by an automatic water spray system.

5.2.10.2 Systems for exterior protection shall be designed with the same attention and care as interior systems.

5.2.10.2.1 Pipe sizing shall be based on hydraulic calculations.

5.2.10.2.2 Water supply and discharge rate shall be based on a minimum 0.15 gpm/ft^2 (6.11 mm/min) for all protected surfaces.

5.2.11 Suppression Design. The design and installations shall comply with the applicable sections of NFPA 13.

5.3 Corrosion Protection.

5.3.1* Piping, fittings, hangers, braces, and attachment hardware including fasteners shall be hot-dipped galvanized steel in accordance with ASTM A153/A153M, or other materials having a superior corrosion resistance.

5.3.1.1 Exposed pipe threads and bolts on fittings shall be protected against corrosion.

5.3.1.2 All other components shall be corrosion resistant or protected against corrosion by a coating.

5.3.2* Wax-type coatings shall not be used on devices without fusible elements.

5.3.3* Special care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating.

5.3.3.1 Corrosion-resistant coatings shall not be applied to the sprinklers by anyone other than the manufacturer of the sprinklers.

5.3.3.2 In all cases, any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in an approved manner, so that no part of the sprinkler is exposed after the installation has been completed.

5.4* Hydrant Protection. Hydrants shall not be located less than 40 ft (12.2 m) from towers.

5.5* Standpipe Protection. Towers with any combustible construction located on a building 50 ft (15.3 m) or more in height shall be provided with Class III standpipe protection with hose connections within 200 ft (61 m) of all parts of the tower.

5.5.1 Sufficient hose shall be provided to reach all parts of the tower.

5.5.2 Provision shall be made for completely draining all exposed standpipe lines during winter.

5.5.3 Hose equipment at each standpipe hose connection on the roof shall be protected from the weather in a cabinet or enclosure in accordance with NFPA 14.

5.6 Water Supply.

5.6.1 Deluge Systems.

5.6.1.1* Where all cells of a cooling tower are protected by a single deluge system, the water supply shall be adequate to supply all discharge outlets on that system.

5.6.1.2* Where two or more deluge systems are used to protect a cooling tower and fire-resistant partitions are not provided between the deluge systems, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjacent systems.

5.6.1.3* Where two or more deluge systems are separated by fire-resistant partitions, the water supply shall be adequate to supply all discharge outlets in the single most hydraulically demanding system.

5.6.1.4* On towers having extended fan decks that completely enclose the distribution basin, one of the following options shall be employed:

(1) The water supply shall be designed for all deluge systems.
(2) Heat barriers shall be installed under the extended fan deck to separate deluge system zones in order to prevent the total number of deluge systems operating from exceeding the number of deluge systems for which the water supply was designed. Heat barriers shall extend from the fan deck structure to the distribution basin dividers.

5.6.2 Wet, Dry, and Preaction Systems.

5.6.2.1* Where each cell of the cooling tower is separated by a fire-resistant partition, the water supply shall be adequate to supply all discharge outlets in the hydraulically most demanding single cell.

5.6.2.2* Where fire-resistant partitions are not provided between each cell of a cooling tower, the water supply shall be adequate to supply all discharge outlets in the two most hydraulically demanding adjoining cells.

5.6.3 Hose Streams. Water supplies shall be sufficient to include a minimum of 500 gpm (1892.5 L/min) for hose streams in addition to the sprinkler requirements.

5.6.4 Duration. A water supply adequate for at least a 2-hour duration shall be provided for the combination of the water supply specified in 5.6.1 or 5.6.2, plus the hose stream demand specified in 5.6.3.

5.7* Lightning Protection. Lightning protection, where provided, shall be installed in accordance with the provisions of NFPA 780.

5.8 Earthquake Protection. Where provided, earthquake-resistant construction shall be in accordance with applicable sections of NFPA 13.

Chapter 6 Electrical Equipment and Wiring

6.1 Installation. Installation of all electrical equipment and wiring pertaining to water-cooling towers shall be in accordance with *NFPA 70*.

6.2* Overcurrent Protection. Electric motors that are driving fans shall be provided with overcurrent protection devices as mandated by *NFPA 70*.

6.3 Stop Fan. A remote fan motor switch shall be provided to stop the fan in case of fire.

6.4 Interlock. When a fire protection system is installed, provisions shall be made to interlock the fan motors with the fire protection system as set forth in Chapter 5.

6.5 Vibration-Controlled Switch. A listed, automatic, vibration-controlled switch shall be provided to automatically shut down fan motors.

Chapter 7 Internal Combustion Engine–Driven Fans

7.1 Internal Combustion Engines.

7.1.1 Electric motors or steam turbines shall be the preferred drives to operate fans on water-cooling towers.

7.1.2 Where neither electric motor nor steam turbines are available, internal combustion engines shall be permitted to be used, provided they are installed, used, and maintained in accordance with NFPA 37.

Chapter 8 Operating Features, Maintenance, and Access

8.1 Housekeeping. Areas around towers located on the ground shall be kept free of grass, weeds, brush, or combustible waste materials.

8.2 Smoking.

8.2.1 Smoking shall not be permitted on or adjacent to any cooling tower of combustible construction.

8.2.2 Signs stating the provisions of 8.2.1 shall be posted and maintained, and this regulation shall be strictly enforced.

8.3 Mechanical Inspection. Forced- and induced-draft towers in continuous operation shall be checked for excessive heating in motors and for excessive fan vibration.

8.4 Inspection Frequency.

8.4.1 At least semiannually, the fan assemblies, including the motors and speed reducers, shall be checked, both during operation and when shut down, for excessive wear or vibration, improper lubrication, corrosion, or other factors that could result in failure.

8.4.2 Where conditions require it, corrective action shall be taken.

8.5 Welding and Cutting. Where work on the tower requires welding or cutting, it shall be done in accordance with NFPA 51B.

8.6 Down Time.

8.6.1* All automatic fire protection on the tower shall be operable during periods when the towers are shut down for repairs or other reasons.

8.6.2* Where the tower does not have automatic fire protection, special protection shall be provided until the tower is back in service.

8.7 Access.

8.7.1 Access to the tops of water-cooling towers for fire fighting and maintenance shall be provided by an approved stairway or ladder.

8.7.2 Towers in excess of 120 ft (37 m) in any dimension shall be provided with not less than two means of access remote from each other.

8.8 Lockout.

8.8.1 Motors, speed reduction units, and drive shafts shall be accessible for servicing and maintenance.

8.8.2 Lockout or tagout of fan equipment shall be conducted when maintenance work is being performed in the vicinity of fans.

8.9 Temporary Supports. After maintenance work is completed, all scaffolding, boards, temporary supports, and other temporary materials shall be removed from the tower.

8.10 Fire Protection Systems Inspection, Testing, and Maintenance. Fire protection systems installed in accordance with this standard shall be inspected, tested, and maintained in accordance with NFPA 25.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 This standard does not apply any more or less strictly to factory-assembled units than did earlier revisions. Because these units have typically been steel frame/structure with PVC fill, the protection requirements should be evaluated in accordance with Section 4.2, with item (2) being specifically noted. In all cases, Section 4.2 should be reviewed for making the determination with regard to the installation of fire suppression systems. In some cases, no fire suppression is required.

The fire record of water-cooling towers indicates a failure to recognize the extent or seriousness of the potential fire hazard of these structures either while in operation or when temporarily shut down. Water-cooling towers of combustible construction, especially those of the induced-draft type, present a potential fire hazard even when in full operation because of the existence of relatively dry areas within the towers.

A significant percentage of fires in water-cooling towers of combustible construction are caused by ignition from outside sources such as incinerators, smokestacks, or exposure fires. Fires in water-cooling towers can create an exposure hazard to adjacent buildings and processing units. Therefore, distance separation from buildings and sources of ignition or the use of noncombustible construction are primary considerations in preventing these fires.

Ignition within these structures can be caused by welding or cutting operations, smoking, overheated bearings, electrical failures, and other heat- or spark-producing sources.

Fires have also occurred during the construction of water-cooling towers. Measures should be taken during construction to prevent the accumulation of combustible waste materials such as wood borings, shavings, scrap lumber, or other easily ignited materials. "No Smoking" regulations and strict control of welding and other heat- or spark-producing operations should be enforced. Wetting down combustible portions of the tower during idle periods of construction is a good fire prevention practice.

Where cooling water is supplied to heat exchangers that are used for cooling flammable gases or liquids or combustible liquids, and where the cooling water pressure is less than that of the material being cooled, an unusual hazard to the cooling tower can be created by the return of the flammables or combustibles to the cooling tower water distribution system.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.2 Cell. Each cell can have one or more fans or stacks and one or more distribution systems. For the purposes of this standard, a cell within a hyperbolic tower is considered the area bounded by fire-resistant partitions.

A.3.3.4 Cooling Tower. See Figure B.1(a).

A.3.3.4.1 Counterflow. See Figure B.1(d).

A.3.3.4.2 Crossflow. See Figure B.1(e).

A.3.3.4.5 Mechanical-Draft. When the fans or blowers are at the air inlet, the tower is considered forced-draft. When the fans or blowers are at the air exit, the tower is considered induced-draft. *[See Figure B.1(c).]*

A.3.3.4.6 Natural-Draft. Natural-draft towers contain no fans or blowers. *[See Figure B.1(b).]*

A.3.3.6 Fire-Resistant Partition. Examples of some types of construction in a wood-framed tower that meet this requirement are ½ in. (12.7 mm) cement board, ½ in. (12.7 mm) plywood, or ¾ in. (19.1 mm) tongue-and-groove boarding where installed on both sides of wood studs. Other types of assemblies, both partition and frame, should be tested in accordance with ASTM E119 or UL 263.

Occasionally, the water level is lowered or the cold-water basin is emptied (e.g., for tower maintenance). Where the tower is empty for an extended period of time, the fire partition should be extended to the bottom of the cold-water basin, for example, by installing a temporary extension. The temporary fire partition should remain in place, except where it interferes with the maintenance activity in a single cell, until the tower is returned to service and the water level in the basin is returned to normal.

A.4.2 No standard can be promulgated that guarantees the elimination of fires in water-cooling towers. Technology in this area is under constant development and is reflected in revisions to this standard. The user of this standard should recognize the complexity of fire protection requirements for water-cooling towers. Therefore, the designer is cautioned that this standard is not a design handbook. This standard does not do away with the need for the engineer or for competent engineering judgment. It is intended that a designer, capable of applying more complete and rigorous analysis to special or unusual problems, has latitude in the development of such designs. In such cases, the designer is responsible for demonstrating the validity of the approach.

Fire experience for mechanical-draft towers does not indicate the general need for automatic fire protection systems. However, exposure protection provided as required by 5.2.10 might be necessary.

A.4.2(2) Several fire tests can be used to evaluate the fire risk related to water-cooling tower materials. The most suitable tests are those that demonstrate low fire risk where tested in a configuration that approximates the large scale of the installation. Tests such as ASTM E136 and ASTM E84 have limitations. The test methods do not duplicate the larger extent of the hazard in its final installation and are not necessarily suitable or generally satisfactory for materials that soften, flow, or melt under fire conditions.

A.4.2(8) Piping arrangements, system capacities, and supervisory air pressures should be designed such that the time for water delivery to the most remote discharge device is minimized. For all water suppression systems using detection, the detection system should be designed to cause actuation of the special water control valve within 20 seconds under expected exposure conditions (*see* NFPA 15).

A.4.9.1 Fire-resistant partition testing for water-cooling towers should reflect their intended purpose (bearing or non-bearing). ASTM E119 or UL 263 sets out two test judgment criteria. Both judgment criteria should be met.

A.5.1.1 The use of antifreeze sprinkler systems in water-cooling towers is not recommended. While in theory this type of system would function, the use of antifreeze systems in water-cooling towers presents problems not encountered in usual antifreeze applications.

Due to the inaccessibility of the piping during normal operation of the cooling tower, it is almost impossible to do any maintenance work or to make routine inspections. The corrosion problem can be quite serious in water-cooling towers, and leaks in the system do not readily become apparent. These leaks would result in loss of the antifreeze solution and could result in freezing of the system.

Local ordinances in many areas prohibit the use of these systems.

A.5.2.2.1 Counterflow design configurations lend themselves to use of open- or closed-orifice fire protection systems. A deluge system provides a higher degree of protection where water supplies are adequate. In climates that are subject to freezing temperatures, a dry pipe, preaction, or deluge system minimizes the possibility of failure due to pipes freezing.

A.5.2.2.2 The crossflow design is such that it is difficult to locate sprinklers in the most desirable spots for both water distribution and heat detection. This situation is best addressed by using a deluge system.

