

NFPA[®] 13

Standard for the Installation of Sprinkler Systems

2025 Edition



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NFPA® 13

Standard for the

Installation of Sprinkler Systems

2025 Edition

This edition of NFPA 13, *Standard for the Installation of Sprinkler Systems*, was prepared by the Technical Committees on Hanging and Bracing of Water-Based Fire Protection Systems, Private Water Supply Piping Systems, Sprinkler System Discharge Criteria, and Sprinkler System Installation Criteria, released by the Correlating Committee on Automatic Sprinkler Systems and acted on by the NFPA membership during the 2024 NFPA Technical Meeting held June 20, 2024. It was issued by the Standards Council on August 29, 2024, with an effective date of September 18, 2024, and supersedes all previous editions.

This document has been amended by one or more Tentative Interim Amendments (TIAs) and/or Errata. See “Codes & Standards” at www.nfpa.org for more information.

This edition of NFPA 13 was approved as an American National Standard on September 18, 2024.

Origin and Development of NFPA 13

NFPA 13 represents the first standard published under the auspices of the NFPA Committee on Automatic Sprinklers. Originally titled *Rules and Regulations of the National Board of Fire Underwriters for Sprinkler Equipments, Automatic and Open Systems*, the standard has been continuously updated to keep in step with change.

Full information about the NFPA actions on various changes will be found in the NFPA Proceedings. The dates of successive editions are as follows: 1896, 1899, 1902, 1905, 1907, 1908, 1912, 1913, 1915, 1916, 1917, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929. In 1930, a separate standard was published on Class B systems. This was integrated into the 1931 edition. Further revisions were adopted in 1934, 1935, and 1936. A two-step revision was presented in the form of a progress report in 1939 and finally adopted in 1940. Further amendments were made in 1947, 1950, 1953, 1956, 1958, 1960, 1961, 1963, 1964, 1965, 1966, 1968, 1969, 1971, 1972, 1973, 1974, 1975, 1976, 1978, 1980, 1982, 1984, 1986, and 1989.

The 1991 edition incorporated an entire rewrite of the standard to make the overall format user friendly. Substantive changes were made to numerous terms, definitions, and descriptions, with additional refinements made in 1994.

The centennial (1996) edition included a significant rework of the requirements pertaining to the application, placement, location, spacing, and use of various types of sprinklers. Other changes provided information on extended coverage sprinklers and recognized the benefits of fast-response sprinkler technology.

The 1999 edition encompassed a major reorganization of NFPA's Sprinkler Project that included the establishment of a Technical Correlating Committee on Automatic Sprinkler Systems and four new sprinkler systems technical committees, the consolidation of NFPA's sprinkler system design and installation requirements, and the implementation of numerous technical changes.

The scope of NFPA 13 was expanded to address all sprinkler system applications. The 1999 edition contained information on the installation of underground pipe from NFPA 24 and sprinkler system discharge criteria for on-floor and rack storage of Class I, II, III, IV, and plastic commodities, rubber tires, baled cotton, and roll paper that were previously located in NFPA 231, 231C, 231D, 231E, and 231F. Additionally, sprinkler system information for specialized hazards from over 40 NFPA documents was either brought into NFPA 13 using NFPA's extract policy or specifically referenced. A new chapter was also added to address the structural aspects of exposed and buried system piping. A table of cross-references to previous editions and material that was in other NFPA documents was included at the end of the 1999 edition.

Other specific changes included a new sprinkler identification marking system and the designation of sprinkler sizes by nominal K-factors. New criteria for the use of steel pipe in underground applications was added, as well as a new provision to guard against microbiologically influenced corrosion. Obstruction rules for specific sprinkler types and rules for locating sprinklers in concealed spaces were revised. New limitations were placed on the sprinkler sizes in storage applications, and criteria for the K-25 sprinkler was added. Additionally, the requirements for protecting sprinklers against seismic events also underwent significant revision.

The 2002 edition of NFPA 13 underwent style formatting and technical revisions. The style formatting was completed to comply with the *Manual of Style for NFPA Technical Committee Documents* and to reorganize many of the requirements in NFPA 13 into unique chapters. Editorially, NFPA 13 eliminated all the exceptions and reworded them as requirements where applicable, moved the mandatory references to Chapter 2, and relocated all the definitions to Chapter 3. In reorganizing NFPA 13, several new chapters were created to consolidate requirements including the following: Chapter 10 contained all of the applicable requirements for underground piping including materials, installation, and acceptance testing; Chapter 11 contained design approaches including pipe schedule, density/area method, room design method, special design areas, residential sprinklers, exposure protection, and water curtains; Chapter 12 contained the design approaches for the protection of storage, including idle pallets, miscellaneous storage, storage less than 12 ft, palletized, solid pile, bin box, and shelf storage, rack storage less than 25 ft, rack storage greater than 25 ft, rubber tire, baled cotton, rolled paper, and special storage designs; and Chapter 13 contained all of the design and installation requirements from all of the various documents that have been extracted into NFPA 13.

The 2002 edition made specific technical changes to address several key issues. Three major areas of irregular ceiling were addressed, including skylights, stepped ceilings, and ceiling pockets. The design requirements for ESFR sprinklers were expanded to allow the user to choose the storage height and then the building height for any allowable arrangement. Design requirements for the protection of storage on solid shelves were added. Requirements for the installation of residential sprinklers were added that parallel the requirements for other types of sprinklers.

For the 2007 edition, definitions were reorganized to place all the storage definitions in one area, and several new definitions addressing private water supply terms were added. The definitions and requirements of Ordinary Hazard Group 1 and 2 Occupancies were clarified where storage is present. The requirements for trapeze hangers were clarified and made consistent for all components, and the seismic bracing criteria were updated to ensure that NFPA 13 contains all the appropriate requirements for installation and design of seismic bracing of fire sprinkler systems. The requirements for storage were further reorganized and divided into separate chapters addressing general requirements for storage; miscellaneous storage; protection of Class I to Class IV commodities that are stored palletized, solid piled, bin boxes, or shelf storage; protection of plastic and rubber commodities that are stored palletized, solid piled, bin boxes, or shelf storage; protection of Class I through Class IV commodities that are stored on racks; protection of plastic and rubber commodities that are stored on racks; protection of rubber tire storage; protection of roll paper; and special designs of storage protection.

For the 2010 edition, many of the major changes related to the requirements for storage protection. First was the combination of large drop sprinkler and the specific application control mode sprinkler requirements and the revision of the terminology to identify them as Control Mode Specific Application sprinklers (CMSA). Next, new criteria for use of smoke vents were added to Chapter 12. The density/area curves in the storage chapters were reduced to a maximum 3000 ft² (278 m²) operating area; this was a significant reduction of some curves that had extended up to 6000 ft² (557 m²). Changes to rack storage in the 2010 edition included a new method to calculate the rack shelf area. Finally, the provisions for back-to-back shelf storage were added to the storage chapters.

Criteria for the protection of three new special storage arrangements were added to Chapter 20. These included protection of carton records storage with catwalk access; compact shelving of commodities consisting of paper files, magazines, books, and similar documents in folders and miscellaneous supplies with no more than 5 percent plastics up to 8 ft high; and protection of high bay record storage.

In Chapter 9, several changes occurred regarding sway bracing of sprinkler systems, including the introduction of new zone of influence tables for Schedule 5 steel pipe, CPVC, and Type M copper tube. Also the means for calculating the loads in the zone of influence were modified to correlate with SEI/ASCE-7, and a new Annex E was added that described this calculation.

Other areas of change included requirements for listed expansion chambers; clarification of ceiling pocket rules; and clarification of the formulas used in calculating large antifreeze systems.

The 2013 edition of NFPA 13 included changes to many technical requirements as well as the reorganization of multiple chapters. One significant change that was made to the administrative chapter of NFPA 13 was to clarify that watermist systems were not covered within NFPA 13 and that NFPA 750 should be used when looking for guidance on the design and installation of those systems. A series of new requirements addressed the need for a compatibility review where nonmetallic piping and fittings are installed in systems also using petroleum-based products such as cutting oils and corrosion inhibitors. Several modifications were made to the standard pertaining to freeze protection. The use of antifreeze in new NFPA 13 sprinkler systems was prohibited unless the solution use was listed, and the listing indicated the inability for the solution to ignite.

Other freeze protection modifications to the standard included clarification on the use of heat tracing, required barrel length for dry sprinklers, and the allowance for engineering analyses to be submitted to support an alternate freeze protection scheme. New sprinkler omission requirements were added for elevator machine rooms and other elevator associated spaces where certain criteria were met. Chapter 9 included updated information on shared support structures as well as a revised seismic bracing calculation form. Chapters 16 and 17 were reorganized to make the chapters easier to follow, to create more consistency between the various storage chapters. A new chapter on alternative approaches for storage applications was added to provide guidance on performance-based approaches dealing with storage arrangements.

One of the largest changes to the 2016 edition of NFPA 13 was the review of all metric conversions. Historically the document had used an “exact” conversion process, but in the 2016 edition an approximate conversion process was used. The intent of this change was to make the document more usable outside the United States. Another major change was the inclusion of a pipe venting requirement to eliminate as much air as possible from wet pipe systems. This requirement contemplates only a single vent in each wet system.

There were a significant number of changes to the storage chapters of NFPA 13. New design criteria were included for the protection of exposed, expanded Group A plastics stored in racks. Also, a ceiling and in-rack design approach, called an “alternative protection scheme,” was added to Chapters 16 and 17. A similar concept had existed for sprinkler protection in NFPA 30 for several revision cycles.

A new section on sprinkler design where cloud ceilings are installed was added. This design scheme allows sprinklers to be omitted above cloud ceilings when the gap between clouds (or clouds and walls) meets a maximum allowable dimension based on the floor-to-cloud ceiling height. This new language was created based on a project conducted by the Fire Protection Research Foundation. Chapter 10, which is extracted from NFPA 24, was significantly revised based on the rewrite of NFPA 24. Most of the technical content remained the same, although the organization and structure were modified.

The 2019 edition of NFPA 13 has undergone a complete reorganization and is now fashioned in order of how one would approach the design of a sprinkler system. Users will now find hazard classifications, water supplies, and underground piping at the beginning of the standard. Chapter 8 has been divided into several new chapters, breaking out general rules for sprinkler locations into one chapter and several other chapters specific to sprinkler technology. The storage chapters have also been reorganized by sprinkler technology and address ceiling-only design. Chapter 25 has been revised and now contains all the requirements for in-rack sprinklers.

Requirements for vertical pipe chases have been clarified as have requirements for electrical equipment rooms where sprinklers can be omitted. Additionally, new beam rules for residential sprinklers have been added and details provided.

Due to the extensive reorganization of the 2019 edition, new features were added to help users locate requirements and identify sections with technical changes. The 2016–2019 Roadmap comparing the section numbers of the 2016 edition to the 2019 edition was compiled and is located after the index. It was provided for information only, to be used as a quick-reference locator. Technical changes from the last edition were also indicated and should be used as a guide. Shaded text identified requirements that were modified because of additions and deletions except for tables and figures. New requirements were marked with the N symbol. Users can view complete revision details in the First and Second Draft Reports in the NFPA 13 archived revision section at www.nfpa.org/docinfo.

Previous editions of this document have been translated into languages other than English, including French and Spanish.

The 2022 edition of NFPA 13 underwent a philosophical change, moving away from the use of density/area curves in favor of single-point density design options for new systems. Existing systems can still use the density/area curves. Many new definitions were added and several existing definitions were modified. Several revisions to Chapter 4 delineate miscellaneous and low-piled storage requirements. As nitrogen generators were new to NFPA 13, supplementary requirements were added throughout the standard. Considerations associated with water flow tests have been added to Chapter 5. Supervision requirements for dry pipe systems were added to Chapter 8. Requirements were added to Chapter 9 to address the use of intermediate-temperature residential and quick-response sprinklers. Also, a new section on small, temporarily occupied spaces was added to address conditions where pods are installed. Obstruction criteria was added for suspended or floor-mounted obstructions in ordinary-hazard occupancies. Chapter 14's ESFR sprinkler location criteria were modified, and obstruction requirements were revised to align with the results of a recent Fire Protection Research Foundation report.

In Chapter 16, the process for determining whether freeze protection is needed has been modified to require the use of the lowest mean temperature for 1 day, obtained for an approved source, and no longer permits the use of the isothermal map. Also, criteria were added to address the protection of piping subject to mechanical damage.

Criteria on multiple-row rack depth was added to Chapter 20, and several tables throughout the storage chapters were revised or reconfigured. New ESFR sprinklers with K-factors of K-28 (400) and K-33.6 (480) were added to Chapter 23. Chapter 25 was rewritten and reorganized completely. The chapter covers the single-point density change and moves existing system criteria to its own sections and special design criteria for storage applications have all been combined into Chapter 26.

The 2025 edition of NFPA 13 includes many technical additions and revisions. Many definitions have been revised or added. One major addition is the inclusion of listed vacuum dry pipe systems in Chapter 8. In addition to allowing listed vacuum dry

pipe systems, provisions have been added to Chapter 7 allowing vapor phase corrosion inhibitors to be added to the air supply for dry pipe and preaction sprinkler systems as a method to reduce corrosion.

Several revisions for sprinkler placement and allowable omissions are included in the 2025 edition. In Chapter 4, miscellaneous and low-piled storage protection requirements have been divided into two different sections. Requirements for sprinklers installed in nonstorage occupancies with ceilings over 30 ft high have been provided in Chapter 9. In addition, based on large-scale fire testing, guidance is provided for sprinklers installed under sloped ceilings. Also, the allowable omission of sprinklers in elevator hoistways, in most situations, has been added to Chapter 9.

Revisions to Chapter 18 have been made, including updating load tables to incorporate seismic forces from piping and changing of seismic coefficient (C_p) values to align with ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. For locations outside of the United States, Annex E has been modified to allow conformance with ASCE/SEI 7.

Correlating Committee on Automatic Sprinkler Systems

William E. Koffel, *Chair*
Koffel Associates, Inc., MD [SE]

Roland A. Asp, National Fire Sprinkler Association, Inc., MD [M]
Rep. National Fire Sprinkler Association

Jose R. Baz, JRB Associates Group Inc., FL [M]
Rep. NFPA Latin American Section

Kerry M. Bell, UL LLC, IL [RT]

Tracey D. Bellamy, Telgian Corporation, GA [U]
Rep. The Home Depot

Chase A. Browning, Medford Fire Department, OR [E]

Steven W. Dellasanta, JENSEN HUGHES, RI [SE]

John August Denhardt, American Fire Sprinkler Association (AFSA), TX [IM]
Rep. American Fire Sprinkler Association

Russell P. Fleming, Northeast Fire Suppression Associates, LLC, NH [SE]

Alex Hoffman, Viking Fire Protection Inc., Canada [IM]
Rep. Canadian Automatic Sprinkler Association

Sultan M. Javeri, SC Engineering, France [IM]

Charles W. Ketner, National Automatic Sprinkler Fitters LU 669, MD [L]

Rep. United Assn. of Journeymen & Apprentices of the Plumbing & Pipe Fitting Industry

James D. Lake, Viking Corporation, MI [M]

John A. LeBlanc, FM Global, MA [I]

Kenneth W. Linder, Swiss Re, FL [I]

David O. Lowrey, City of Boulder Fire Rescue, CO [E]

Bryan Edwin Matthews, Liberty Mutual Group, NY [I]

Garner A. Palenske, Wiss, Janney, Elstner Associates, Inc., CA [SE]

Lawrence Richard Phillips, US Department of the Navy, VA [E]

Adam Seghi, Coda Risk Analysis, TX [I]

Joseph Su, National Research Council of Canada, Canada [RT]

J. Michael Thompson, GHD/The Protection Engineering Group, PC, VA [SE]

Alternates

Ralph E. Bless, Jr., Telgian Corporation, GA [U]
(Alt. to Tracey D. Bellamy)

Bruce H. Clarke, American International Group, Inc. (AIG), SC [I]
(Alt. to Adam Seghi)

David B. Fuller, FM Approvals, RI [I]
(Alt. to John A. LeBlanc)

Kevin Ryan Hall, American Fire Sprinkler Association (AFSA), MD [IM]
(Alt. to John August Denhardt)

Jeffrey E. Harper, JENSEN HUGHES, IL [SE]
(Alt. to Steven W. Dellasanta)

Jeff Hebenstreit, UL LLC, IL [RT]
(Alt. to Kerry M. Bell)

Jeffrey M. Hugo, National Fire Sprinkler Association, Inc., MI [M]
(Alt. to Roland A. Asp)

Matthew Osburn, Canadian Automatic Sprinkler Association (CASA), Canada [IM]
(Alt. to Alex Hoffman)

Donato A. Pirro, Electro Sistemas De Panama, S.A., Panama [M]
(Alt. to Jose R. Baz)

Matthew T. Smith, GHD, Inc., MD [SE]
(Alt. to J. Michael Thompson)

Jeffrey J. Van Rhyn, Jr., Local 669 JATC, NV [L]
(Alt. to Charles W. Ketner)

Nonvoting

Robert G. Caputo, American Fire Sprinkler Association (AFSA), TX [IM]
Rep. TC on Private Water Supply Piping Systems

Raymond A. Grill, Ray Grill Consulting PLLC, VA [SE]
Rep. TC on Sprinkler System Installation Criteria

Kenneth E. Isman, University of Maryland, MD [SE]
Rep. TC on Residential Sprinkler Systems

Thomas Goss, NFPA Staff Liaison

William B. Smith, Code Consultants, Inc., MO [SE]
Rep. TC on Sprinkler System Discharge Criteria

John J. Walsh, UA Joint Apprenticeship Committee Local 669, MD [O]
Rep. United Assn. of Journeymen & Apprentices of the Plumbing & Pipe Fitting Industry
(Member Emeritus)

Chad Duffy, Co-Staff Liaison, NFPA

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Committee Scope: This Committee shall have overall responsibility for documents that pertain to the criteria for the design and installation of automatic, open and foam-water sprinkler systems including the character and adequacy of water supplies, and the selection of sprinklers, piping, valves, and all materials and accessories. This Committee does not cover the installation of tanks and towers, nor the installation, maintenance, and use of central station, proprietary, auxiliary, and local signaling systems for watchmen, fire alarm, supervisory service, nor the design of fire department hose connections.

Technical Committee on Hanging and Bracing of Water-Based Fire Protection Systems

Joe Beagen, ASC Engineering Solutions/ FlexHead Industries/
Anvil International, RI [M]

James B. Biggins, CAC Specialty - Natural Resources, IL [I]

Chase A. Browning, Medford Fire Department, OR [E]

Samuel S. Dannaway, Coffman Engineers, HI [SE]

Daniel C. Duggan, Sr., Caddy/nVent, MO [M]

Mark E. Fessenden, Johnson Controls, WI [M]
Rep. National Fire Sprinkler Association

Jeffrey E. Harper, JENSEN HUGHES, IL [SE]

Jeff Hebenstreit, UL LLC, IL [RT]

Michael J. Joanis, National Fire Sprinkler Association (NFSA), NH
[M]

Alan R. Laguna, Merit Sprinkler Company, Inc., LA [IM]

Leslie “Chip” L. Lindley, II, Lindley Fire Protection Company Inc.,
CA [IM]

Wayne M. Martin, Wayne Martin & Associates Inc., CA [SE]

Michael Wade McDaniel, F Tech, Mexico [IM]

Rep. Mexican Fire Sprinkler Association (AMRACI)

J. Scott Mitchell, CNS Y-12/Pantex, TN [U]

Marco R. Nieraeth, Global Asset Protection Services, LLC, CA [I]

Amutha Rangaraju, FM Global, RI [I]

Michael A. Rothmier, UA Joint Apprenticeship Committee LU 669,
CO [L]

Rep. United Assn. of Journeymen & Apprentices of the
Plumbing & Pipe Fitting Industry

Joseph R. Sanford, Liberty Mutual Property Risk Engineering, MA
[I]

Peter T. Schwab, Wayne Automatic Fire Sprinklers, Inc., FL [IM]

John Silva, Hilti North America, CA [M]

Brian Sloan, Victaulic, PA [M]

Zeljko Sucevic, Vipond Fire Protection, Canada [IM]
Rep. Canadian Automatic Sprinkler Association

James Tauby, Mason Industries, Inc., NY [M]

Victoria B. Valentine, American Fire Sprinkler Association (AFSA),
PA [IM]

Kenneth W. Wagoner, Parsley Consulting, MO [IM]
Rep. American Fire Sprinkler Association

Ronald N. Webb, S.A. Comunale Company, Inc., OH [IM]
Rep. National Fire Sprinkler Association

Alternates

Cecil Bilbo, Jr., Academy of Fire Sprinkler Technology, Inc., IL [M]
(Alt. to Mark E. Fessenden)

Scott Butler, Mason Industries, Inc., NY [M]
(Alt. to James Tauby)

Sheldon Dacus, Security Fire Protection Company, TN [IM]
(Alt. to Ronald N. Webb)

John Deutsch, ASC Engineered Solutions, CA [M]
(Alt. to Joe Beagen)

Todd A. Dillon, AXA XL/Global Asset Protection Services, LLC,
OH [I]
(Alt. to Marco R. Nieraeth)

Daniel J. Duggan, Jr., Caddy/nVent, MO [M]
(Alt. to Daniel C. Duggan, Sr.)