A.5.2.4.1 Figure A.5.2.4.1(a) through Figure A.5.2.4.1(d) show typical plan and section views of fire protection systems in counterflow water-cooling towers. For the requirement to screen area beneath the tower in Figure A.5.2.4.1(b), see 4.8.1.

A.5.2.4.2 Figure A.5.2.4.2(a) through Figure A.5.2.4.2(d) show typical plan and section views of fire protection systems in crossflow water-cooling towers.

A.5.2.4.3 Location of the nozzle relative to surfaces to be protected should be determined by the particular nozzle's discharge characteristics. Care should also be taken in the selection of nozzles to obtain waterways not easily obstructed by debris, sediment, sand, and so forth, in the water. *[See Figure A.5.2.4.3(a) and Figure A.5.2.4.3(b).]*

A.5.2.4.5 Figure A.5.2.4.5 shows a detail of the sprinklers and target nozzles for an enclosed distribution basin in a crossflow tower.

A.5.2.5.1 In towers where vibration is anticipated to cause movement of the fire protection system, resulting in wear of water piping, detection piping, or tubing at the hangers, it is necessary to install vibration absorbers between the hangers and the pipe.

Special consideration should be given to the support of detection piping or tubing due to its small diameter. Thin-wall or nonmetallic pipe or tubing usually requires close spacing of hangers for adequate support.

A.5.2.5.2 Where plastic piping or tubing is used for pneumatic detection systems, consideration should be given to the effects of ultraviolet radiation.

A.5.2.7 See NFPA 15 for further details.

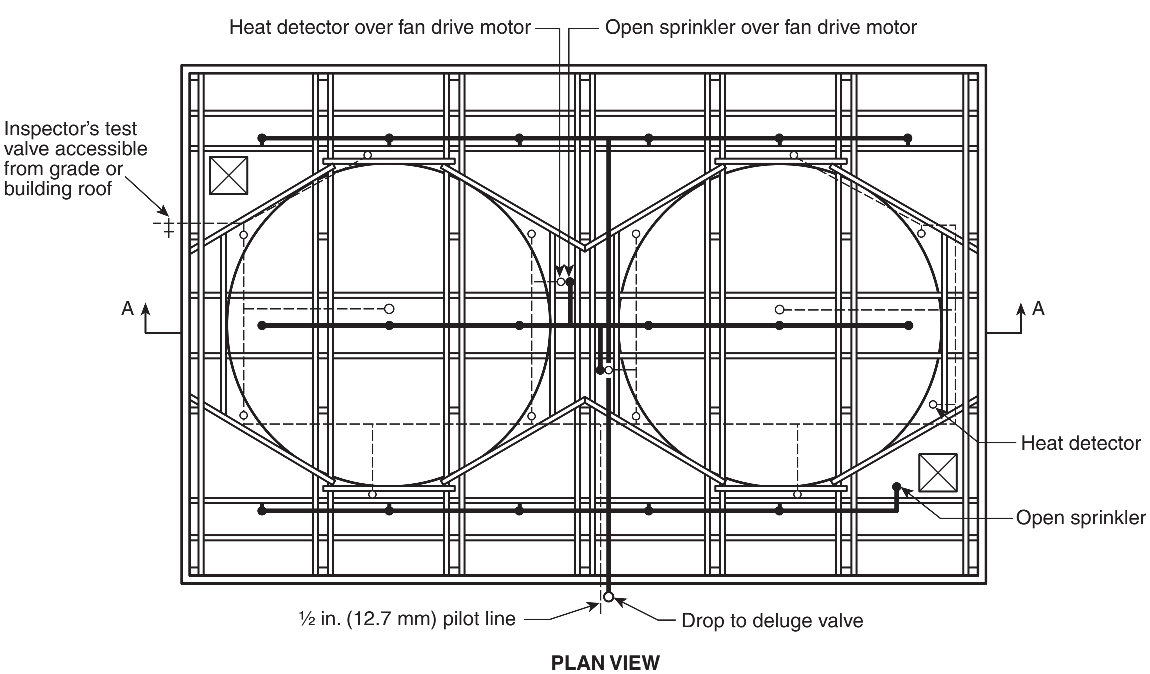
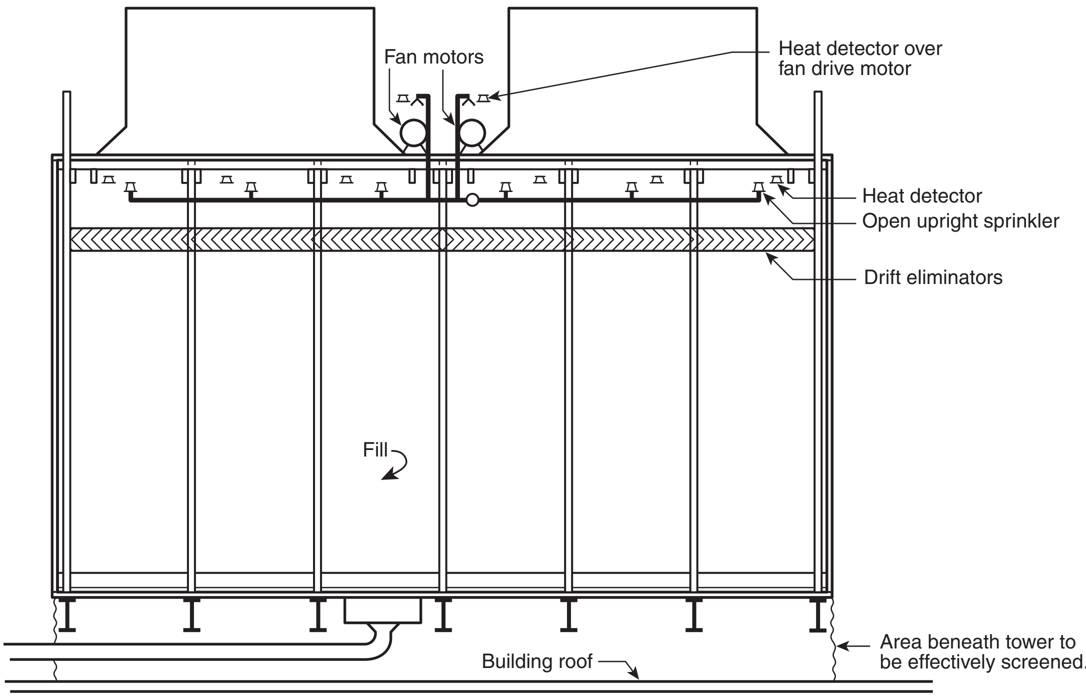
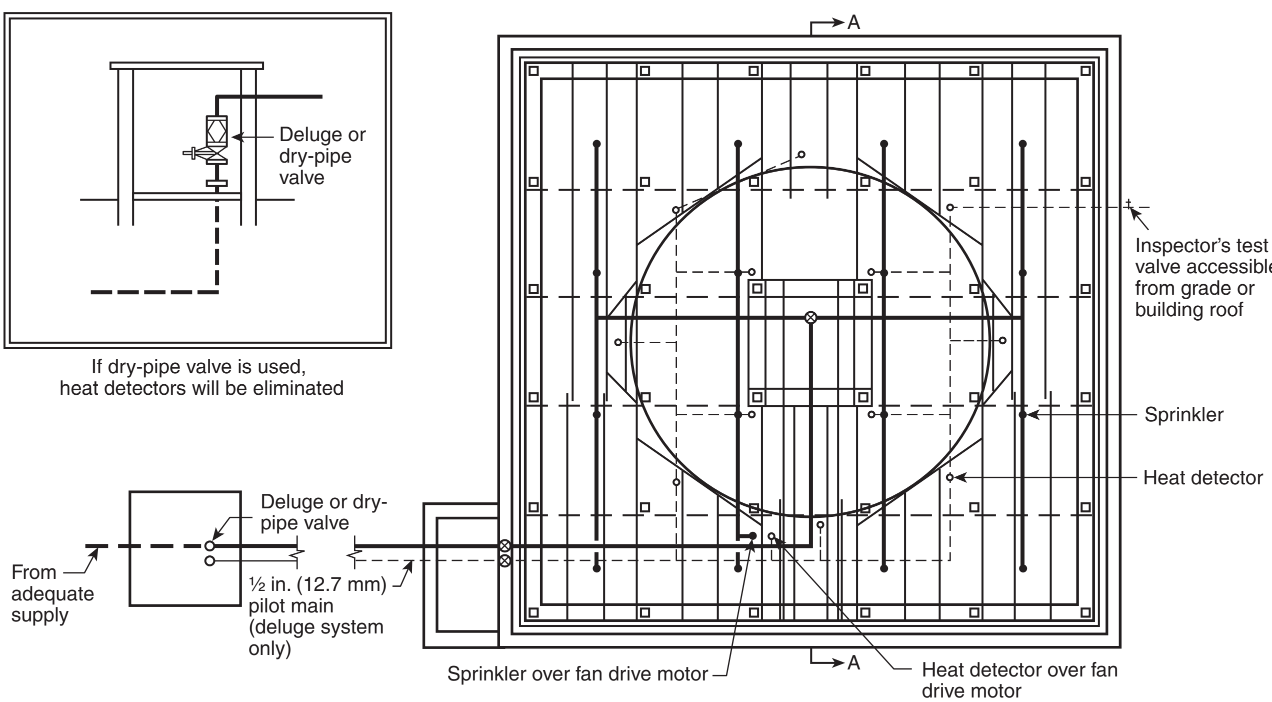


FIGURE A.5.2.4.1(a) Plan View, Typical Deluge Fire Protection Arrangement for Counterflow Towers.



SECTION A–A

FIGURE A.5.2.4.1(b) Section View, Typical Deluge Fire Protection Arrangement for Counterflow Towers.



PLAN VIEW

FIGURE A.5.2.4.1(c) Plan View, Typical Deluge or Dry-Pipe Fire Protection Arrangement for Counterflow Towers.

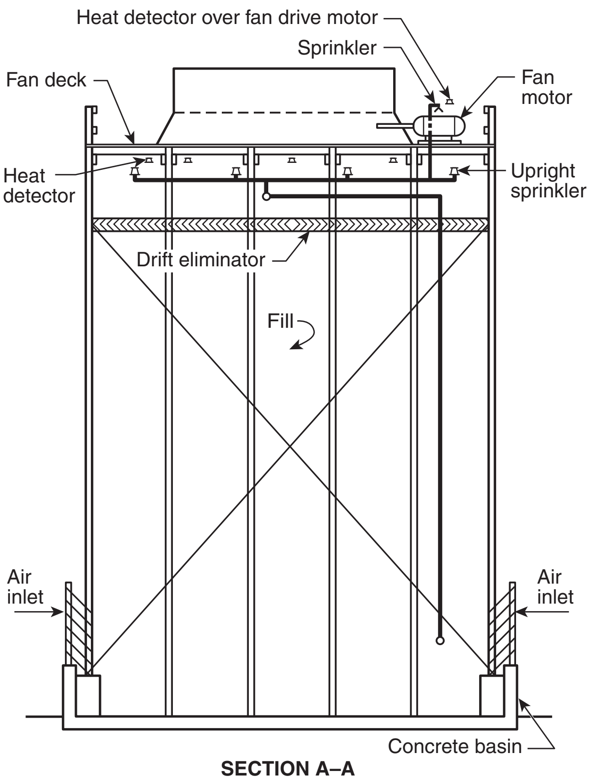


FIGURE A.5.2.4.1(d) Section View, Typical Deluge or Dry-Pipe Fire Protection Arrangement for Counterflow Towers.

A.5.2.8 Over the years, rate-of-rise detection systems were installed for the actuation of deluge or preaction systems. Some of these systems are still in the field and are being maintained in accordance with their listing. The design criterion was that these rate-of-rise detectors were spaced not more than 15 ft (4.6 m) apart in any direction. In pneumatic-type systems, for detectors inside the tower, these detectors were to be no more than one detector for each mercury check in towers operating in cold climates, and two detectors for each mercury check in towers used during the warm months only or year-round in warm climates. Also, these detectors were to be no more than four detectors for each mercury check where the detectors are located outside the tower.

A.5.2.8.1.1.3 Consideration should be given to the protection of the detection system in areas subject to earthquake damage. Some guidance on this topic is provided in NFPA 13.

A.5.2.8.2.2 Due to the extremely humid atmosphere and potentially corrosive conditions in water-cooling towers, it is very difficult to maintain electrical detection equipment. Experience has shown that even with weatherproof equipment and wiring practices, an electrical system malfunctions frequently. Therefore, the information in the subparagraphs of this section is based on the use of detectors operating on pneumatic or hydraulic principles.

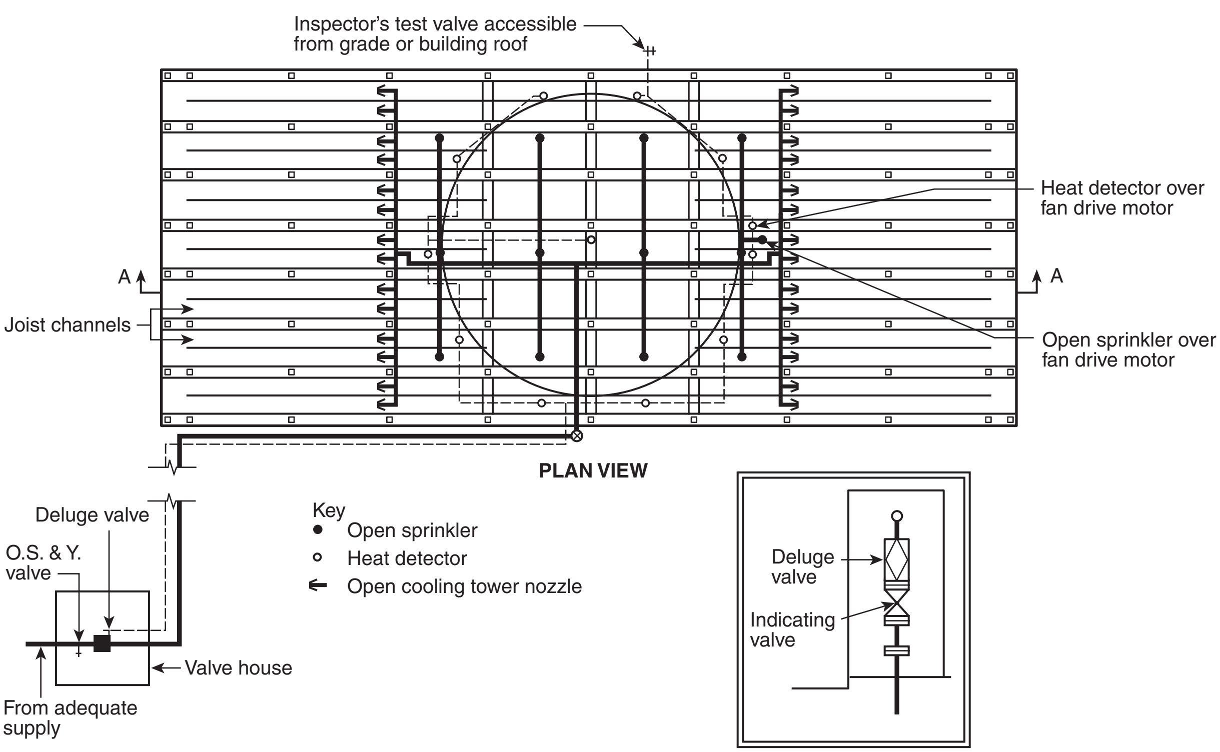


FIGURE A.5.2.4.2(a) Plan View, Typical Deluge Fire Protection Arrangement for Crossflow Towers.

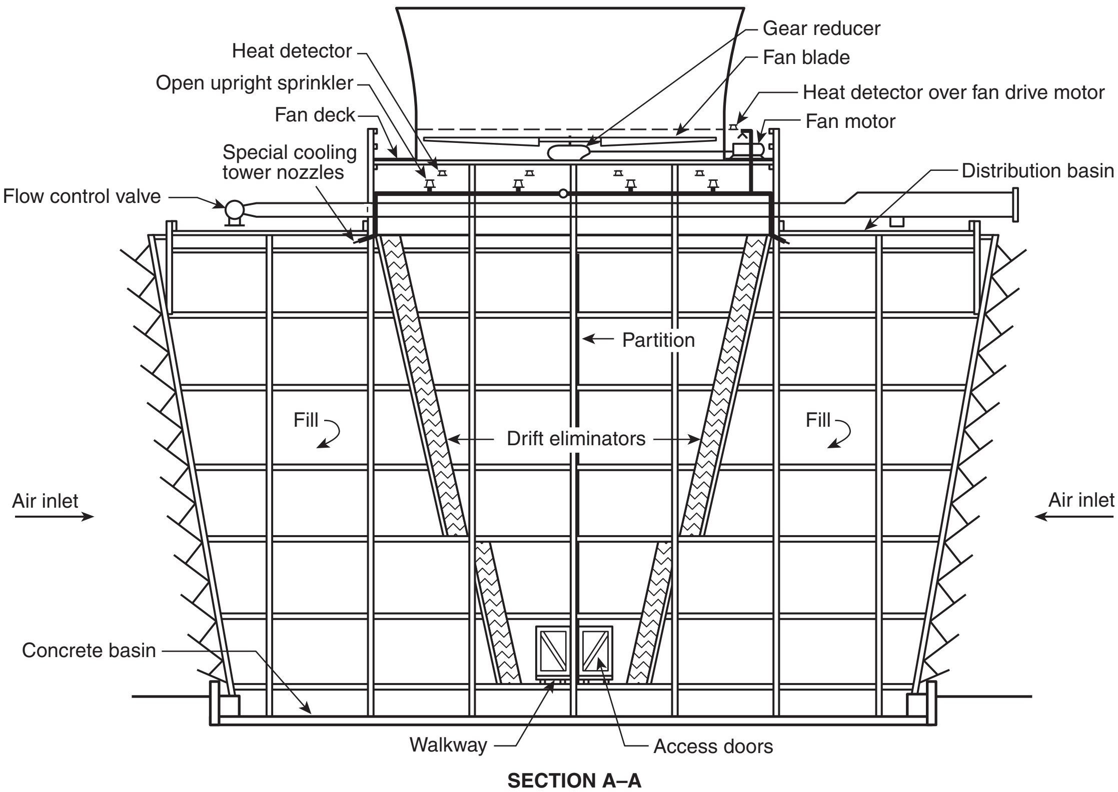
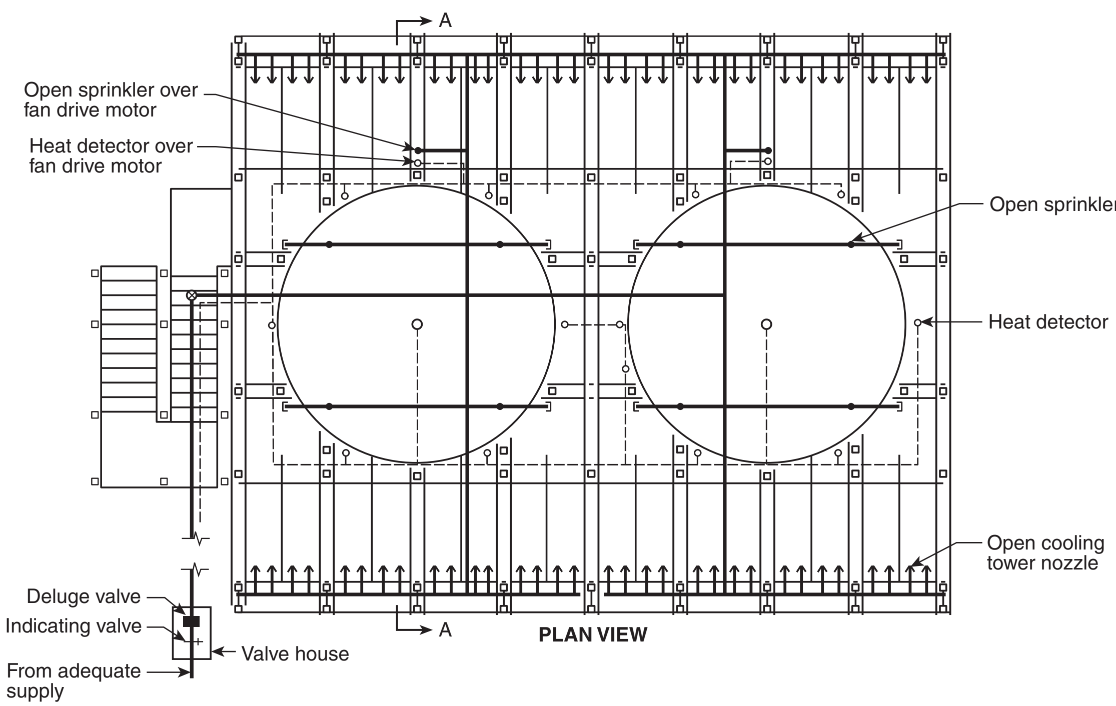
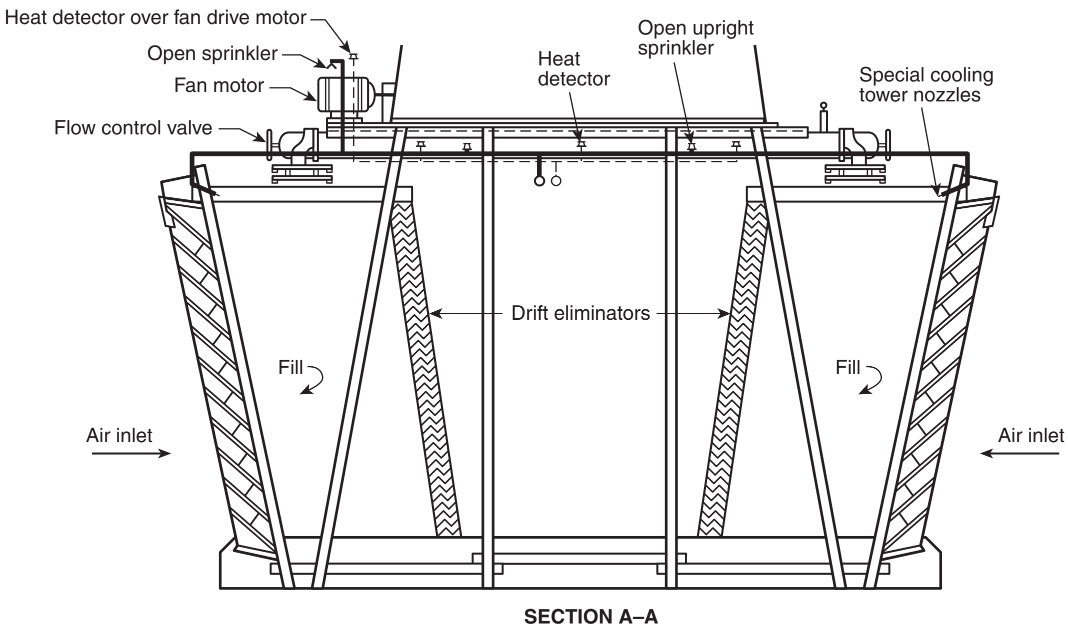


FIGURE A.5.2.4.2(b) Section View, Typical Deluge Fire Protection Arrangement for Crossflow Towers.



Note: Where air seal boards prevent installation of cooling tower nozzles on drift eliminator side of fill, this nozzle location should be used.

FIGURE A.5.2.4.2(c) Plan View, Typical Deluge Fire Protection Arrangement for Multicell Crossflow Towers.



Note: Where air seal boards prevent installation of cooling tower nozzles on drift eliminator side of fill, this nozzle location should be used.

FIGURE A.5.2.4.2(d) Section View, Typical Deluge Fire Protection Arrangement for Multicell Crossflow Towers.

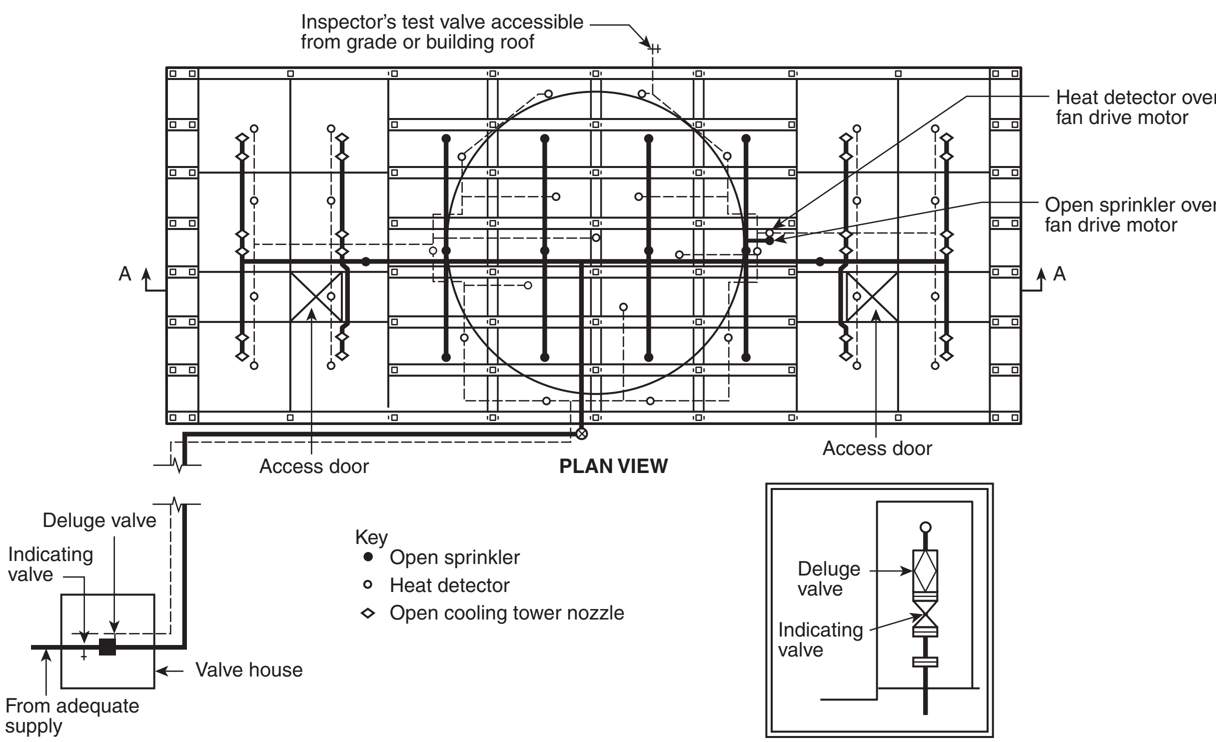


FIGURE A.5.2.4.3(a) Plan View, Typical Deluge Fire Protection Arrangement for Crossflow Towers with Completely Enclosed Distribution Basins.