Sorrel M. Hanson, FM Global, CA [I]
(Alt. to Amutha Rangaraju)

Charles W. Ketner, National Automatic Sprinkler Fitters LU 669,
MD [L]
(Alt. to Michael A. Rothmier)

Thomas Goss, NFPA Staff Liaison

Jonah Lund, Jensen Hughes, TX [SE]
(Alt. to Jeffrey E. Harper)

Matthew Osburn, Canadian Automatic Sprinkler Association
(CASA), Canada [IM]
(Alt. to Zeljko Sucevic)

Ryan Lee Peterson, Wayne Automatic Fire Sprinklers, Inc., FL [IM]
(Alt. to Peter T. Schwab)

William Scott Roberts, Quick Response Fire Protection, NJ [M]
(Alt. to Michael J. Joanis)

Jack W. Thacker, Shambaugh and Sons, CA [IM]
(Voting Alt.)

Byron Weisz, Cen-Cal Fire Systems, Inc., CA [IM]
(Alt. to Kenneth W. Wagoner)

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Committee Scope: This Committee shall have the primary responsibility for those portions of NFPA 13 that pertain to the criteria for the use and installation of components and devices used for the support of water-based fire protection system piping including protection against seismic events.

Technical Committee on Private Water Supply Piping Systems

Robert G. Caputo, *Chair*

American Fire Sprinkler Association (AFSA), TX [IM]

Alhassan Kamel Taha Ahmed, WSP Middle East, Saudi Arabia [SE]

Roland A. Asp, National Fire Sprinkler Association, Inc., MD [M]
Rep. National Fire Sprinkler Association

James B. Biggins, CAC Specialty - Natural Resources, IL [I]

Dominic Bosco, Shambaugh & Son, NV [IM]
Rep. Illinois Fire Prevention Association

Flora F. Chen, Hayward Fire Department, California, CA [E]

Stephen A. Clark, Jr., Allianz, GA [I]

Steven W. Dellasanta, JENSEN HUGHES, RI [SE]

Jeffrey T. Dudley, National Aeronautics & Space Administration,
Kennedy Space Center (NASA), FL [U]

Byron E. Ellis, Entergy Corporation, LA [U]
Rep. Edison Electric Institute

Brandon W. Frakes, AXA XL/Global Asset Protection Services,
LLC, NC [I]

Robert M. Gagnon, Gagnon Engineering, MD [SE]

LaMar Hayward, All-In FPC, LLC, ID [SE]

Jeff Hebenstreit, UL LLC, IL [RT]

Conor J. Kauffman, Kauffman Company, TX [IM]
Rep. National Fire Sprinkler Association

Larry Keeping, PLC Fire Safety Engineering, Canada [SE]

Kevin J. Kelly, Victaulic, PA [M]
Rep. National Fire Sprinkler Association

Alan R. Laguna, Merit Sprinkler Company, Inc., LA [IM]

Leslie “Chip” L. Lindley, II, Lindley Fire Protection Company Inc.,
CA [IM]

Cody Blake Melton, Wichita Falls Fire Department, TX [E]

Bob D. Morgan, Fort Worth Fire Department, TX [E]

Mohamed Mustafa, Norman Disney and Young (NDY)/TetraTek,
Inc., Australia [SE]

Jason R. Olliges, Sprinkler Fitters Local 268, MO [L]
Rep. United Assn. of Journeymen & Apprentices of the
Plumbing & Pipe Fitting Industry

John H. Pecot, Johnson Controls, TX [M]
Rep. Johnson Controls

Dion Powell, Liberty Mutual, IL [I]

James R. Richardson, Lisle Woodridge Fire District, IL [E]

Peter T. Schwab, Wayne Automatic Fire Sprinklers, Inc., FL [IM]

David A. Shindle, US Department of the Navy, VA [U]

Austin L. Smith, Consolidated Nuclear Security, LLC, Y-12, TN [U]

Dustin Stokes, Battelle Energy Alliance, ID [U]

Chen-Hsiang Su, US Consumer Product Safety Commission
(CPSC), MD [C]

Kenneth W. Wagoner, Parsley Consulting, MO [SE]

Alternates

Zainul Abedeen, WSP Middle East, United Arab Emirates [SE]
(Alt. to Alhassan Kamel Taha Ahmed)

Mark A. Bowman, Global Asset Protection Services, LLC, OH [I]
(Alt. to Brandon W. Frakes)

Johnathan C. Carl, Victaulic Company of America, PA [M]
(Alt. to Kevin J. Kelly)

Christopher D. Fulkerson, Local 669 Jatc, IN [L]
(Alt. to Jason R. Olliges)

Andrew C. Higgins, Allianz, NC [I]
(Alt. to Stephen A. Clark, Jr.)

John L. Hulett, APi National Service Group, CO [IM]
(Alt. to Conor J. Kauffman)

Bryan Edwin Matthews, Liberty Mutual Group, NY [I]
(Alt. to Dion Powell)

Thomas Goss, NFPA Staff Liaison

Joshua P. McDonald, American Fire Sprinkler Association (AFSA),
TX [IM]

(Alt. to Robert G. Caputo)

William Overton, Consolidated Nuclear Security, LLC, Y-12, TN [U]
(Alt. to Austin L. Smith)

Ryan Lee Peterson, Wayne Automatic Fire Sprinklers, Inc., FL [IM]
(Alt. to Peter T. Schwab)

William Scott Roberts, Quick Response Fire Protection, NJ [M]
(Alt. to Roland A. Asp)

Joseph W. Spokis, JENSEN HUGHES, RI [SE]
(Alt. to Steven W. Dellasanta)

Craig M. Vesely, Alliant Energy, WI [U]
(Alt. to Byron E. Ellis)

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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 the primary responsibility for documents on private piping systems supplying water for fire protection and for hydrants, hose houses, and valves. The Committee is also responsible for documents on fire flow testing and marking of hydrants.

Technical Committee on Sprinkler System Discharge Criteria

William B. Smith, *Chair*
Code Consultants, Inc., MO [SE]

Khamis H. Al-Kaabi, General Admin. Of Civil Defense - Qatar, Qatar [E]

Carl P. Anderson, The Fire Protection International Consortium, WA [E]

Rep. Washington State Association of Fire Marshals

Paul Armstrong, PACCS, CA [M]

Rep. Rack Manufacturers Institute

Weston C. Baker, Jr., FM Global, RI [I]

Charles O. Bauroth, Liberty Mutual, MA [I]

Kerry M. Bell, UL LLC, IL [RT]

Chase A. Browning, Medford Fire Department, OR [E]

John August Denhardt, American Fire Sprinkler Association (AFSA), TX [IM]

Rep. American Fire Sprinkler Association

James M. Fantauzzi, North East Fire Protection Systems Inc., NY [IM]

Rep. American Fire Sprinkler Association

Abram Selim Fouad, Elite Consolidated Engineers, Egypt [SE]

Brice Franc, SPK Engineering, France [SE]

Ingunn Haraldseid, Autostore, Norway [M]

Bo Hjorth, AlbaCon AB, Sweden [SE]

Donald Hopkins, Jr., JENSEN HUGHES, MD [SE]

Kenneth E. Isman, University of Maryland, MD [SE]

Sultan M. Javeri, SC Engineering, France [IM]

Michael J. Joanis, National Fire Sprinkler Association (NFSA), NH [M]

Rep. National Fire Sprinkler Association

Larry Keeping, PLC Fire Safety Engineering, Canada [SE]

Kevin J. Kelly, Victaulic, PA [M]

Rep. National Fire Sprinkler Association

Elley Klausbruckner, Klausbruckner & Associates, Inc., CA [SE]

William E. Koffel, Koffel Associates, Inc., MD [SE]

Chris LaFleur, Sandia National Laboratories, NM [U]

Russell B. Leavitt, Telgian Corporation, AZ [SE]

Stuart Lloyd, Zurich Risk Engineering UK, Great Britain [I]

Joseph A. Lynch, Swiss Re, GA [I]

Brian Mosberian, Phoenix Fire Department, AZ [E]

Garner A. Palenske, Wiss, Janney, Elstner Associates, Inc., CA [SE]

Richard Pehrson, Pehrson Fire PC, MN [E]

Rep. International Fire Marshals Association

Nicholas Pinto, Life Safety Systems, Canada [IM]

Rep. Canadian Automatic Sprinkler Association

Kenneth R. Schneider, UA - ITF, MO [L]

Rep. United Assn. of Journeymen & Apprentices of the Plumbing & Pipe Fitting Industry

Peter T. Schwab, Wayne Automatic Fire Sprinklers, Inc., FL [IM]

Michael D. Sides, Global Asset Protection Services, LLC, FL [I]

Manuel R. Silva, Johnson Controls, RI [M]

Michael Six, Bremerton Fire Department, WA [E]

George W. Stanley, Wiginton Fire Protection Engineering, Inc., FL [IM]

Rep. National Fire Sprinkler Association

Steven D. Wolin, Reliable Automatic Sprinkler Company, Inc., SC [M]

Martin H. Workman, The Viking Corporation, MI [M]

Alternates

Joakim Bauer, AlbaCon AB, Sweden [SE]
(Alt. to Bo Hjorth)

Tracey D. Bellamy, Telgian Corporation, GA [SE]
(Alt. to Russell B. Leavitt)

Mark A. Bowman, Global Asset Protection Services, LLC, OH [I]
(Alt. to Michael D. Sides)

Thomas Larry Frank, Code Consultants, Inc., MO [SE]
(Alt. to William B. Smith)

Scott T. Franson, UL Solutions, IL [RT]
(Alt. to Kerry M. Bell)

Richard A. Gallagher, Zurich Services Corporation, DE [I]
(Alt. to Stuart Lloyd)

Kevin Ryan Hall, American Fire Sprinkler Association (AFSA), MD [IM]
(Alt. to John August Denhardt)

Jeffrey A. Hewitt, American Fire Protection, LLC, AL [M]
(Alt. to Michael J. Joanis)

Robert C. Holliday, Sprinkler Fitters LU 268 JAC, MO [L]
(Alt. to Kenneth R. Schneider)

Mark Hopkins, TERPconsulting, MD [SE]
(Alt. to Larry Keeping)

Shaun R. Kramer, The Viking Corporation, MI [M]
(Alt. to Martin H. Workman)

Bradley T. Merritt, Swiss Re Corporate Solutions, SC [I]
(Alt. to Joseph A. Lynch)

Matthew Osburn, Canadian Automatic Sprinkler Association (CASA), Canada [IM]

(Alt. to Nicholas Pinto)

Ryan Lee Peterson, Wayne Automatic Fire Sprinklers, Inc., FL [IM]
(Alt. to Peter T. Schwab)

Milosh T. Puchovsky, Worcester Polytechnic Institute, MA [SE]
(Alt. to Kenneth E. Isman)

Tomas M. Sanchez, Sandia National Laboratories, NM [U]
(Alt. to Chris LaFleur)

Steven J. Scandaliato, SDG, LLC, TX [IM]
(Alt. to James M. Fantauzzi)

Gerald R. Schultz, The FPI Consortium, Inc., IL [M]
(Alt. to Paul Armstrong)

Jack W. Thacker, Shambaugh and Sons, CA [IM]
(Alt. to George W. Stanley)

Stephanie C. Thomas, FM Global, RI [I]
(Alt. to Weston C. Baker, Jr.)