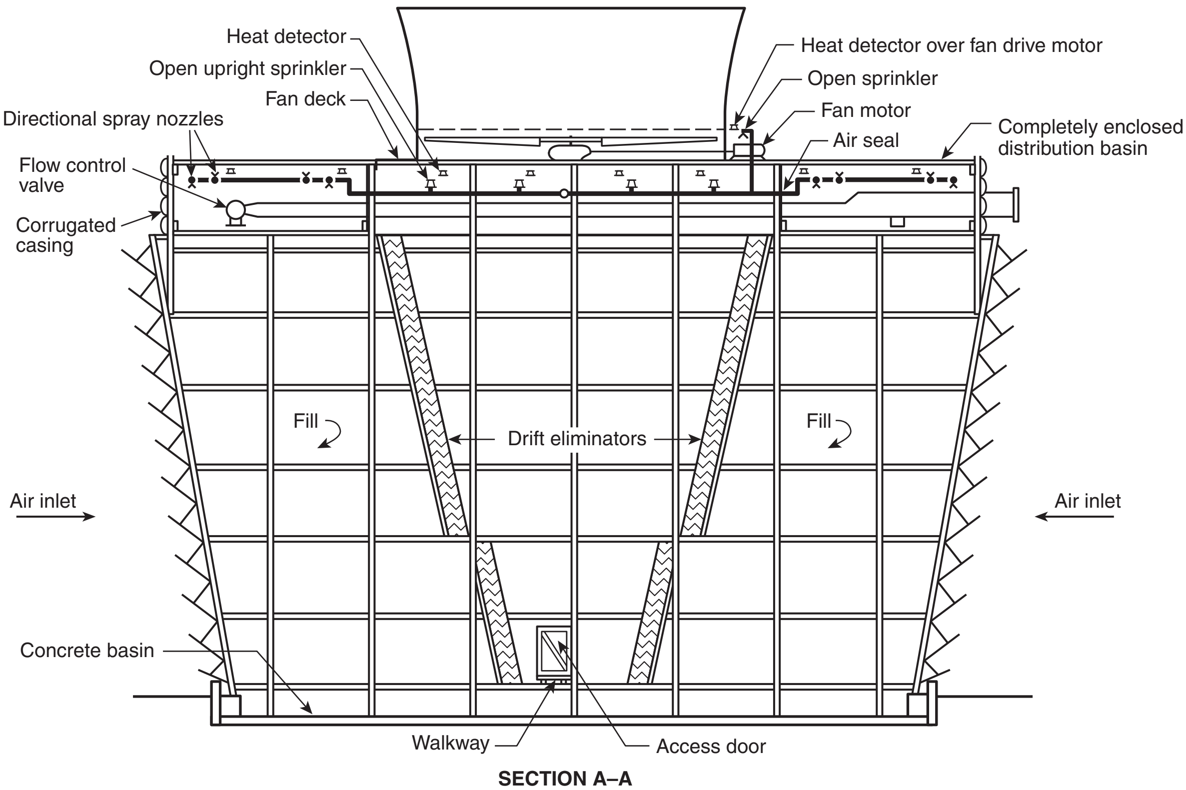


FIGURE A.5.2.4.3(b) Section View, Typical Deluge Fire Protection Arrangement for Crossflow Towers with Completely Enclosed Distribution Basins.

A.5.3.1 Corrosion of exposed pipe threads and bolts on fittings is a concern. Therefore, care should be taken to ensure that corrosion protection is as equivalent to hot-dipped galvanized steel as possible. Experience has shown that cadmium-plated components corrode at an accelerated rate compared to hot-dipped galvanized components.

If circulating tower water quality has the following characteristics, an upgrade of hot-dipped galvanized sprinkler components should be considered:

(1) Calcium, as $CaCO_3$ <50 ppm
(2) Chloride >450 ppm as Cl^- (750 ppm as NaCl)
(3) pH <6.5
(4) pH >9.0
(5) Hot water temperature >140°F (60°C)

Other unusual water uses include geothermal power, paper processing, and Stretford process, each of which can require component material upgrade.

A.5.3.2 Approved discharge devices are made of nonferrous material and are corrosion-resistant to normal atmospheres. Some atmospheres require special coatings on the discharge devices.

A.5.3.3 Corrosion attacks the exposed metal and, in time, creeps under the wax coating.

A.5.4 Hydrant protection should be provided within 200 ft (61 m) of all parts of towers having combustible construction and located on the ground or on buildings less than 50 ft (15.3 m) in height. A hose house and standard hose house equipment should be provided at each hydrant. *(See NFPA 24 for further details.)*

A.5.5 Standpipes should preferably be located in stair towers. If located on an open roof, they should not be closer than 40 ft (12.2 m) to the cooling tower. For a definition of Class III standpipe protection, see NFPA 14.

A.5.6.1.1 Where a single deluge system protects an entire water-cooling tower, regardless of the number of cells, the water supply needs to be based on the entire deluge system coverage. *(See Figure A.5.6.1.1.)*

A.5.6.1.2 Without fire-resistant partitions between cells, the worst-case situation involves the most demanding adjoining cells. *(See Figure A.5.6.1.2.)*

A.5.6.1.3 Deluge systems separated by fire-resistant partitions can be treated independently as worst-case water supply situations. *(See Figure A.5.6.1.3.)*

A.5.6.1.4 Acceptable materials are ⅜ in. (9.5 mm) plywood or $\frac{3}{16}$ in. (4.8 mm) asbestos cement board on one side of studs.

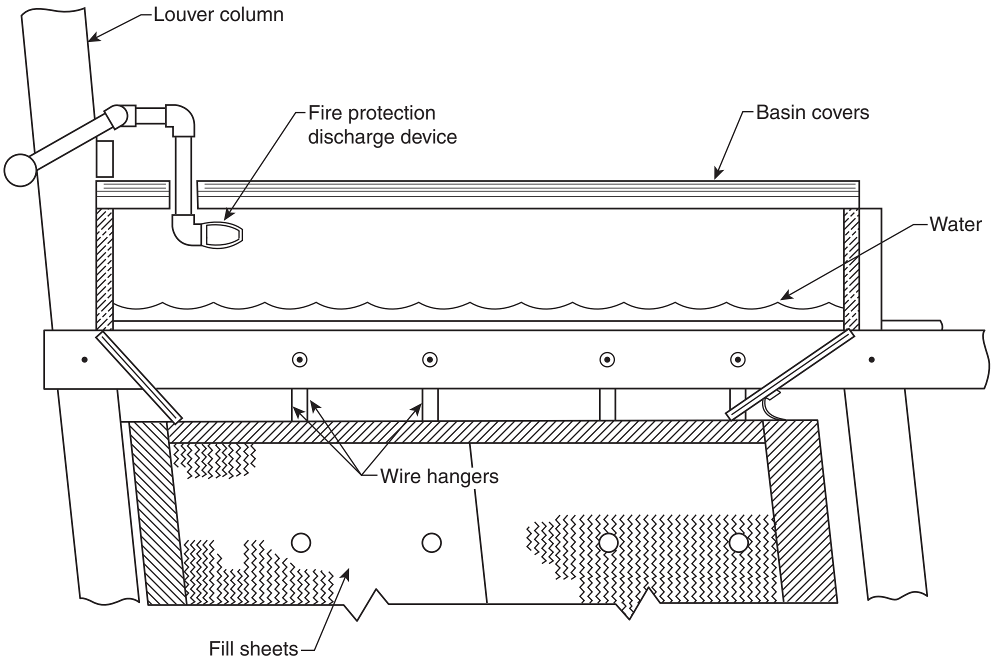


FIGURE A.5.2.4.5 Typical Deluge Fire Protection Arrangement for Crossflow Towers with Covers Completely Enclosing Distribution Basins.

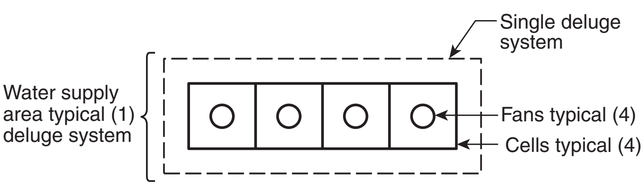


FIGURE A.5.6.1.1 Single Deluge System.

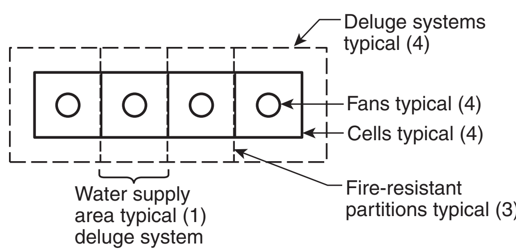


FIGURE A.5.6.1.3 Multiple Deluge Systems.

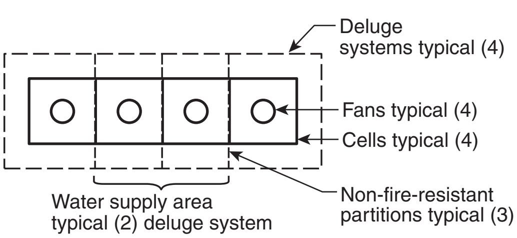


FIGURE A.5.6.1.2 Multiple Deluge Systems with No Fire-Resistant Partitions.

A.5.6.2.1 Water-cooling towers with each cell separated by a fire-resistant partition and protected by wet, dry, or preaction system(s) should have the water supply based on the most demanding individual cell. *(See Figure A.5.6.2.1.)*

A.5.6.2.2 Without fire-resistant partitions between cells, the worst-case situation involves the most demanding adjoining cells. *(See Figure A.5.6.2.2.)*

A.5.7 Towers located on roofs of buildings in certain geographical locations can be particularly susceptible to lightning damage.

A.6.2 Motors should be totally enclosed to protect them from dirt or moisture and to prevent sparks from reaching adjacent combustible construction.

A.8.6.1 During periods when combustible water-cooling towers are shut down for repairs or other reasons, the towers become particularly susceptible to ignition as the wood dries out.

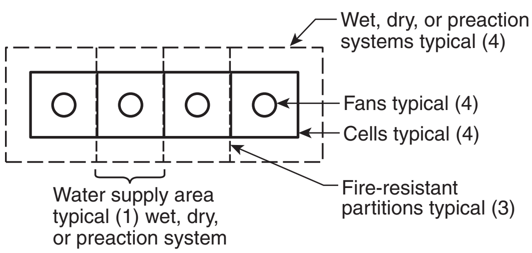


FIGURE A.5.6.2.1 Multiple Wet, Dry, or Preaction Systems with Fire-Resistant Partitions.

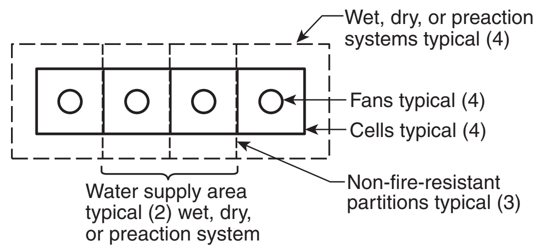


FIGURE A.5.6.2.2 Multiple Wet, Dry, or Preaction Systems with No Fire-Resistant Partitions.

A.8.6.2 Examples of special protection are watch service or intermittent wetting, or both.

Annex B Water-Cooling Tower Types

This annex is not a part of the requirements of this NFPA document but is included for informational purposes only.

B.1 Figure B.1(a) through Figure B.1(e) represent typical configurations of the many types of water-cooling towers.

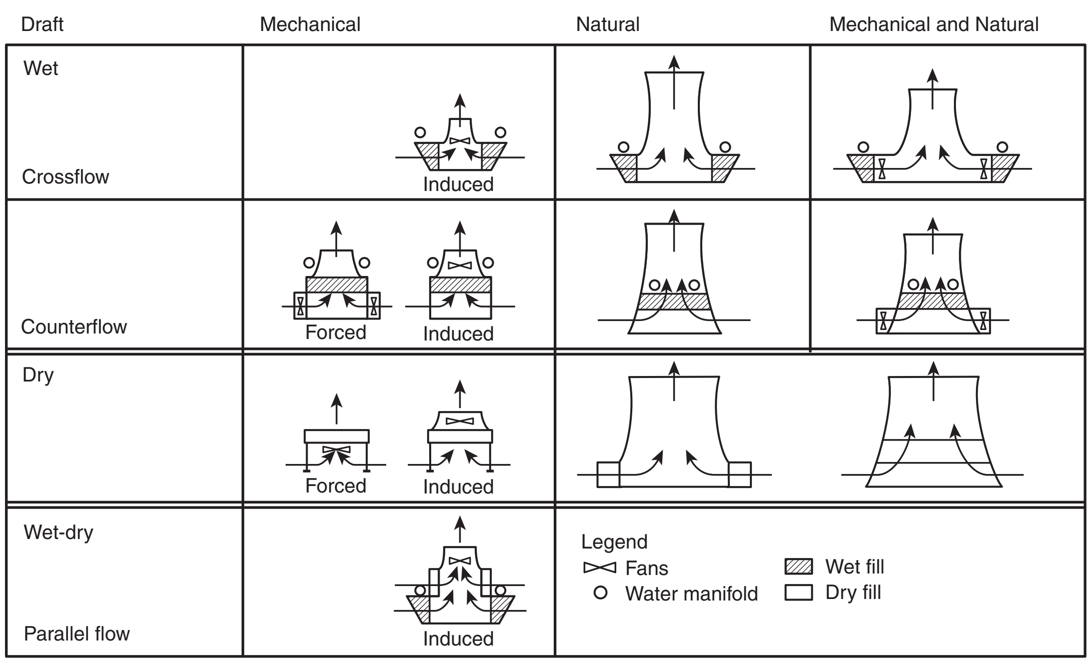


FIGURE B.1(a) Summary of Typical Water-Cooling Towers. ***(Courtesy of FM Global)***

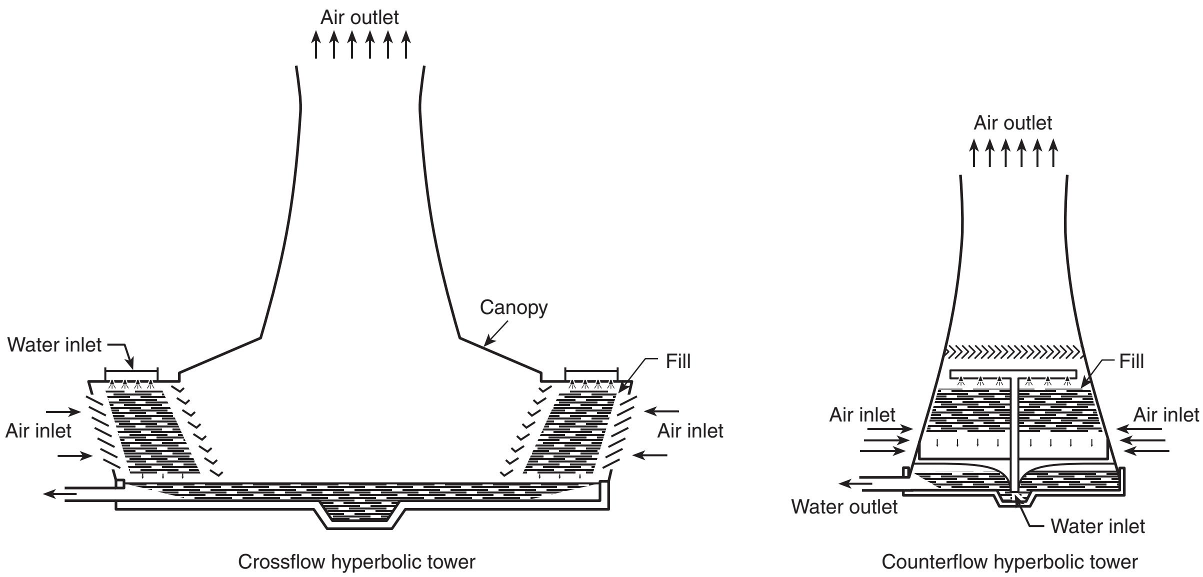


FIGURE B.1(b) Types of Natural-Draft Towers.

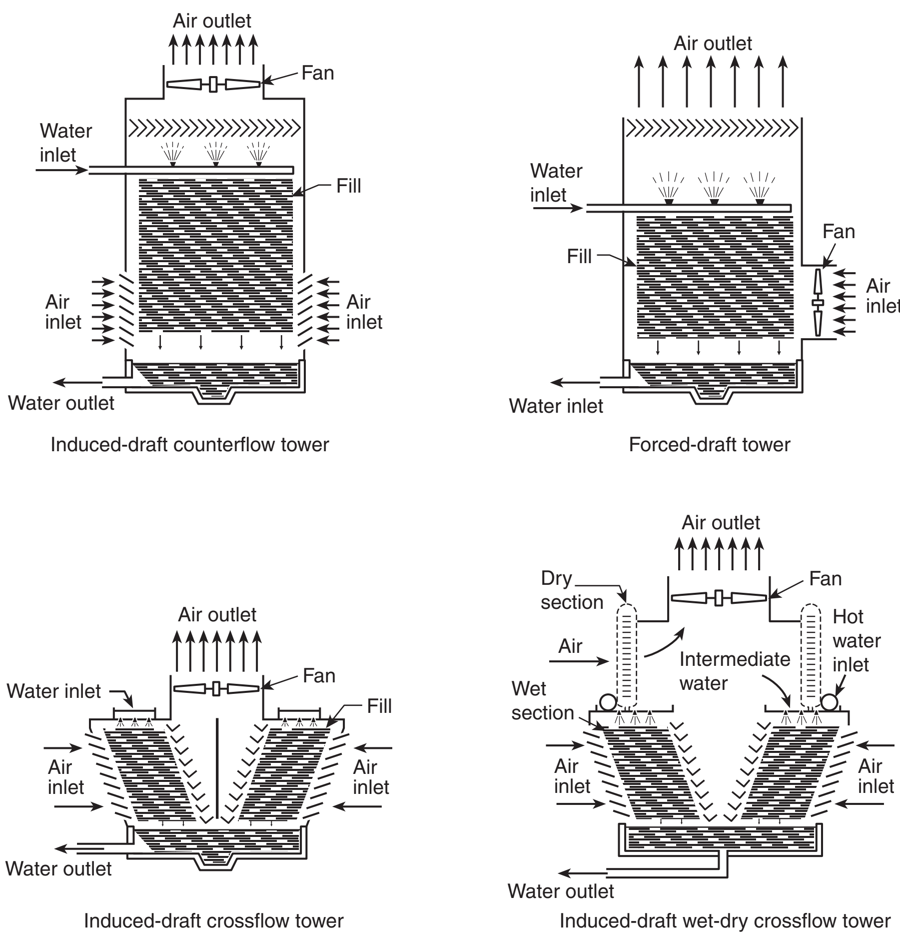


FIGURE B.1(c) Types of Mechanical-Draft Towers.

FIGURE B.1(d) Typical Induced-Draft Counterflow Water-Cooling Tower.

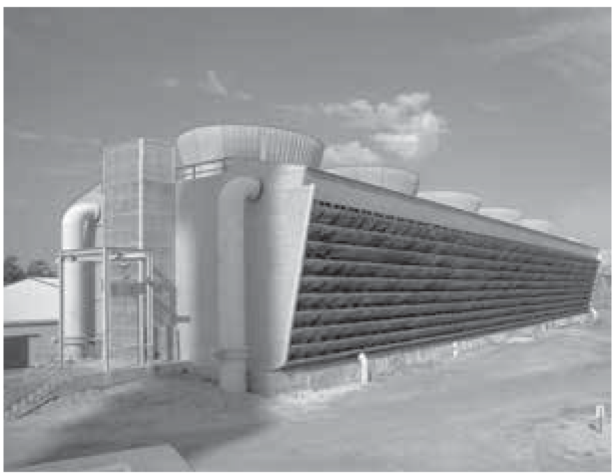


FIGURE B.1(e) Typical Induced-Draft Crossflow Water-Cooling Tower.

Annex C Informational References

C.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

C.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2016 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2016 edition.

NFPA 15, *Standard for Water Spray Fixed Systems for Fire Protection*, 2012 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2016 edition.

C.1.2 Other Publications.

C.1.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 1995.

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

ASTM E136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2012.

C.1.2.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingston Rd., Northbrook, IL 60062–2096.

UL 263, *Fire Tests of Building Construction and Materials*, 2011.

C.2 Informational References. (Reserved)

C.3 References for Extracts in Informational Sections. (Reserved)

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NFPA® 220

Standard on

Types of Building Construction

2015 Edition

This edition of NFPA 220, *Standard on Types of Building Construction*, was prepared by the Technical Committee on Building Construction. It was issued by the Standards Council on April 29, 2014, with an effective date of May 19, 2014, and supersedes all previous editions.

This edition of NFPA 220 was approved as an American National Standard on May 19, 2014.

Origin and Development of NFPA 220

In 1952, the Committee on Building Construction secured tentative adoption of NFPA 220, *Standard on Types of Building Construction*, at the NFPA Annual Meeting. At the 1954 NFPA Annual Meeting, revisions of the 1952 tentative text were adopted by the Association, and in 1955 minor revisions also were acted on favorably. A new definition of *noncombustibility* and editorial changes in the description of the fire resistance rating of structural members (under the definition of *fire-resistive construction*) were adopted at the 1956 NFPA Annual Meeting on the recommendation of the Committee on Building Construction.

In 1958, with the development of the use of plastics in building construction, recommendations on the types of standard fire tests to be used in evaluating the fire safety of these materials were adopted and inserted in the appendix.

In 1961, an appendix was adopted to furnish a guide to NFPA committees, regulatory officials, and others that addressed the classification of air-supported structures.

In 1975, a more fundamental definition of *noncombustible* was added, including the introduction of a definition of the term *limited-combustible,* based on potential heat value limitations and more generalized definitions for types of building construction.

In 1979, the standard was extensively rewritten to introduce the nomenclature related to construction Type I through Type V, which included parenthetically placed hourly fire resistance designations of the structural components.

The 1985 edition included the addition of a new Chapter 4, which provided referenced publications whose use is mandated within this standard. The 1992 and 1995 editions provided changes in technical terminology as well as changes to increase the user-friendliness of the standard.

The 1999 edition implemented a number of relatively minor changes, including the addition of several new definitions, the addition of a new requirement pertaining to exterior non–load-bearing walls, and a new provision concerning the use of heavy timber exterior walls.

In the 2006 edition, NFPA 220 became an extract document of *NFPA 5000®*, Section 7.2. At the request of the Standards Council, the new edition provided users with a stand-alone set of requirements for construction types and fire resistance ratings of structural elements.

The 2009 edition provided updates to the extracted text that was sourced back to *NFPA 5000* and NFPA 90A. These revisions included updates to the test protocols used to establish flame spread/smoke developed index values, modified criteria for materials used in air handling plenum spaces, and provided recognition of the new criteria used to determine building height and grade geometries.

The 2012 edition was updated to reflect changes in *NFPA 5000* and NFPA 90A. Revisions included updates to the requirements for plenums and noncombustible materials.

The 2015 edition has been revised to include new requirements for limited and noncombustible materials. Referenced publications have also been updated.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This committee shall have primary responsibility for documents on the selection and design of types of building construction, exterior walls, building height and area, firewalls, and fire barrier walls, as they relate to the protection of life and property from fire. For the processing of *NFPA 5000*, Chapter 7, and Sections 8.3 and 8.4, this committee reports directly to the *NFPA 5000* TCC; whereas, for the processing of NFPA 220 and NFPA 221, this committee does not report to the *NFPA 5000* TCC.

NFPA 220

Standard on

Types of Building Construction

2015 Edition

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NOTICE: An asterisk (*) following the number or letter designating a paragraph indicates that explanatory material on the paragraph can be found in Annex A.