Cary M. Webber, Reliable Automatic Sprinkler, SC [M]
(Alt. to Steven D. Wolin)

Karl Wiegand, Victaulic Company of America, MI [M]
(Alt. to Kevin J. Kelly)

John Wurts, Jensen Hughes, TX [SE]
(Alt. to Donald Hopkins, Jr.)

Thomas Goss, NFPA Staff Liaison

Chad Duffy, Co-Staff Liaison, NFPA

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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 those portions of NFPA 13 that pertain to the classification of various fire hazards and the determination of associated discharge criteria for sprinkler systems employing automatic and open sprinklers, sprinkler system plans and calculations, and water supplies.

Technical Committee on Sprinkler System Installation Criteria

Raymond A. Grill, *Chair*

Ray Grill Consulting PLLC, VA [SE]

Adam Seghi, *Secretary*

Coda Risk Analysis, TX [I]

Roland A. Asp, National Fire Sprinkler Association, Inc., MD [M]

Rep. National Fire Sprinkler Association

Hamid R. Bahadori, JENSEN HUGHES, FL [SE]

Weston C. Baker, Jr., FM Global, RI [I]

Cecil Bilbo, Jr., Academy of Fire Sprinkler Technology, Inc., IL [SE]

Chase A. Browning, Medford Fire Department, OR [E]

Caleb Case, The Viking Corporation, MI [M]

Jason Gill, Crews & Gregory Fire Sprinkler, Inc., VA [IM]

Rep. American Fire Sprinkler Association

Jeff Hebenstreit, UL LLC, IL [RT]

Elwin G. Joyce, II, Eastern Kentucky University, KY [U]

Rep. NFPA Industrial Fire Protection Section

Larry Keeping, PLC Fire Safety Engineering, Canada [SE]

Charles W. Ketner, National Automatic Sprinkler Fitters LU 669, MD [L]

Rep. United Assn. of Journeymen & Apprentices of the Plumbing & Pipe Fitting Industry

Ryan Kunst, MN Department Of Public Safety, MN [E]

Russell B. Leavitt, Telgian Corporation, AZ [SE]

Rep. Telgian Corporation

David O. Lowrey, City of Boulder Fire Rescue, CO [E]

Floyd Luinstra, Oklahoma State University, OK [SE]

Rodney A. McPhee, Canadian Wood Council, Canada [U]

Michael F. Meehan, VSC Fire & Security, VA [IM]

Rep. American Fire Sprinkler Association

Brian Mosberian, Phoenix Fire Department, AZ [E]

Joe W. Noble, Noble Consulting Services, LLC, NV [E]

Rep. International Fire Marshals Association

Patrick George Noble, City of North Las Vegas, NV [E]

James S. Peterkin, TLC Engineering, FL [U]

Rep. American Society for Healthcare Engineering

Laura Joy Ridenour, Dearborn Fire Department, MI [E]

Steven J. Scandaliato, SDG, LLC, TX [SE]

Peter T. Schwab, Wayne Automatic Fire Sprinklers, Inc., FL [IM]

Jose Manuel Segnini, Swiss Re Corporate Solutions, FL [I]

Austin L. Smith, Consolidated Nuclear Security, LLC, Y-12, TN [U]

William B. Smith, Code Consultants, Inc., MO [SE]

Paul A. Statt, Eastman Kodak Company, NY [U]

Zeljko Sucevic, Vipond Fire Protection, Canada [IM]

Rep. Canadian Automatic Sprinkler Association

Lawrence M. Taylor, Schindler Elevator Corporation, TX [IM]

Rep. National Elevator Industry Inc.

Robert Vincent, Shambaugh & Son, L.P., IN [IM]

Rep. National Fire Sprinkler Association

Daniel P. Wake, Victaulic Company of America, PA [M]

Jason E. Webb, Potter Electric Signal Company, MO [M]

Cary M. Webber, Reliable Automatic Sprinkler, SC [M]

Rep. National Fire Sprinkler Association

Alternates

Robert F. Accosta, Jr., Arup, NY [SE]

(Alt. to Raymond A. Grill)

Kerry M. Bell, UL LLC, IL [RT]

(Alt. to Jeff Hebenstreit)

Ralph E. Bless, Jr., Telgian Corporation, GA [SE]

(Alt. to Russell B. Leavitt)

Robert G. Caputo, American Fire Sprinkler Association (AFSA), TX [IM]

(Alt. to Michael F. Meehan)

Virginia R. Charter, Oklahoma State University, OK [SE]

(Alt. to Floyd Luinstra)

Michael A. Henke, Potter Electric Signal Company, MO [M]

(Alt. to Jason E. Webb)

Jeffrey A. Hewitt, American Fire Protection, LLC, AL [M]

(Alt. to Roland A. Asp)

Jim Kinslohr, Code Consultants, MO [SE]

(Alt. to William B. Smith)

Jennie Levario, Phoenix Fire Department, AZ [E]

(Alt. to Brian Mosberian)

Michael Wade McDaniel, F Tech, Mexico [SE]

(Alt. to Steven J. Scandaliato)

E. Parks Moore, S&S Sprinkler Company, LLC, AL [IM]

(Alt. to Jason Gill)

Michael Newell, Belvedere LLC, TX [SE]

(Alt. to Cecil Bilbo, Jr.)

Matthew Osburn, Canadian Automatic Sprinkler Association (CASA), Canada [IM]

(Alt. to Zeljko Sucevic)

William Overton, Consolidated Nuclear Security, LLC, Y-12, TN [U]

(Alt. to Austin L. Smith)

Ryan Lee Peterson, Wayne Automatic Fire Sprinklers, Inc., FL [IM]

(Alt. to Peter T. Schwab)

Joshua Reichert, Eastern Kentucky University, KY [U]

(Alt. to Elwin G. Joyce, II)

Michael A. Rothmier, UA Joint Apprenticeship Committee LU 669, CO [L]

(Alt. to Charles W. Ketner)

Thomas Ruppenthal, Swiss Re, IL [I]

(Alt. to Jose Manuel Segnini)

Manuel R. Silva, Johnson Controls, RI [M]

(Voting Alt.)

LeJay Slocum, JENSEN HUGHES, GA [SE]

(Alt. to Hamid R. Bahadori)

Brandon Telford, Reliable Automatic Sprinkler, DE [M]

(Alt. to Cary M. Webber)

Katayon Teunessen, Viking Corporation, MI [M]

(Alt. to Caleb Case)

Stephanie C. Thomas, FM Global, RI [I]

(Alt. to Weston C. Baker, Jr.)

Ronald N. Webb, S.A. Comunale Company, Inc., OH [IM]

(Alt. to Robert Vincent)

Karl Wiegand, Victaulic Company of America, MI [M]
(Alt. to Daniel P. Wake)

Thomas Goss, Staff Liaison, NFPA

Chad Duffy, Co-Staff Liaison, NFPA

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Committee Scope: This Committee shall have the primary responsibility for those portions of NFPA 13 that pertain to the criteria for the use and installation of sprinkler systems components (with the exception of those components used for supporting of piping), position of sprinklers, types of systems, and acceptance testing.

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NFPA 13

Standard for the

Installation of Sprinkler Systems

2025 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. 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 and extracted publications can be found in Chapter 2 and Annex G.

Chapter 1 Administration

1.1* Scope.

1.1.1 This standard shall provide the minimum requirements for the design and installation of automatic fire sprinkler systems and exposure protection sprinkler systems covered within this standard.

1.1.2* This standard shall not provide requirements for the design or installation of water mist fire protection systems.

1.1.2.1 Water mist fire protection systems shall not be considered fire sprinkler systems.

1.1.2.2 The design and installation of water mist fire protection systems shall comply with NFPA 750.

1.1.3* This standard is written with the assumption that the sprinkler system shall be designed to protect against a single fire originating within the building.

1.2* Purpose.

1.2.1 The purpose of this standard shall be to provide a reasonable degree of protection for life and property from fire through standardization of design, installation, and testing requirements for sprinkler systems, including private fire service mains, based on sound engineering principles, test data, and field experience.

1.2.2 Sprinkler systems and private fire service mains are specialized fire protection systems and shall require design and installation by knowledgeable and trained personnel.

1.3 Application.

1.3.1 This standard shall apply to the following:

- (1) Character and adequacy of water supplies
- (2) Sprinklers
- (3) Fittings
- (4) Piping
- (5) Valves
- (6) All materials and accessories, including the installation of private fire service mains

1.3.2 Level of Protection. A building, where protected by an automatic sprinkler system installation, shall be provided with sprinklers in all areas except where specific sections of this standard permit the omission of sprinklers.

1.3.3 This standard shall also apply to “combined service mains” used to carry water for both fire service and other uses as well as to mains for fire service use only.

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 shall 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 Units and Symbols.

1.6.1 Units.

1.6.1.1* Metric units of measurement in this standard shall be in accordance with the modernized metric system known as the International System of Units (SI).

1.6.1.2 These units with conversion factors shall be used as listed in Table 1.6.1.2.

1.6.1.3* If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement.

1.6.2 Hydraulic Symbols. The standard abbreviations in Table 1.6.2 shall be used on the hydraulic calculation form discussed in Chapter 28.

1.6.3* Some dimensions used in this standard are exact and some are not. Nominal dimension are often used, such as the

dimensions used for pipe sizes. The metric equivalent shown in this standard might not be an exact conversion to the SI unit, but the nominal metric equivalent is typically used or a reasonably equivalent value or approximate conversion is used. It shall be acceptable to use the exact conversion or the conversions stated in the standard, even though they might not be exact.

1.7 New Technology.

1.7.1 Nothing in this standard shall be intended to restrict new technologies or alternate arrangements, provided the level of safety prescribed by this standard is not lowered.

1.7.2 Materials or devices not specifically designated by this standard shall be utilized in complete accord with all conditions, requirements, and limitations of their listings.

Table 1.6.1.2 Conversion Factors

	Name of Unit	Unit Symbol	Conversion Factor
Length	Millimeter	mm	1 in. = 25 mm
	Meter	m	1 ft = 0.3048 m
Area	Square millimeters	mm ²	1 in. ² = 645.2 mm ²
	Square meter	m ²	1 ft ² = 0.0929 m ²
Volume	Cubic millimeter	mm ³	1 in. ³ = 16,387 mm ³
	Cubic meter	m ³	1 ft ³ = 0.02832 m ³
Fluid capacity	Liter	L	1 fl oz = 0.02957 L
	Liter	L	1 gal = 3.785 L
Flow	Liter per minute	L/min	1 gpm = 3.7848 L/min
Pressure	Bar	bar	1 psi = 0.0689 bar
Discharge density	Millimeter/minute	mm/min	1 gpm/ft ² = 40.746 mm/min
	Liter/minute/m ²	(L/min)/m ²	1 gpm/ft ² = 40.746 (L/min)/m ²
K-factor	K-factor	L/min/(bar) ²	1 gpm/(psi) ² = 14.285 L/min/(bar) ²
Weight	Kilogram	kg	1 lb = 0.4536 kg
Density	Kilogram/cubic meter	kg/m ³	1 lb/ft ³ = 16.02 kg/m ³
Temperature	Fahrenheit	°F	F° = $\frac{9}{5} \times C^{\circ} + 32$
	Celsius	°C	C° = $\frac{5}{9} (F^{\circ} - 32)$
Velocity	Kilometers per hour	km/h	1 mph = 1.609 km/h
Pound force	Newtons	N	1 lb force = 4.44822 N
Gauge (sheet steel)	Millimeter	mm	12 gauge = 2.8 mm
			14 gauge = 1.98 mm
			16 gauge = 1.57 mm
			22 gauge = 0.78 mm
			24 gauge = 0.63 mm

Note: For additional conversions and information, see ASTM SI 10, *IEEE/ASTM SI 10 American National Standard for Metric Practice*.