A reference in brackets [ ] following a section or paragraph indicates material that has been extracted from another NFPA document. As an aid to the user, the complete title and edition of the source documents for extracts in mandatory sections of the document are given in Chapter 2 and those for extracts in informational sections are given in Annex B. Extracted text may be edited for consistency and style and may include the revision of internal paragraph references and other references as appropriate. Requests for interpretations or revisions of extracted text shall be sent to the technical committee responsible for the source document.

Information on referenced publications can be found in Chapter 2 and Annex B.

Chapter 1 Administration

1.1* Scope. This standard defines types of building construction based on the combustibility and the fire resistance rating of a building's structural elements. Fire walls, nonbearing exterior walls, nonbearing interior partitions, fire barrier walls, shaft enclosures, and openings in walls, partitions, floors, and roofs are not related to the types of building construction and are regulated by other standards and codes, where appropriate.

1.2 Purpose. This standard provides definitions for standard types of building construction.

1.3 Application. (Reserved)

1.4 Retroactivity.

1.4.1 The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued.

1.4.2 Unless otherwise specified, the provisions of this standard shall not apply to facilities, equipment, structures, or installations that existed or were approved for construction or installation prior to the effective date of the standard. Where specified, the provisions of this standard shall be retroactive.

1.4.3 In those cases where the authority having jurisdiction determines that the existing situation presents an unacceptable degree of risk, the authority having jurisdiction shall be permitted to apply retroactively any portions of this standard deemed appropriate.

1.4.4 The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.5 Equivalency.

1.5.1 Nothing in this standard is intended to prevent the use of systems, methods, or devices of equivalent or superior quality, strength, fire resistance, effectiveness, durability, and safety over those prescribed by this standard.

1.5.2 Technical documentation shall be submitted to the authority having jurisdiction to demonstrate equivalency. The system, method, or device shall be approved for the intended purpose by the authority having jurisdiction.

1.6 Units.

1.6.1 SI Units. Metric units in this standard are in accordance with the modernized metric system known as the International System of Units (SI).

1.6.2 Primary and Equivalent Values. If a value for a measurement as given in this standard is followed by an equivalent value in other units, the first stated value shall be regarded as the requirement. A given equivalent value might be approximate.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

2.2 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems,* 2015 edition.
NFPA *101*®, *Life Safety Code*®, 2015 edition.
NFPA 259, *Standard Test Method for Potential Heat of Building Materials,* 2013 edition.
NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components,* 2012 edition.
NFPA 5000®, *Building Construction and Safety Code*®, 2015 edition.

2.3 Other Publications.

2.3.1 ASTM Publications. ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, 2013.

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750°C,* 2012.

ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C,* 2012.

2.3.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials,* 2003, Revised 2011.

ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials,* 2008, Revised 2010.

2.3.3 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2003.

2.4 References for Extracts in Mandatory Sections.

NFPA 5000®, *Building Construction and Safety Code*®, 2015 edition.

Chapter 3 Definitions

3.1* General. The definitions contained in this chapter shall apply to the terms used in this standard. Where terms are not defined in this chapter or within another chapter, they shall be defined using their ordinarily accepted meanings within the context in which they are used. *Merriam-Webster's Collegiate Dictionary*, 11th edition, shall be the source for the ordinarily accepted meaning.

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

3.2.2* Authority Having Jurisdiction (AHJ). An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an installation, or a procedure.

3.2.3* Listed. Equipment, materials, or services included in a list published by an organization that is acceptable to the authority having jurisdiction and concerned with evaluation of products or services, that maintains periodic inspection of production of listed equipment or materials or periodic evaluation of services, and whose listing states that either the equipment, material, or service meets appropriate designated standards or has been tested and found suitable for a specified purpose.

3.2.4 Shall. Indicates a mandatory requirement.

3.2.5 Should. Indicates a recommendation or that which is advised but not required.

3.2.6 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions are not to be considered a part of the requirements of a standard and shall be located in an appendix, annex, footnote, informational note, or other means as permitted in the *Manual of Style for NFPA Technical Committee Documents.*

3.3 General Definitions.

3.3.1 Fire Resistance Rating. The time, in minutes or hours, that materials or assemblies have withstood a fire exposure as determined by the tests, or methods based on tests, prescribed by this standard. [**5000,** 2015]

3.3.2* Flame Spread Index. A number obtained according to ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials.*

3.3.3 Limited-Combustible Material. See 4.1.6.

3.3.4 Noncombustible Material. See 4.1.5.

Chapter 4 Types of Construction

4.1 General. [**5000:**7.2.1]

4.1.1* Buildings and structures shall be classified according to their type of construction, which shall be based upon one of five basic types of construction designated as Type I, Type II, Type III, Type IV, and Type V, with fire resistance ratings not less than those specified in Table 4.1.1 and Sections 4.3 through 4.6 and with fire resistance ratings meeting the requirements of Chapter 5. [**5000:**7.2.1.1]

4.1.2 Where two or more types of construction are used in the same building, the entire building shall be classified as the least type of construction in the building and shall be subject to the requirements for that type, except as permitted by other provisions of *NFPA 5000.* [**5000:**7.2.1.2]

4.1.3 Requirements for specific materials, types of construction, and fire protection shall be minimum requirements, and any material, type of construction, or fire protection affording safety or a fire resistance rating equal to or greater than that provided in *NFPA 5000*, shall be permitted. [**5000:**7.2.1.3]

4.1.4 Materials shall be in accordance with all of the following, except as modified by any special requirements in Section 4.3:

(1) *NFPA 5000*, Chapter 41, Concrete
(2) *NFPA 5000*, Chapter 42, Aluminum
(3) *NFPA 5000*, Chapter 43, Masonry
(4) *NFPA 5000*, Chapter 44, Steel
(5) *NFPA 5000*, Chapter 45, Wood
(6) *NFPA 5000*, Chapter 46, Glass and Glazing
(7) *NFPA 5000*, Chapter 47, Gypsum Board, Lath, and Plaster
(8) *NFPA 5000*, Chapter 48, Plastics

[**5000:**7.2.1.4]

4.1.5 Noncombustible Material.

4.1.5.1* The material that complies with any of the following shall be considered a noncombustible material:

(1)*The material that, in the form in which it is used and under the conditions anticipated, will not ignite, burn, support combustion, or release flammable vapors, when subjected to fire or heat
(2) The material that is reported as passing ASTM E 136, *Standard Test Method for Behavior of Materials in a Vertical Tube Furnace at 750 Degrees C*
(3) The material that is reported as complying with the pass/fail criteria of ASTM E 136 when tested in accordance with the test method and procedure in ASTM E 2652, *Standard Test Method for Behavior of Materials in a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750 Degrees C.*

[**5000:**7.1.4.1.1]

4.1.5.2 Where the term *limited-combustible* is used in this Code, it shall also include the term *noncombustible.* [**5000:**7.1.4.1.2]

Table 4.1.1 Fire Resistance Ratings for Type I through Type V Construction (hr)

	Type I		Type II			Type III		Type IV	Type V	
	442	**332**	**222**	**111**	**000**	**211**	**200**	**2HH**	**111**	**000**
Exterior Bearing Walls [a]										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting one floor only	4	3	2	1	0[b]	2	2	2	1	0[b]
Supporting a roof only	4	3	1	1	0[b]	2	2	2	1	0[b]
Interior Bearing Walls										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	2	1	0
Supporting one floor only	3	2	2	1	0	1	0	1	1	0
Supporting roofs only	3	2	1	1	0	1	0	1	1	0
Columns										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	3	2	2	1	0	1	0	H	1	0
Supporting roofs only	3	2	1	1	0	1	0	H	1	0
Beams, Girders, Trusses, and Arches										
Supporting more than one floor, columns, or other bearing walls	4	3	2	1	0	1	0	H	1	0
Supporting one floor only	2	2	2	1	0	1	0	H	1	0
Supporting roofs only	2	2	1	1	0	1	0	H	1	0
Floor-Ceiling Assemblies	2	2	2	1	0	1	0	H	1	0
Roof-Ceiling Assemblies	2	1½	1	1	0	1	0	H	1	0
Interior Nonbearing Walls	0	0	0	0	0	0	0	0	0	0
Exterior Nonbearing Walls [c]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]	0[b]

H: heavy timber members *(see text for requirements)*.
[a]See *NFPA 5000*, 7.3.2.1.
[b]See *NFPA 5000*, Section 7.3.
[c]See 4.3.2.12, 4.4.2.3, and 4.5.6.8.
[**5000:** Table 7.2.1.1]

4.1.6* Limited-Combustible Material. A material shall be considered a limited-combustible material where both of the following conditions of 4.1.6.1 and 4.1.6.2, and the conditions of either 4.1.6.3 or 4.1.6.4 are met. [**5000:**7.1.4.2]

4.1.6.1 The material does not comply with the requirements for a noncombustible material, in accordance with 4.1.5. [**5000:**7.1.4.2(1)]

4.1.6.2 The material, in the form in which it is used, exhibits a potential heat value not exceeding 3500 Btu/lb (8141 kJ/kg), when tested in accordance with NFPA 259, *Standard Test Method for Potential Heat of Building Materials*. [**5000:**7.1.4.2(2)]

4.1.6.3 The material shall have a structural base of a noncombustible material with a surfacing not exceeding a thickness of ⅛ in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials* or ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*. [**5000:**7.1.4.2.1]

4.1.6.4 The material shall be composed of materials that in the form and thickness used, neither exhibit a flame spread index greater than 25 nor evidence of continued progressive combustion when tested in accordance with ASTM E 84 or ANSI/UL 723, and are of such composition that all surfaces that would be exposed by cutting through the material on any plane would neither exhibit a flame spread index greater than 25 nor exhibit evidence of continued progressive combustion when tested in accordance with ASTM E 84 or ANSI/UL 723. [**5000:**7.1.4.2.2]

4.1.6.5 Where the term *limited-combustible* is used in this Code, it shall also include the term *noncombustible*. [**5000:**7.1.4.2.3]

4.2 Reserved.

4.3 Type I (442 or 332) and Type II (222, 111, or 000) Construction. [**5000:**7.2.3]

4.3.1 Type I and Type II Construction. Type I (442 or 332) and Type II (222, 111, or 000) construction shall be those types in which the fire walls, structural elements, walls, arches, floors, and roofs are of approved noncombustible or limited-combustible materials. [**5000:**7.2.3.1]

4.3.2 Special Requirements — Type I and Type II Construction. The special requirements in 4.3.2.1 through 4.3.2.20 shall apply to Type I and Type II construction. [**5000:**7.2.3.2]

4.3.2.1 Wood Sleepers. Where wood sleepers are used for installing wood flooring on noncombustible floors, the furring space shall be filled with noncombustible or limited-combustible material or shall be fireblocked so that there will be no open space exceeding 100 ft^2 (9 m^2) in area under the flooring. [**5000:**7.2.3.2.1]

4.3.2.2 Sleeper Space. The furring spaces created by sleepers in 4.3.2.1 shall be filled solidly under all permanent partitions to prevent spread of fire under the flooring. [**5000:**7.2.3.2.2]

4.3.2.3 Mezzanine Floors in Type I and Type II (222 or 111) Construction. Mezzanine floors in Type I and Type II (222 or 111) construction shall have a fire resistance rating of not less than 1 hour. [**5000:**7.2.3.2.3]

4.3.2.4 Mezzanine Floors in Type II (000) Construction. Mezzanine floors in Type II (000) construction shall not be required to have a fire resistance rating. [**5000:**7.2.3.2.4]

4.3.2.5 Platforms. Permanent platforms shall be constructed of noncombustible or limited-combustible materials. [**5000:**7.2.3.2.5]

4.3.2.6 Space Beneath Platforms. When the space beneath any permanent platform is used for storage or any other purpose other than equipment, wiring, or plumbing, the floor construction shall have a fire resistance rating not less than 1 hour. [**5000:**7.2.3.2.6]

4.3.2.7 Fire-Retardant-Treated Wood Platforms. Fire-retardant-treated wood shall be permitted for permanent platforms that do not exceed 3000 ft^2 (278 m^2), that are not more than 30 in. (760 mm) above the floor, and that do not occupy more than 50 percent of the floor area of the room or space in which they are located. [**5000:**7.2.3.2.7]

4.3.2.8 Roofs 20 ft (6100 mm) or More Above Any Floor. In occupancies other than mercantile, industrial, or storage occupancies with ordinary or high hazard contents, or other occupancies with high hazard contents exceeding the maximum allowable quantities (MAQ) per control area as set forth in 34.1.3 of *NFPA 5000*, the fire-resistive protection of the roof-ceiling assembly required by Table 4.1.1 shall not be required where every part of the roof/ceiling assembly is 20 ft (6100 mm) or more above any floor immediately below. [**5000:**7.2.3.2.8]

4.3.2.9 Fire-Retardant-Treated Wood Roof. [**5000:**7.2.3.2.9]

4.3.2.9.1 Fire-retardant-treated wood members shall be permitted to be used for unprotected members specified in 4.3.2.8. [**5000:**7.2.3.2.9.1]

4.3.2.9.2 Fire-retardant-treated wood shall be permitted for roof construction, including girders and trusses, under the following conditions:

(1) In Type II buildings
(2) In Type I buildings where the number of stories is two or fewer
(3) In Type I buildings where the number of stories is three or more when the vertical distance from the floor to the roof is 20 ft (6100 mm) or more

[**5000:**7.2.3.2.9.2]

4.3.2.10 Heavy Timber Structural Elements. In all occupancies, heavy timber structural members shall be permitted to be used for the roof construction where a 1-hour fire resistance rating or less is required. [**5000:**7.2.3.2.10]

4.3.2.11 Interior Nonbearing Walls. [**5000:**7.2.3.2.11]

4.3.2.11.1 Interior nonbearing walls shall be constructed of noncombustible or limited-combustible materials. [**5000:**7.2.3.2.11.1]

4.3.2.11.2 Interior nonbearing walls required to have a fire resistance rating of 2 hours or less shall be permitted to be fire-retardant-treated wood enclosed within noncombustible or limited-combustible materials, provided that such walls are not used as shaft enclosures. [**5000:**7.2.3.2.11.2]

4.3.2.12 Exterior Nonbearing Walls. Nonbearing exterior walls shall be constructed of noncombustible materials, limited-combustible materials, or materials specified in 4.3.2.12.1 or 4.3.2.12.2. [**5000:**7.2.3.2.12]

4.3.2.12.1 Fire-retardant-treated wood shall be permitted in exterior nonbearing walls when such walls are not required to have fire resistance ratings. [**5000:**7.2.3.2.12.1]

4.3.2.12.2 Exterior nonbearing walls tested in accordance with, and meeting the conditions of acceptance of, NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*, shall be permitted. [**5000:**7.2.3.2.12.2]

4.3.2.13 Combustible Materials. Combustible materials shall be permitted in accordance with the following:

(1) Foam plastic insulation complying with Section 48.4 of *NFPA 5000*
(2) Metal composite material complying with Section 37.4 of *NFPA 5000*
(3) Thermal and acoustical insulation, other than foam plastic, complying with Section 8.16 of *NFPA 5000*
(4) Interior floor finish and interior finish, trim, and millwork, such as doors, door frames, window sashes, and window frames
(5) Light-transmitting plastic complying with Sections 38.11 and 48.7 of *NFPA 5000*
(6) Class A, Class B, or Class C roof coverings
(7) Blocking

[**5000:**7.2.3.2.13]

4.3.2.14 Ceiling Cavity Plenums and Raised Floor Plenums. The space between the top of the finished ceiling and the underside of the floor or roof above and the space between the top of the finished floor and the underside of a raised floor shall be permitted to be used to supply air to the occupied area or return and exhaust air from the occupied area, provided that the requirements of 4.3.2.15 through 4.3.2.20 are met.

4.3.2.15 Plenum Materials Combustibility. Materials exposed to the airflow within ceiling cavity plenums and raised floor plenums shall comply with NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

4.3.2.15.1 Fire-retardant-treated wood complying with, Chapter 45 of *NFPA 5000* shall be permitted.

4.3.2.16 Plenum Fire Stopping. The integrity of the fire stopping for penetrations shall be maintained.

4.3.2.17 Plenum Light Diffusers. Light diffusers, other than those made of metal or glass, used in air-handling light fixtures shall be listed and marked as follows:

Fixture Light Diffusers for Air-Handling Fixtures

4.3.2.18 Plenum Air Temperature. The temperature of air delivered to plenums shall not exceed 250°F (121°C).

4.3.2.19 Plenum Materials Exposure. Materials used in the construction of a plenum shall be suitable for continuous exposure to the temperature and humidity conditions of the environmental air in the plenum.

4.3.2.20 Ceiling Plenum Tested Assembly. Where the plenum is a part of a floor/ceiling or roof/ceiling assembly that has been tested or investigated and assigned a fire resistance rating of 1 hour or more, and the assembly contains air ducts and openings for air ducts, all the materials and the construction of the assembly, including the air duct materials and the size and protection of the openings, shall conform with the design of the fire resistance–rated assembly, as tested in accordance with ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*; or UL 263, *Standard for Fire Tests of Building Construction and Materials*. [**5000:**8.2.1.4]

4.4 Type III (211 or 200) Construction. [**5000:**7.2.4]

4.4.1 Type III Construction. Type III (211 or 200) construction shall be that type in which exterior walls and structural elements that are portions of exterior walls are of approved noncombustible or limited-combustible materials, and in which fire walls, interior structural elements, walls, arches, floors, and roofs are entirely or partially of wood of smaller dimensions than required for Type IV construction or are of approved noncombustible, limited-combustible, or other approved combustible materials. [**5000:**7.2.4.1]

4.4.2 Special Requirements — Type III Construction. The special requirements in 4.4.2.1 through 4.4.2.3 shall apply to Type III construction. [**5000:**7.2.4.2]

4.4.2.1 Fire-Retardant-Treated Wood. Approved fire-retardant-treated wood framing shall be permitted within the assembly of exterior walls having a required fire resistance rating of 2 hours or less and a horizontal separation of not less than 60 in. (1525 mm), provided that the fire resistance rating is maintained and the exposed outer and inner faces of such walls are constructed of limited-combustible or noncombustible materials. [**5000:**7.2.4.2.1]

4.4.2.2 Heavy Timber. Wood columns and arches conforming to heavy timber sizes shall be permitted where exterior walls are required to have a 1-hour fire resistance rating or less. [**5000:**7.2.4.2.2]

4.4.2.3 Exterior Nonbearing Walls. Exterior nonbearing walls tested in accordance with, and meeting the conditions of acceptance of, NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*, shall be permitted. [**5000:**7.2.4.2.3]

4.5 Type IV (2HH) Construction. [**5000:**7.2.5]

4.5.1 Type IV Construction. Type IV (2HH) construction shall be that type in which fire walls, exterior walls, and interior bearing walls and structural elements that are portions of such walls are of approved noncombustible or limited-combustible materials. Other interior structural elements, arches, floors, and roofs shall be of solid or laminated wood without concealed spaces and shall comply with the allowable dimensions of 4.5.5. [**5000:**7.2.5.1]

4.5.2 Exterior Wall Separation. Exterior walls greater than 30 ft (9.1 m) from the property line shall be permitted to be of heavy timber construction, provided that the 2-hour rating as required by Table 4.1.1 is maintained and such walls contain no combustible concealed spaces. [**5000:**7.2.5.2]

4.5.3 Interior Columns, Arches, Beams, Girders, and Trusses. Interior columns, arches, beams, girders, and trusses of approved materials other than wood shall be permitted, provided that they are protected to provide a fire resistance rating of not less than 1 hour. [**5000:**7.2.5.3]

4.5.4 Concealed Space. Certain concealed spaces shall be permitted in accordance with 4.5.5.3.4. [**5000:**7.2.5.4]

4.5.5 Type IV (2HH) Allowable Dimensions. All dimensions in 4.5.5 shall be considered nominal. [**5000:**7.2.5.5]

4.5.5.1 Columns. [**5000:**7.2.5.5.3]

4.5.5.1.1 Wood columns supporting floor loads shall be not less than 8 in. (205 mm) in any dimension. [**5000:**7.2.5.5.3.1]

4.5.5.1.2 Wood columns supporting only roof loads shall be not less than 6 in. (150 mm) in width and not less than 8 in. (205 mm) in depth. [**5000:**7.2.5.5.3.2]

4.5.5.2 Beams. [**5000:**7.2.5.5.4]

4.5.5.2.1 Wood beams and girders supporting floor loads shall be not less than 6 in. (150 mm) in width and not less than 10 in. (255 mm) in depth. [**5000:**7.2.5.5.4.1]

4.5.5.2.2 Wood beams and girders and other roof framing supporting roof loads only shall be not less than 4 in. (100 mm) in width and not less than 6 in. (150 mm) in depth. [**5000:**7.2.5.5.4.2]

4.5.5.3 Arches. [**5000:**7.2.5.5.5]

4.5.5.3.1 Framed or glued laminated arches that spring from grade or the floor line, and timber trusses that support floor loads, shall be not less than 8 in. (205 mm) in width or depth. [**5000:**7.2.5.5.3.1]

4.5.5.3.2 Framed or glued laminated arches for roof construction that spring from the finished ground level or the floor line and do not support floor loads shall have members not less than 6 in. (150 mm) in width and not less than 8 in. (205 mm) in depth for the lower half of the member height and not less than 6 in. (150 mm) in depth for the upper half of the member height. [**5000:**7.2.5.5.5.2]

4.5.5.3.3 Framed or glued laminated arches for roof construction that spring from the top of walls or wall abutments, and timber trusses that do not support floor loads, shall have members not less than 4 in. (100 mm) in width and not less than 6 in. (150 mm) in depth. [**5000:**7.2.5.5.5.3]

4.5.5.3.4 Spaced members shall be permitted to be composed of two or more pieces not less than 3 in. (75 mm) in thickness where blocked solidly throughout their intervening spaces or where such spaces are tightly closed by a continuous wood cover plate not less than 2 in. (51 mm) in thickness that is secured to the underside of the members. [**5000:**7.2.5.5.5.4]

4.5.5.4 Splice Plates. Splice plates shall be not less than 3 in. (75 mm) in thickness. [**5000:**7.2.5.5.6]

4.5.5.5 Floors. Floors shall be constructed of spline or tongue-and-groove plank not less than 3 in. (75 mm) in thickness that is covered with 1 in. (25 mm) tongue-and-groove flooring, laid crosswise or diagonally to the plank, or with ½ in. (13 mm) wood structural panel; or they shall be constructed of laminated planks not less than 4 in. (100 mm) in width, set close together on edge, spiked at intervals of 18 in. (455 mm), and covered with 1 in. (25 mm) tongue-and-groove flooring, laid crosswise or diagonally to the plank, or with ½ in. (13 mm) wood structural panel. [**5000:**7.2.5.5.7]

4.5.5.6 Roof Decks. Roof decks shall be constructed of spline or tongue-and-groove plank not less than 2 in. (51 mm) in thickness; or of laminated planks not less than 3 in. (75 mm) in width, set close together on edge, and laid as required for floors; or of 1⅛ in. (29 mm) thick interior wood structural panel (exterior glue); or of approved noncombustible or limited-combustible materials of equivalent fire durability. [**5000:**7.2.5.5.8]

4.5.6 Special Requirements — Type IV Construction. The special requirements in 4.5.6.1 through 4.5.6.8 shall apply to Type IV construction. [**5000:**7.2.5.6]

4.5.6.1 Structural Elements. Structural elements shall be of heavy timber members (sawn or glued-laminated) or of fire resistance–rated construction as set forth in Table 4.1.1 when materials other than heavy timber are used. [**5000:**7.2.5.6.1]

4.5.6.2 Columns, Arches, Beams, and Roof Decking. Where horizontal separation of 20 ft (6100 mm) or more is provided, wood columns, arches, beams, and roof decking conforming to the requirements for heavy timber in 4.5.5 shall be permitted to be used on the exterior of the building. [**5000:**7.2.5.6.2]

4.5.6.3 Partitions. Permanent partitions shall be permitted to be of solid wood construction formed by not less than two layers of matched boards of 1 in. (25 mm) nominal thickness or of 1-hour fire resistance–rated construction as set forth in Table 4.1.1. [**5000:**7.2.5.6.3]

4.5.6.4 Floors. Floors shall be permitted to be of heavy timber, masonry, concrete, wood, or steel and shall be constructed as required in Chapter 8 of *NFPA 5000*. [**5000:**7.2.5.6.4]

4.5.6.5 Roofs. Roofs of 1-hour fire resistance–rated construction shall be permitted. [**5000:**7.2.5.6.5]

4.5.6.6 Stairways. [**5000:**7.2.5.6.6]

4.5.6.6.1 Stairways shall be permitted to be constructed with wood treads and risers of not less than 2 in. (51 mm) nominal thickness. [**5000:**7.2.5.6.6.1]

4.5.6.6.2 Where built-on, laminated, or plank inclines are required for floors, stairways shall be permitted to be 1 in. (25 mm) nominal thickness or shall be permitted to be constructed as required for buildings of Type I or Type II construction. [**5000:**7.2.5.6.6.2]

4.5.6.7 Exterior Walls. Approved fire-retardant-treated wood framing shall be permitted within the assembly of exterior walls having a required fire resistance rating of 2 hours or less and a horizontal separation of not less than 60 in. (1525 mm), provided that the fire resistance rating is maintained and the exposed outer and inner faces of such walls are constructed of limited-combustible or noncombustible materials. [**5000:**7.2.5.6.7]

4.5.6.8 Exterior Nonbearing Walls. Exterior nonbearing walls tested in accordance with, and meeting the conditions of acceptance of, NFPA 285, *Standard Fire Test Method for Evaluation of Fire Propagation Characteristics of Exterior Non-Load-Bearing Wall Assemblies Containing Combustible Components*, shall be permitted. [**5000:**7.2.5.6.8]

4.6 Type V (111 or 000) Construction. Type V (111 or 000) construction shall be that type in which structural elements, walls, arches, floors, and roofs are entirely or partially of wood or other approved material. [**5000:**7.2.6]

Chapter 5 Fire Resistance Rating Requirements for Structural Elements

5.1 Fire Resistance Rating Requirements.

5.1.1 The fire resistance ratings of structural elements and building assemblies shall be determined in accordance with Section 8.2 in *NFPA 5000, Building Construction and Safety Code*, or 8.2.3 in NFPA *101, Life Safety Code*.