Table 1.6.2 Hydraulic Symbols

Symbol or Abbreviation	Item
p	Pressure in psi
gpm	US gallons per minute
q	Flow increment in gpm to be added at a specific location
Q	Summation of flow in gpm at a specific location
P_t	Total pressure in psi at a point in a pipe
P_f	Pressure loss due to friction between points indicated in location column
P_e	Pressure due to elevation difference between indicated points. This can be a plus value or a minus value. If minus, the (–) shall be used; if plus, no sign is needed.
P_v	Velocity pressure in psi at a point in a pipe
P_n	Normal pressure in psi at a point in a pipe
E	90-degree ell
EE	45-degree ell
Lt.E	Long-turn elbow
Cr	Cross
T	Tee-flow turned 90 degrees
GV	Gate valve
BV	Butterfly (wafer) valve
Del V	Deluge valve
ALV	Alarm valve
DPV	Dry pipe valve
CV	Swing check valve
WCV	Butterfly (wafer) check valve
St	Strainer
psi	Pounds per square inch
v	Velocity of water in pipe in feet per second
K	K-factor
C-factor	Friction loss coefficient

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 11, *Standard for Low-, Medium-, and High-Expansion Foam*, 2024 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2024 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2025 edition.

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 2023 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2023 edition.

NFPA 30, *Flammable and Combustible Liquids Code*, 2024 edition.

NFPA 30B, *Code for the Manufacture and Storage of Aerosol Products*, 2023 edition.

NFPA 32, *Standard for Drycleaning Facilities*, 2021 edition.

NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*, 2024 edition.

NFPA 34, *Standard for Dipping, Coating, and Printing Processes Using Flammable or Combustible Liquids*, 2024 edition.

NFPA 36, *Standard for Solvent Extraction Plants*, 2025 edition.

NFPA 37, *Standard for the Installation and Use of Stationary Combustion Engines and Gas Turbines*, 2024 edition.

NFPA 40, *Standard for the Storage and Handling of Cellulose Nitrate Film*, 2025 edition.

NFPA 45, *Standard on Fire Protection for Laboratories Using Chemicals*, 2024 edition.

NFPA 51, *Standard for the Design and Installation of Oxygen–Fuel Gas Systems for Welding, Cutting, and Allied Processes*, 2023 edition.

NFPA 51B, *Standard for Fire Prevention During Welding, Cutting, and Other Hot Work*, 2024 edition.

NFPA 55, *Compressed Gases and Cryogenic Fluids Code*, 2023 edition.

NFPA 59, *Utility LP-Gas Plant Code*, 2024 edition.

NFPA 59A, *Standard for the Production, Storage, and Handling of Liquefied Natural Gas (LNG)*, 2023 edition.

NFPA 70®, *National Electrical Code®*, 2023 edition.

NFPA 72®, *National Fire Alarm and Signaling Code®*, 2025 edition.

NFPA 75, *Standard for the Fire Protection of Information Technology Equipment*, 2024 edition.

NFPA 76, *Standard for the Fire Protection of Telecommunications Facilities*, 2024 edition.

NFPA 82, *Standard on Incinerators and Waste and Linen Handling Systems and Equipment*, 2024 edition.

NFPA 86, *Standard for Ovens and Furnaces*, 2023 edition.

NFPA 91, *Standard for Exhaust Systems for Air Conveying of Vapors, Gases, Mists, and Particulate Solids*, 2020 edition.

NFPA 96, *Standard for Ventilation Control and Fire Protection of Commercial Cooking Operations*, 2024 edition.

NFPA 99, *Health Care Facilities Code*, 2024 edition.

NFPA 101®, *Life Safety Code®*, 2024 edition.

NFPA 120, *Standard for Fire Prevention and Control in Coal Mines*, 2023 edition.

NFPA 122, *Standard for Fire Prevention and Control in Metal/Nonmetal Mining and Metal Mineral Processing Facilities*, 2023 edition.

NFPA 130, *Standard for Fixed Guideway Transit and Passenger Rail Systems*, 2023 edition.

NFPA 140, *Standard on Motion Picture and Television Production Studio Soundstages, Approved Production Facilities, and Production Locations*, 2024 edition.

NFPA 150, *Fire and Life Safety in Animal Housing Facilities Code*, 2025 edition.

NFPA 170, *Standard for Fire Safety and Emergency Symbols*, 2024 edition.

NFPA 214, *Standard on Water-Cooling Towers*, 2021 edition.

NFPA 259, *Standard Test Method for Potential Heat of Building Materials*, 2023 edition.

NFPA 307, *Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves*, 2021 edition.

NFPA 318, *Standard for the Protection of Semiconductor Fabrication Facilities*, 2025 edition.

NFPA 400, *Hazardous Materials Code*, 2025 edition.

NFPA 409, *Standard on Aircraft Hangars*, 2022 edition.

NFPA 415, *Standard on Airport Terminal Buildings, Fueling Ramp Drainage, and Loading Walkways*, 2022 edition.

NFPA 423, *Standard for Construction and Protection of Aircraft Engine Test Facilities*, 2022 edition.

NFPA 701, *Standard Methods of Fire Tests for Flame Propagation of Textiles and Films*, 2023 edition.

NFPA 703, *Standard for Fire-Retardant-Treated Wood and Fire-Retardant Coatings for Building Materials*, 2024 edition.

NFPA 750, *Standard on Water Mist Fire Protection Systems*, 2023 edition.

NFPA 780, *Standard for the Installation of Lightning Protection Systems*, 2023 edition.

NFPA 804, *Standard for Fire Protection for Advanced Light Water Reactor Electric Generating Plants*, 2020 edition.

NFPA 805, *Performance-Based Standard for Fire Protection for Light Water Reactor Electric Generating Plants*, 2020 edition.

NFPA 909, *Code for the Protection of Cultural Resource Properties — Museums, Libraries, and Places of Worship*, 2021 edition.

NFPA 915, *Standard for Remote Inspections and Tests*, 2024 edition.

NFPA 1960, *Standard for Fire Hose Connections, Spray Nozzles, Manufacturer's Design of Fire Department Ground Ladders, Fire Hose, and Powered Rescue Tools*, 2024 edition.

2.3 Other Publications.

2.3.1 ACI Publications. American Concrete Institute, 38800 Country Club Drive, Farmington Hills, MI 48331-3439.

ACI 318, *Building Code Requirements for Structural Concrete and Commentary*, 2019, reapproved, 2022.

ACI 355.2, *Qualification of Post-Installed Mechanical Anchors in Concrete and Commentary*, 2019.

2.3.2 ASCE Publications. American Society of Civil Engineers, 1801 Alexander Bell Drive, Reston, VA 20191-4400.

ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, 2022.

2.3.3 ASME Publications. American Society of Mechanical Engineers, Two Park Avenue, New York, NY 10016-5990.

Boiler and Pressure Vessel Code, Section IX, "Welding, Brazing, and Fusing Qualifications," 2021.

ASME A17.1/CSA B44, *Safety Code for Elevators and Escalators*, 2022.

ASME B1.20.1, *Pipe Threads, General Purpose, Inch*, 2013 (R2018).

ASME B16.1, *Gray Iron Pipe Flanges and Flanged Fittings: Classes 25, 125, and 250*, 2020.

ASME B16.3, *Malleable Iron Threaded Fittings: Classes 150 and 300*, 2021.

ASME B16.4, *Gray Iron Threaded Fittings: Classes 125 and 250*, 2021.

ASME B16.5, *Pipe Flanges and Flanged Fittings: NPS ½ through NPS 24 Metric/Inch Standard*, 2020.

ASME B16.9, *Factory-Made Wrought Butt Welding Fittings*, 2018.

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*, 2021.

ASME B16.15, *Cast Copper Alloy Threaded Fittings: Classes 125 and 250*, 2018.

ASME B16.18, *Cast Copper Alloy Solder Joint Pressure Fittings*, 2021.

ASME B16.22, *Wrought Copper and Copper Alloy Solder — Joint Pressure Fittings*, 2021.

ASME B16.25, *Butt Welding Ends*, 2017.

ASME B36.10M, *Welded and Seamless Wrought Steel Pipe*, 2018.

2.3.4 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM A53/A53M, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 2022.

ASTM A106/A106M, *Standard Specification for Seamless Carbon Steel Pipe for High Temperature Service*, 2019.

ASTM A135/A135M, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 2021.

ASTM A234/A234M, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and High Temperature Service*, 2023.

ASTM A312/A312M, *Standard Specification for Seamless, Welded, and Heavily Cold Worked Austenitic Stainless Steel Pipes*, 2022.

ASTM A403/A403M, *Standard Specification for Wrought Austenitic Stainless Steel Piping Fittings*, 2022.

ASTM A795/A795M, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 2021.

ASTM B32, *Standard Specification for Solder Metal*, 2020.

ASTM B43, *Standard Specification for Seamless Red Brass Pipe, Standard Sizes*, 2020.

ASTM B75/B75M, *Standard Specification for Seamless Copper Tube*, 2020.

ASTM B88, *Standard Specification for Seamless Copper Water Tube*, 2022.

ASTM B251/B251M, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 2017.

ASTM B446, *Standard Specification for Nickel-Chromium-Molybdenum-Columbium Alloy (UNS N06625), Nickel-Chromium-Molybdenum-Silicon Alloy (UNS N06219), and Nickel-Chromium-Molybdenum-Tungsten Alloy (UNS N06625) Rod and Bar*, 2019.

ASTM B813, *Standard Specification for Liquid and Paste Fluxes for Soldering of Copper and Copper Alloy Tube*, 2016.

ASTM B828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, 2016.

ASTM C635/C635M, *Standard Specification for Manufacture, Performance, and Testing of Metal Suspension Systems for Acoustical Tile and Lay-In Panel Ceilings*, 2022.

ASTM C636/C636M, *Standard Practice for Installation of Metal Ceiling Suspension Systems for Acoustical Tile and Lay-In Panels*, 2019.

ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, 2021.

ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, 2022.

ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*, 2022.

ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer, at 750°C*, 2022.

ASTM E2768, *Standard Test Method for Extended Duration Surface Burning Characteristics of Building Materials (30 min Tunnel Test)*, reapproved 2018.

ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, 2022.

ASTM F437, *Standard Specification for Threaded Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2021.

ASTM F438, *Standard Specification for Socket-Type Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 2023.

ASTM F439, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 2019.

ASTM F442/F442M, *Standard Specification for Chlorinated Poly(Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 2023.

ASTM F1121, *Standard Specification for International Shore Connections for Marine Fire Applications*, 1987, 2019.

ASTM SI 10, *IEEE/ASTM SI 10 American National Standard for Metric Practice*, 2016.

2.3.5 AWS Publications. American Welding Society, 8669 NW 36 Street, #130, Miami, FL 33166-6672.

AWS A5.8M/A5.8, *Specification for Filler Metals for Brazing and Braze Welding*, 2019.

AWS B2.1/B2.1M, *Specification for Welding Procedure and Performance Qualification*, 2021.

2.3.6 AWWA Publications. American Water Works Association, 6666 West Quincy Avenue, Denver, CO 80235.

AWWA C104/A21.4, *Cement-Mortar Lining for Ductile-Iron Pipe and Fittings*, 2023.

AWWA C105/A21.5, *Polyethylene Encasement for Ductile-Iron Pipe Systems*, 2018.

AWWA C110/A21.10, *Ductile-Iron and Gray-Iron Fittings*, 2021.

AWWA C111/A21.11, *Rubber-Gasket Joints for Ductile-Iron Pressure Pipe and Fittings*, 2017.

AWWA C115/A21.15, *Flanged Ductile-Iron Pipe with Ductile-Iron or Gray-Iron Threaded Flanges*, 2020.

AWWA C150/A21.50, *Thickness Design of Ductile-Iron Pipe*, 2021.

AWWA C151/A21.51, *Ductile-Iron Pipe, Centrifugally Cast*, 2017, errata, 2018.

AWWA C153/A21.53, *Ductile-Iron Compact Fittings*, 2019.

AWWA C300, *Reinforced Concrete Pressure Pipe, Steel-Cylinder Type*, 2022.

AWWA C301, *Prestressed Concrete Pressure Pipe, Steel-Cylinder Type*, 2014, Reaffirmed without Revision 2019.

AWWA C302, *Reinforced Concrete Pressure Pipe, Non-Cylinder Type*, 2022.

AWWA C303, *Reinforced Concrete Pressure Pipe, Bar-Wrapped, Steel-Cylinder Type*, 2017.

AWWA C600, *Installation of Ductile-Iron Water Mains and Their Appurtenances*, 2017.

AWWA C602, *Cement-Mortar Lining of Water Pipelines in Place, 4 in. (100 mm) and Larger*, 2023.

AWWA C900, *Polyvinyl Chloride (PVC) Pressure Pipe and Fabricated Fittings, 4 in. Through 60 in. (100 mm Through 1,500 mm)*, 2022.

AWWA C906, *Polyethylene (PE) Pressure Pipe and Fittings, 4 in. (100 mm) Through 65 in. (1,650 mm), for Waterworks*, 2021.

AWWA C909, *Molecularly Oriented Polyvinyl Chloride (PVCO) Pressure Pipe, 4 in. Through 24 in. (100 mm Through 600 mm), for Water, Wastewater, and Reclaimed Water Service*, 2022.

AWWA M9, *Concrete Pressure Pipe*, 2008, errata, 2014.

AWWA M23, *PVC Pipe — Design and Installation*, 2020.

AWWA M55, *PE Pipe — Design and Installation*, 2020.

2.3.7 ICC-ES Publications. ICC Evaluation Service, 900 Montclair Road, Suite A, Birmingham, AL 35213.

ICC-ES AC446, *Acceptance Criteria for Headed Cast-in Specialty Inserts in Concrete*, 2018.

2.3.8 IEEE Publications. IEEE Operations Center, 445 Hoes Lane, Piscataway, NJ 08854-4141.

IEEE 45, *Recommended Practice for Electric Installations on Shipboard*, 2002.

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

UL 263, *Fire Tests of Building Construction and Materials*, 2011, revised 2022.

UL 723, *Test for Surface Burning Characteristics of Building Materials*, 2018.

UL 2556, *Wire and Cable Test Methods*, 2015, revised 2021.

2.3.10 US Government Publications. US Government Publishing Office, 732 North Capitol Street, NW, Washington, DC 20401-0001.

Title 46, CFR, Parts 54.15-10 Safety and Relief Valves, 56.20 Valves, 56.20-5(a) Markings, 56.50-95 Overboard Discharges and Shore Connections, 56.60 Materials, and 58.01-40 Machinery, Angles of Inclination.

Title 46, CFR, Subchapter F, “Marine Engineering.”

Title 46, CFR, Subchapter J, “Electrical Engineering.”

2.3.11 Other Publications.

Merriam-Webster's Collegiate Dictionary, 11th edition, Merriam-Webster, Inc., Springfield, MA, 2020.

2.4 References for Extracts in Mandatory Sections.

NFPA 1, *Fire Code*, 2024 edition.

NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, 2024 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2025 edition.

NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, 2025 edition.

NFPA 5000®, *Building Construction and Safety Code*®, 2024 edition.

Chapter 3 Definitions

3.1 General.

3.1.1 The definitions contained in this chapter shall apply to the terms used in this standard.

3.1.2 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.

3.1.3 *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.** 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 phrases “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 A-Class Boundary. See 3.3.130.1.

3.3.2 Air Receiver. A chamber, compatible with an air compressor, that can store air under pressure that is higher in pressure than that in the dry pipe or preaction system piping. (AUT-SSI)

3.3.3 Air Reservoir. A chamber that can store air at the same pressure that is in the wet pipe system piping. (AUT-SSI)

3.3.4* **Aisle Width.** The horizontal dimension between the face of the loads in racks under consideration. (AUT-SSD)

3.3.5* **Alcove.** An area in a compartment or corridor that is set back from the rest of the wall it is located along. (AUT-SSI)

3.3.6 Antifreeze Sprinkler System. See 3.3.224.1.

3.3.7 Appurtenance. An accessory or attachment that enables the private fire service main to perform its intended function. [24, 2025] (AUT-PRI)

3.3.8 Area of Discharge. The floor area covered by a sprinkler that takes into account any walls or obstructions whose summation determines the remote area. (See *Figure A.28.2.4.2.1.*) (AUT-SSD)

3.3.9 Arm-Over. A horizontal pipe that extends from the branch line to a single sprinkler or a sprinkler above and below a ceiling. (AUT-SSI)

3.3.10 Array.

3.3.10.1 Closed Array (Palletized, Solid-Piled, Bin Box, and Shelf Storage). A storage arrangement where air movement through the pile is restricted because of 6 in. (150 mm) or less vertical flues. (AUT-SSD)

3.3.10.2 Closed Array (Rolled Paper). A vertical storage arrangement in which the distances between columns in both directions are short [not more than 2 in. (50 mm) in one direction and 1 in. (25 mm) in the other]. (AUT-SSD)

3.3.10.3* Open Array (Palletized, Solid-Piled, Bin Box, and Shelf Storage). A storage arrangement where air movement through the pile is enhanced because of vertical flues larger than 6 in. (150 mm). (AUT-SSD)

3.3.10.4 Open Array (Rolled Paper). A vertical storage arrangement in which the distance between columns in both directions is lengthy (all vertical arrays other than closed or standard). (AUT-SSD)

3.3.10.5* Standard Array (Rolled Paper). A vertical storage arrangement in which the distance between columns in one direction is short [1 in. (25 mm) or less] and is in excess of 2 in. (50 mm) in the other direction. (AUT-SSD)

3.3.11 Automated Inspection and Testing. The performance of inspections and tests at a distant location from the system or component being inspected or tested through the use of electronic devices or equipment installed for the purpose. (AUT-SSI)

3.3.12 Automatic Sprinkler. See 3.3.223.1.

3.3.13 Automotive Components on Portable Racks. All automotive components with or without expanded Group A plastic dunnage; excludes the storage of air bags, tires, and seats on portable racks. (AUT-SSD)

3.3.14 Average Roof Height. See 3.3.24, Building Height. (AUT-HBS)

3.3.15* Back-to-Back Shelf Storage. Two solid or perforated shelves up to 30 in. (750 mm) in depth each, not exceeding a total depth of 60 in. (1.5 m), separated by a longitudinal vertical barrier such as plywood, particleboard, sheet metal, or

equivalent, with a maximum 0.25 in. (6 mm) diameter penetrations and no longitudinal flue space and a maximum storage height of 15 ft (4.6 m). (AUT-SSD)

3.3.16* Baled Cotton. A natural seed fiber wrapped and secured in industry-accepted materials, usually consisting of burlap, woven polypropylene, or sheet polyethylene, and secured with steel, synthetic or wire bands, or wire; also includes linters and motes. (AUT-SSD)

3.3.17 Banded Roll Paper Storage. See 3.3.197.1.

3.3.18 Banded Tires. A storage method in which a number of tires are strapped together. (AUT-SSD)

3.3.19* Bathroom. Within a dwelling unit, any room or compartment dedicated to personal hygiene, containing a toilet, sink, or bathing capability such as a shower or tub. (AUT-SSI)

3.3.20 B-Class Boundary. See 3.3.130.2.

3.3.21 Bin Box Storage. Storage in five-sided wood, metal, or cardboard boxes with open face on the aisles in which boxes are self-supporting or supported by a structure so designed that little or no horizontal or vertical space exists around boxes. (AUT-SSD)

3.3.22* Blocking. A means by which the horizontal spread of flame or heat during a fire event is stopped by the installation of materials that will stay in place before and during sprinkler operation to limit the channeling of heat between structural members. (AUT-SSD)

3.3.23 Branch Lines. The pipes supplying sprinklers, either directly or through sprigs, drops, return bends, or arm-overs. (AUT-SSI)

3.3.24 Building Height. For the purposes of seismic protection, the vertical distance from the grade plane to the average elevation of the highest roof surface. (AUT-HBS)

3.3.25 Bulkhead. A vertical barrier across the rack. (AUT-SSI)

3.3.26* Carton Records Storage. A Class III commodity consisting predominantly of paper records in cardboard cartons. (AUT-SSD)

3.3.27 Cartoned. A method of storage consisting of corrugated cardboard or paperboard containers fully enclosing the commodity. (AUT-SSD)

3.3.28 Catwalk. For the purposes of carton records storage, a storage aid consisting of either open metal grating or solid horizontal barriers supported from a rack storage system that is utilized as a walkway for access to storage at elevated levels. Catwalks are accessed using stairs and are not separate floors of a building. (AUT-SSD)

3.3.29 Ceiling Height. The distance between the floor and the underside of the ceiling above (or roof deck) within the area. (AUT-SSD)