5.1.2 Fire resistance protection shall be provided for structural elements as set forth in Chapter 5.

5.1.3 Structural elements shall meet the requirements of 5.1.3.1 through 5.1.3.3.

5.1.3.1 Structural elements, floors, and bearing walls shall have a fire resistance rating not less than the fire resistance rating required for the structural element, bearing or nonbearing wall, floor, or roof they support. [**5000:**7.2.7.2.1]

5.1.3.2 Structural elements, floors, and bearing walls shall be required to have only the fire resistance rating required for the construction classification of the building, provided that both of the following criteria are met:

(1) The structural elements support nonbearing wall or partition assemblies having a required fire resistance rating of 1 hour or less.
(2) The structural elements do not serve as exit enclosures, protection for vertical openings, or occupancy separations.

[**5000:**7.2.7.2.2]

5.1.3.3 Structural elements, such as girders, beams, trusses, and spandrels, that have direct connections to columns carrying gravity loads, and that are essential to the stability of the building as a whole, shall have a fire resistance rating not less than that of the columns to which they are connected. [**5000:**7.2.7.2.3]

5.1.4 Structural elements required to have a fire resistance rating and that support more than two floors, one floor and roof, a bearing wall, or a nonbearing wall more than two stories high shall be individually protected on all sides for their full length with materials providing the required fire resistance rating. [**5000:**7.2.7.3]

5.1.5* Structural elements, other than those specified in 5.1.3, required to have a fire resistance rating shall be protected by individual encasement, or by membrane or ceiling protection in accordance with *NFPA 5000*, Section 8.6, or a combination of both. [**5000:**7.2.7.4]

5.1.6 In addition to the requirements of 5.1.3 and 5.1.4, columns shall meet the following requirements:

(1) Where columns require a fire resistance rating, the entire column, including its connections to beams or girders, shall be individually protected.
(2) Where the column extends through a ceiling, the fire-resistive protection provided for the column shall be continuous from the top of the floor through the ceiling space to the top of the column.

[**5000:**7.2.7.5]

5.1.7 Structural elements complying with Section 4.5 shall not be required to comply with 5.1.4. [**5000:**7.2.7.6]

5.1.8 The required thickness and construction of fire-resistive materials or assemblies enclosing trusses shall be based on one of the following:

(1) Results of full-scale tests or combinations of tests on truss components
(2) Approved calculations based on such tests to verify that the assembly is provided with the required fire resistance rating in accordance with 8.2.3 of *NFPA 5000*

[**5000:**7.2.7.7]

5.1.9 The fire resistance rating required for external structural elements located beyond the perimeter of the building floor area shall be permitted to be calculated by using analytical methods in accordance with the provisions set forth in 8.2.3 of *NFPA 5000*. [**5000:**7.2.7.8]

5.1.10 Structural elements within exterior walls or located along the exterior perimeter of a building or structure shall have a fire resistance rating as required by Table 4.1.1 for exterior bearing walls based on the type of construction. [**5000:**7.2.7.9]

5.1.11* Structural elements within an exterior wall located where openings are not permitted, or where protection of openings is required in accordance with 7.3.5 of *NFPA 5000*, shall have a fire resistance rating based on protection against exterior fire exposure as required for exterior bearing walls or the structural element, whichever requires the greater fire resistance rating. [**5000:**7.2.7.10]

5.1.12 The edges of lugs, brackets, rivets, and bolt heads attached to structural elements shall be permitted to extend to within 1 in. (25 mm) of the surface of the fire-resistive protection. [**5000:**7.2.7.11]

5.1.13 Conduits, pipes, or ducts shall not be embedded within the required fire-resistive protection of any structural elements requiring individual encasement to achieve the required fire resistance rating. [**5000:**7.2.7.12]

5.1.14 Fire-resistive materials covering columns required to have a fire resistance rating, where exposed to impact damage by moving vehicles, handling of merchandise, or by other means, shall be protected from damage. [**5000:**7.2.7.13]

5.1.15 In load bearing, light frame walls requiring a fire resistance rating, membrane protection shall not be required to extend beyond the edge or flange of the construction in openings that are framed or where doors or windows are installed. [**5000:**7.2.7.14]

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 It is necessary for the user to consider the influence of location, occupancy, exterior exposure, possibility of mechanical and physical damage to fire-resistant material, and other features that could impose additional requirements for safeguarding life and property, as commonly covered in building codes.

For information on the construction of fire walls and fire barrier walls, see NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*. For the installation of opening protection, see NFPA 80, *Standard for Fire Doors and Other Opening Protectives* and NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*.

A.3.1 These definitions apply to the materials used in the construction of buildings but do not apply to furnishings, the contents of buildings, or the fire hazard evaluation of materials.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A.3.2.3 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.2 Flame Spread Index. Under the criteria of ASTM E 84, *Standard Test Method for Surface Burning Characteristics of Building Materials,* and ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials* the flame spread index is expressed numerically on a scale for which the zero point is fixed by the performance of inorganic-reinforced cement board and the

100 point (approximately) is fixed by the performance of untreated red oak flooring.

A.4.1.1 The system of designating types of construction also includes a specific breakdown of the types of construction through the use of Arabic numbers. These Arabic numbers follow the roman numeral notation where identifying a type of construction [eg., Type I(442), Type II(111), Type III(200)] and indicate the fire resistance rating requirements for certain structural elements as follows:

(1) First Arabic number — exterior bearing walls
(2) Second Arabic number — columns, beams, girders, trusses and arches, supporting bearing walls, columns, or loads from more than one floor
(3) Third Arabic number — floor construction

Table A.4.1.1 provides a comparison of similar types of construction for various model building codes.
[**5000:** A.7.2.1.1]

A.4.1.5.1 The provisions of 4.1.5.1 do not require inherently noncombustible materials to be tested in order to be classified as noncombustible materials. [**5000:** A.7.1.4.1]

A.4.1.5.1(1) Examples of such materials include steel, concrete, masonry, and glass. [**5000:** A.7.1.4.1.1(1)]

A.4.1.6 Material subject to increase in combustibility or flame spread index beyond the limits herein established through the effects of age, moisture, or other atmosphereic condition is considered combustible. *(See NFPA 259, Standard Test Method for Potential Heat of Building Materials.)*

A.5.1.5 Fire resistance–rated bearing wall assemblies, floor/ceiling assemblies, and roof/ceiling assemblies that are not addressed by 5.1.4 can intersect and provide protection to each other to the extent that the same level of protection is provided by the individual protective elements that intersect.

A.5.1.11 It is not the intent to require protection of structural elements against exterior fire exposure due merely to the presence of fire sprinklers or an occupiable exterior space, such as a porch or balcony, unless specifically required by other codes, such as *NFPA 5000, Building Construction and Safety Code.*

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 80, *Standard for Fire Doors and Other Opening Protectives*, 2013 edition.

NFPA 90A, *Standard for the Installation of Air-Conditioning and Ventilating Systems*, 2015 edition.

NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls*, 2015 edition.

B.1.2 Other Publications.

B.1.2.1 ASTM Publications. ASTM International, P.O. Box C700, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

ASTM E 84, *Standard Test Method of Surface Burning Characteristics of Building Materials*, 2013.

ASTM E 119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2012a.

B.1.2.2 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

ANSI/UL 263, *Standard for Fire Tests of Building Construction and Materials*, 2003, Revised 2011.

ANSI/UL 723, *Standard for Test for Surface Burning Characteristics of Building Materials*, 2008, Revised 2010.

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections.

NFPA 5000®, Building Construction and Safety Code®, 2015 edition.

Table A.4.1.1 Cross-Reference of Building Construction Types

NFPA 5000	I(442)	I(332)	II(222)	II(111)	II(000)	III(211)	III(200)	IV(2HH)	V(111)	V(000)
UBC	—	I FR	II FR	II 1 hr	II N	III 1 hr	III N	IV HT	V 1 hr	V N
B/NBC	1A	1B	2A	2B	2C	3A	3B	4	5A	5B
SBC	I	II	—	IV 1 hr	IV UNP	V 1 hr	V UNP	III	VI 1 hr	VI UNP
IBC	—	IA	IB	IIA	IIB	IIIA	IIIB	IV	VA	VB

UBC: *Uniform Building Code.*
FR: Fire rated.
N: Nonsprinklered.
HT: Heavy timber.
B/NBC: *National Building Code.*
SBC: *Standard Building Code.*
IBC: *International Building Code.*
UNP: Unprotected.
[**5000:** Table A.7.2.1.1]

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NFPA® 221

Standard for

High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls

2015 Edition

This edition of NFPA 221, *Standard for High Challenge Fire Walls, Fire Walls, and Fire Barrier Walls,* was prepared by the Technical Committee on Building Construction. It was issued by the Standards Council on April 29, 2014, with an effective date of May 19, 2014, and supersedes all previous editions.

This edition of NFPA 221 was approved as an American National Standard on May 19, 2014.

Origin and Development of NFPA 221

The Technical Committee on Building Construction undertook a project to develop a new document to govern fire walls in 1991. At the time, no standard existed to assist code authorities, architects, or engineers on the criteria that were necessary to properly design and construct a fire wall. The first edition of NFPA 221 was issued in 1994. It contained information on various types of fire walls including basic design criteria, proper protection of penetrations, and special design practices for exterior protection features.

The 1997 edition of NFPA 221 contained several changes, including the addition of specific criteria for treatment of seismic separation assemblies, additional criteria for proper protection of raceway penetrations, and the addition of several suggested protection schemes for properly protecting an egress door located in a fire wall.

The 2000 edition addressed specific testing criteria for performance of rated assemblies that included expansion, seismic, and control joints in fire wall and fire barrier wall assemblies. In addition, a second test protocol was recognized for tests of through penetrations.

The 2006 edition introduced two distinct types of fire walls. Presented in Chapter 5, the "high challenge fire wall" requirements are an evolution of the fire wall requirements found in the 2000 edition of NFPA 221, while the "fire wall" requirements presented in Chapter 6 are based upon the requirements found in the 2003 edition of *NFPA 5000®, Building Construction and Safety Code®*. Chapter 4 of this document contains extracts from *NFPA 5000*, Chapter 8, on such topics as analytical methods, duct and air-transfer openings, joints, opening protectives, and penetrations. Please note these extracts were stylistically adjusted to reflect this document's exclusive focus on walls by eliminating references to floors, floor-ceiling assemblies, smoke dampers, and partitions.

The 2009 edition was updated to reflect changes to Chapter 8 of *NFPA 5000*. Other changes included recognition of the new criteria used to determine building height and grade geometries, further clarifications as to where a provision applies to a particular type of wall, and the addition of a new requirement concerning horizontal exits served by bridges between buildings.

The 2012 edition was a reaffirmation of the previous edition, with updated references to reflect changes in UL and ASTM documents.

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For the 2015 edition, extracts from *NFPA 5000* have been removed. *NFPA 5000* now extracts material from NFPA 221. Definitions and referenced documents have also been updated.

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This list represents the membership at the time the Committee was balloted on the final text of this edition. Since that time, changes in the membership may have occurred. A key to classifications is found at the back of the document.

NOTE: Membership on a committee shall not in and of itself constitute an endorsement of the Association or any document developed by the committee on which the member serves.

Committee Scope: This committee shall have primary responsibility for documents on the selection and design of types of building construction, exterior walls, building height and area, fire walls, and fire barrier walls, as they relate to the protection of life and property from fire. For the processing of NFPA 5000, Chapter 7, and Sections 8.3 and 8.4, this committee reports directly to the NFPA 5000 TCC; whereas, for the processing of NFPA 220 and NFPA 221, this committee does not report to the NFPA 5000 TCC.