3.3.30* Ceiling Pocket. An architectural ceiling feature that consists of a bounded area of ceiling located at a higher elevation than the attached lower ceiling. (AUT-SSI)

3.3.31 Ceiling Types.

3.3.31.1 Flat Ceiling. A continuous ceiling in a single plane. (AUT-SSI)

3.3.31.2 Horizontal Ceiling. A ceiling with a slope not exceeding 2 in 12 (16.7 percent). (AUT-SSI)

3.3.31.3 Sloped Ceiling. A ceiling with a slope exceeding 2 in 12 (16.7 percent). (AUT-SSI)

3.3.31.4 Smooth Ceiling. A continuous ceiling free from irregularities, lumps, or indentations greater than 4 in. (100 mm) in depth. (AUT-SSI)

3.3.32 Central Safety Station. See 3.3.130.3.

3.3.33 Check Valve. See 3.3.243.1.

3.3.34 Clearance to Ceiling. The distance from the top of storage to the ceiling above. (AUT-SSD)

3.3.35 Closed Array (Palletized, Solid-Piled, Bin Box, and Shelf Storage). See 3.3.10.1.

3.3.36 Closed Array (Rolled Paper). See 3.3.10.2.

3.3.37 Cloud Ceiling. Any ceiling system, not including sloped ceilings, installed in the same plane with horizontal openings to the structure above on two or more sides. (AUT-SSI)

3.3.38 Column (Rolled Paper). A single vertical stack of rolls. (AUT-SSD)

3.3.39 Combined Dry Pipe Preaction Sprinkler System. See 3.3.224.2.

3.3.40 Commodity. The combination of products, packing material, and container that determines commodity classification. (AUT-SSD)

3.3.41 Compact Storage. Storage on solid shelves not exceeding 36 in. (900 mm) in total depth, arranged as part of a compact storage module, with no more than 30 in. (750 mm) between shelves vertically and with no internal vertical flue spaces other than those between individual shelving sections. (AUT-SSD)

3.3.42 Compact Storage Module. A type of shelving unit consisting of compact storage whereby the units move to allow for storage to be pushed together creating a storage unit with no flues or minimal spaces between units. Aisles are created by moving the shelving unit. Compact storage modules can be manual or electric in operation. (AUT-SSD)

3.3.43 Compartment. A space completely enclosed by walls and a ceiling. Each wall in the compartment is permitted to have openings to an adjoining space if the openings have a minimum lintel depth of 8 in. (200 mm) from the ceiling and the total width of the openings in each wall does not exceed 8 ft (2.4 m). A single opening of 36 in. (900 mm) or less in width without a lintel is permitted where there are no other openings to adjoining spaces. (AUT-SSI)

3.3.44* Compartmented. The rigid separation of the products in a container by dividers that form a stable unit under fire conditions. (AUT-SSD)

3.3.45 Concealed Sprinkler. See 3.3.223.3.1.

3.3.46 Construction Definitions.

3.3.46.1* Obstructed Construction. Panel construction and other construction where beams, trusses, or other members impede heat flow or water distribution in a manner that

materially affects the ability of sprinklers to control or suppress a fire. (AUT-SSI)

3.3.46.2* Unobstructed Construction. Construction where beams, trusses, or other members do not impede heat flow or water distribution in a manner that materially affects the ability of sprinklers to control or suppress a fire. Unobstructed construction has horizontal structural members that are not solid, where the openings are at least 70 percent of the cross-section area and the depth of the member does not exceed the least dimension of the openings, or all construction types, with the exception of panel construction, where the spacing of structural members exceeds 7½ ft (2.3 m) on center. (AUT-SSI)

3.3.47* Container (Shipping, Master, or Outer Container). A receptacle strong enough, by reason of material, design, and construction, to be shipped safely without further packaging. (AUT-SSD)

3.3.48 Continuous Obstruction. See 3.3.147.1.

3.3.49 Control Mode Density/Area (CMDA) Sprinkler. See 3.3.223.4.1.

3.3.50 Control Mode Specific Application (CMSA) Sprinkler. See 3.3.223.4.2.

3.3.51 Control Valve. See 3.3.243.3.

3.3.52 Conventional Pallet. See 3.3.161.1.

3.3.53 Core (Rolled Paper). The central tube around which paper is wound to form a roll. (AUT-SSD)

3.3.54 Corrosion-Resistant Piping. Piping that has the property of being able to withstand deterioration of its surface or its properties when exposed to its environment. [24, 2025] (AUT-PRI)

3.3.55 Corrosion-Resistant Sprinkler. See 3.3.223.4.3.

3.3.56 Corrosion-Retarding Material. A lining or coating material that when applied to piping or appurtenances has the property of reducing or slowing the deterioration of the object's surface or properties when exposed to its environment. [24, 2025] (AUT-PRI)

3.3.57 Cross Mains. The pipes supplying the branch lines, either directly or through riser nipples. (AUT-SSI)

3.3.58 Deluge Sprinkler System. See 3.3.224.3.

▲ 3.3.59 Design Spectral Response Acceleration at Short Periods, S_{DS} . The spectral response acceleration at short periods for the site of the building or structure being designed to satisfy the seismic requirements of ASCE/SEI 7 *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*, based on ASCE/SEI 7 Chapter 22 seismic ground motion maps and Chapter 11 seismic design criteria, or directly from the ASCE/SEI 7 Hazard Tool, or by using the site-specific ground motion procedures of ASCE/SEI 7 Chapter 21. (AUT-HBS)

3.3.60 Differential Dry Pipe Valve. See 3.3.243.5.1.

3.3.61 Distance Monitoring. The monitoring of various conditions of a system or component from a distant location from the system or component through the use of electronic devices, meters, or equipment installed for the purpose. (AUT-SSI)

3.3.62 Double-Row Racks. Racks less than or equal to 12 ft (3.7 m) in depth or single-row racks placed back to back having an aggregate depth up to 12 ft (3.7 m), with aisles having an aisle width of at least 3.5 ft (1.1 m) between loads on racks. (AUT-SSD)

3.3.63* Draft Curtain. A fixed or deployable barrier that protrudes downward from the ceiling to channel, contain, or prevent the migration of smoke and/or heat. (AUT-SSD)

3.3.64 Drop. A vertical pipe supplying one sprinkler from above. (AUT-SSI)

3.3.65 Drop-Out Ceiling. A suspended ceiling system, which is installed below the sprinklers, with listed translucent or opaque panels that are heat sensitive and fall from their setting when exposed to heat. (AUT-SSI)

3.3.66 Dry Barrel Hydrant (Frostproof Hydrant). See 3.3.112.1.

3.3.67 Dry Pipe Sprinkler System. See 3.3.224.4.

3.3.68 Dry Sprinkler. See 3.3.223.4.4.

3.3.69* Dwelling Unit (for sprinkler system installations). One or more rooms arranged for the use of one or more individuals living together, as in a single housekeeping unit normally having cooking, living, sanitary, and sleeping facilities that include, but are not limited to, hotel rooms, dormitory rooms, apartments, condominiums, sleeping rooms in nursing homes, and similar living units. (AUT-SSI)

3.3.70 Early Suppression Fast-Response (ESFR) Sprinkler. See 3.3.223.4.5.

3.3.71 Electrically Operated Sprinkler. See 3.3.223.4.6.

3.3.72* Encapsulation. A method of packaging that either consists of a plastic sheet completely enclosing the sides and top of a pallet load containing a combustible commodity, a combustible package, or a group of combustible commodities or combustible packages, or consists of combustible commodities individually wrapped in plastic sheeting and stored exposed in a pallet load. (AUT-SSD)

3.3.73 Expanded (Foamed or Cellular) Plastics. Those plastics, the density of which is reduced by the presence of numerous small cavities (cells), interconnecting or not, dispersed throughout their mass. (AUT-SSD)

3.3.74 Exposed Group A Plastic Commodities. Those plastics not in packaging or coverings that absorb water or otherwise appreciably retard the burning hazard of the commodity. (Paper wrapped or encapsulated, or both, should be considered exposed.) (AUT-SSD)

3.3.75 Extended Coverage Sprinkler. See 3.3.223.4.7.

3.3.76 Extension Fitting. A male by female adapter intended to be used with a sprinkler to adjust the final fit where the sprinkler is installed in a finished ceiling or wall. (AUT-SSI)

3.3.77 Exterior Projection. An extension beyond an exterior wall capable of collecting heat below. (AUT-SSI)

3.3.78 Extra Hazard (Group 1) (EH1). See 3.3.148.1.

3.3.79 Extra Hazard (Group 2) (EH2). See 3.3.148.2.

3.3.80* Face Sprinklers. Standard sprinklers that are located in transverse flue spaces along the aisle or in the rack, are

within 18 in. (450 mm) of the aisle face of storage, and are used to oppose vertical development of fire on the external face of storage. (AUT-SSD)

3.3.81 Feed Mains. The pipes supplying cross mains, either directly or through risers. (AUT-SSI)

3.3.82 Fire Control. Limiting the size of a fire by distribution of water so as to decrease the heat release rate and pre-wet adjacent combustibles, while controlling ceiling gas temperatures to avoid structural damage. (AUT-SSD)

3.3.83 Fire Department Connection. A connection through which the fire department can pump supplemental water into the sprinkler system, standpipe, or other water-based fire protection systems, furnishing water for fire extinguishment to supplement existing water supplies. [24, 2025] (AUT-PRI)

3.3.84 Fire Pump. A pump that is a provider of liquid flow and pressure dedicated to fire protection. [20, 2025] (AUT-SSI)

3.3.85 Fire Suppression. Sharply reducing the heat release rate of a fire and preventing its regrowth by means of direct and sufficient application of water through the fire plume to the burning fuel surface. (AUT-SSD)

3.3.86 Flat Ceiling. See 3.3.31.1.

3.3.87 Flexible Coupling. A listed coupling or fitting that allows axial displacement, rotation, and at least 1 degree of angular movement of the pipe without inducing harm on the pipe. For pipe diameters of 8 in. (200 mm) and larger, the angular movement is permitted to be less than 1 degree but not less than 0.5 degree. (AUT-HBS)

3.3.88 Flow Hydrant. See 3.3.112.2.

3.3.89 Flow Test. A test performed by the flow and measurement of water from one hydrant and the static and residual pressures from an adjacent hydrant for the purpose of determining the available water supply at that location. [24, 2025] (AUT-PRI)

3.3.90 Flush Sprinkler. See 3.3.223.3.2.

3.3.91 Flushing Test. A test of a piping system using flowrates intended to remove debris from the piping system prior to it being placed in service. [24, 2025] (AUT-SSI)

3.3.92* Four-Way Bracing. Adjacent sway braces or a sway brace assembly intended to resist differential movement of the system piping in all horizontal directions. (AUT-HBS)

3.3.93* Free-Flowing Plastic Materials. Those plastics that fall out of their containers during a fire, fill flue spaces, and create a smothering effect on the fire. (AUT-SSD)

3.3.94 Fuel-Fired Heating Unit. An appliance that produces heat by burning fuel. (AUT-SSI)

3.3.95 General Sprinkler Characteristics. See 3.3.223.2.

3.3.96 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. [See also 3.3.222, *Finished Ground Level (Grade)*, of NFPA 5000.] [5000, 2024] (AUT-HBS)

3.3.97 Gridded Sprinkler System. See 3.3.224.5.

3.3.98 Hanger. A device or assembly used to support the gravity load of the system piping. (AUT-HBS)

3.3.99 Heat-Sensitive Material. See 3.3.130.4.

3.3.100 Heel. See 3.3.130.5.

3.3.101 Heel Angle. See 3.3.130.6.

3.3.102 High Volume Low Speed Fan. A ceiling fan that is approximately 6 ft (1.8 m) to 24 ft (7.3 m) in diameter with a rotational speed of approximately 30 to 70 revolutions per minute. (AUT-SSD)

3.3.103 High-Challenge Fire Hazard. A fire hazard typical of that produced by fires in combustible high-piled storage. (AUT-SSD)

3.3.104* High-Piled Storage. Solid-piled, palletized, rack storage, bin box, and shelf storage of Class I through Class IV commodities more than 12 ft (3.7 m) in height and solid-piled, palletized, rack storage, bin box, and shelf storage of Group A plastic commodities more than 5 ft (1.5 m) in height. (AUT-SSD)

3.3.105 Horizontal Barrier. A solid barrier in the horizontal position covering the rack at certain height increments to prevent vertical fire spread. (AUT-SSD)

3.3.106 Horizontal Ceiling. See 3.3.31.2.

3.3.107 Horizontal Channel. Any uninterrupted space in excess of 5 ft (1.5 m) in length between horizontal layers of stored tires. Such channels can be formed by pallets, shelving, racks, or other storage arrangements. (AUT-SSD)

3.3.108 Horizontal Force, F_{pw} . The horizontal force due to seismic load acting on a sprinkler system at working stress levels. (AUT-HBS)

3.3.109 Horizontal Roll Paper Storage. See 3.3.197.2.

3.3.110 Hose House. An enclosure located over or adjacent to a hydrant or other water supply designed to contain the necessary hose nozzles, hose wrenches, gaskets, and spanners to be used in firefighting in conjunction with and to provide aid to the local fire department. [24, 2025] (AUT-PRI)

N 3.3.111 Hose Station. A combination of a hose rack or reel, hose nozzle, hose, and hose connection. [14, 2024] (AUT-SSI)

3.3.112 Hydrant. An exterior valved connection to a water supply system that provides hose connections. [24, 2025] (AUT-PRI)

3.3.112.1 Dry Barrel Hydrant (Frostproof Hydrant). A type of hydrant with the main control valve below the frost line between the footpiece and the barrel. [24, 2025] (AUT-PRI)

3.3.112.2 Flow Hydrant. The hydrant that is used for the flow and flow measurement of water during a flow test. [24, 2025] (AUT-PRI)

3.3.112.3 Private Fire Hydrant. A valved connection on a water supply system having one or more outlets and that is used to supply hose and fire department pumpers with water on private property. [24, 2025] (AUT-PRI)

3.3.112.4 Public Hydrant. A valved connection on a water supply system having one or more outlets and that is used to supply hose and fire department pumpers with water. [24, 2025] (AUT-PRI)

3.3.112.5 Residual Hydrant. The hydrant that is used for measuring static and residual pressures during a flow test. [24, 2025] (AUT-PRI)

3.3.112.6 Wet Barrel Hydrant. A type of hydrant that is intended for use where there is no danger of freezing weather, where each outlet is provided with a valve and an outlet. [24, 2025] (AUT-PRI)

3.3.113 Hydrant Butt. The hose connection outlet of a hydrant. [24, 2025] (AUT-PRI)

3.3.114 Hydraulically Calculated Water Demand Flow Rate. The waterflow rate for a system or hose stream that has been calculated using accepted engineering practices. [24, 2025] (AUT-PRI)

3.3.115 Hydraulically Designed System. A calculated sprinkler system in which pipe sizes are selected on a pressure loss basis to provide a prescribed water density, in gallons per minute per square foot (mm/min), or a prescribed minimum discharge pressure or flow per sprinkler, distributed with a reasonable degree of uniformity over a specified area. (AUT-SSD)

3.3.116 Hydrostatic Test. A test of a closed piping system and its attached appurtenances consisting of subjecting the piping to an increased internal pressure for a specified period of duration to verify system integrity and leak rates. [24, 2025] (AUT-PRI)

3.3.117 Indicating Valve. See 3.3.243.4.

3.3.118 Installation Orientation. See 3.3.223.3.

3.3.119 Institutional Sprinkler. See 3.3.223.4.8.

3.3.120 Intermediate-Level Sprinkler/Rack Storage Sprinkler. See 3.3.223.4.9.

3.3.121 International Shore Connection. See 3.3.130.7.

3.3.122 Laced Tire Storage. Tires stored where the sides of the tires overlap, creating a woven or laced appearance. [See Figure A.3.3.200(g).] (AUT-SSD)

3.3.123 Lateral Brace. A sway brace intended to resist differential movement perpendicular to the axis of the system piping. (AUT-HBS)

3.3.124 Light Hazard. See 3.3.148.3.

3.3.125* Limited-Combustible Material. See Section 4.9.

3.3.126 Longitudinal Brace. A sway brace intended to resist differential movement parallel to the axis of the system piping. (AUT-HBS)

3.3.127* Longitudinal Flue Space. The space between rows of storage perpendicular to the direction of loading with a width not exceeding 24 in. (600 mm) between storage. (AUT-SSD)

3.3.128 Looped Sprinkler System. See 3.3.224.6.

3.3.129* Low-Piled Storage. Solid-piled, palletized, rack storage, bin box, and shelf storage of Class I through Class IV commodities up to 12 ft (3.7 m) in height and solid-piled, palletized, rack storage, bin box, and shelf storage of Group A plastic commodities up to 5 ft (1.5 m) in height. (AUT-SSD)

3.3.130 Marine Definitions. These definitions apply to Chapter 31 only. (AUT-SSI)

▲ **3.3.130.1 A-Class Boundary.** A boundary designed to resist the passage of smoke and flame for 1 hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Fire Tests of Building Construction and Materials*. (AUT-SSI)

▲ **3.3.130.2 B-Class Boundary.** A boundary designed to resist the passage of flame for ½ hour when tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Fire Tests of Building Construction and Materials*. (AUT-SSI)

3.3.130.3 Central Safety Station. A continuously manned control station from which all of the fire control equipment is monitored. If this station is not the bridge, direct communication with the bridge must be provided by means other than the ship's service telephone. (AUT-SSI)

3.3.130.4* Heat-Sensitive Material. A material whose melting point is below 1700°F (927°C). (AUT-SSI)

3.3.130.5 Heel. The inclination of a ship to one side. (AUT-SSI)

3.3.130.6 Heel Angle. The angle defined by the intersection of a vertical line through the center of a vessel and a line perpendicular to the surface of the water. (AUT-SSI)

3.3.130.7* International Shore Connection. A universal connection to the vessel's fire main to which a shoreside firefighting water supply can be connected. (AUT-SSI)

3.3.130.8* Marine System. A sprinkler system installed on a ship, boat, or other floating structure that takes its supply from the water on which the vessel floats. (AUT-SSI)

▲ **3.3.130.9* Marine Thermal Barrier.** An assembly that is constructed of noncombustible materials and made intact with the main structure of the vessel, such as shell, structural bulkheads, and decks; meets the requirements of a B-Class boundary; and is insulated such that, if tested in accordance with ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Fire Tests of Building Construction and Materials*, for 15 minutes, the average temperature of the unexposed side does not rise more than 250°F (139°C) above the original temperature, nor does the temperature at any one point, including any joint, rise more than 405°F (225°C) above the original temperature. (AUT-SSI)

3.3.130.10 Marine Water Supply. The supply portion of the sprinkler system from the water pressure tank or the sea suction of the designated sprinkler system pump up to and including the valve that isolates the sprinkler system from these two water sources. (AUT-SSI)

3.3.130.11 Supervision. A visual and audible alarm signal given at the central safety station to indicate when the system is in operation or when a condition that would impair the satisfactory operation of the system exists. Supervisory alarms must give a distinct indication for each individual system component that is monitored. (AUT-SSI)

3.3.130.12 Survival Angle. The maximum angle to which a vessel is permitted to heel after the assumed damage required by stability regulations is imposed. (AUT-SSI)

3.3.130.13 Type 1 Stair. A fully enclosed stair that serves all levels of a vessel in which persons can be employed. (AUT-SSI)

3.3.131 Marine System. See 3.3.130.8.

3.3.132 Marine Thermal Barrier. See 3.3.130.9.

3.3.133 Marine Water Supply. See 3.3.130.10.

3.3.134 Mechanical Dry Pipe Valve. See 3.3.243.5.2.

3.3.135* Miscellaneous Storage. Storage that does not exceed 12 ft (3.7 m) in height, is incidental to another occupancy use group, does not constitute more than 10 percent of the building area or 4000 ft² (370 m²) of the sprinklered area, whichever is greater, does not exceed 1000 ft² (93 m²) in one pile or area, and is separated from other storage areas by at least 25 ft (7.6 m). (AUT-SSD)

3.3.136* Miscellaneous Tire Storage. The storage of rubber tires that is incidental to the main use of the building; storage areas do not exceed 2000 ft² (185 m²), and on-tread storage piles, regardless of storage method, do not exceed 25 ft (7.6 m) in the direction of the wheel holes. Acceptable storage arrangements include (a) on-floor, on-side storage up to 12 ft (3.7 m) high; (b) on-floor, on-tread storage up to 5 ft (1.5 m) high; (c) double-row or multirow fixed or portable rack storage on-side or on-tread up to 5 ft (1.5 m) high; (d) single-row fixed or portable rack storage on-side or on-tread up to 12 ft (3.7 m) high; and (e) laced tires in racks up to 5 ft (1.5 m) in height. (AUT-SSD)

3.3.137 Movable Racks. Racks on fixed rails or guides that can be moved back and forth only in a horizontal, two-dimensional plane. A moving aisle is created as abutting racks are either loaded or unloaded, then moved across the aisle to abut other racks. (AUT-SSD)

3.3.138 Multicycle System. See 3.3.224.7.

3.3.139 Multiple-Row Racks. Racks greater than 12 ft (3.7 m) in depth or single- or double-row racks separated by aisles less than 3.5 ft (1.1 m) wide having an overall width greater than 12 ft (3.7 m). (AUT-SSD)

3.3.140 Net Vertical Force. The vertical reaction due to the angle of installation of sway braces on system piping resulting from earthquake motion. (AUT-HBS)

3.3.141 Noncombustible Material. See Section 4.9.

3.3.142 Noncontinuous Obstruction. See 3.3.147.2.

3.3.143* Non-Flat Obstruction. An obstruction where the underside of the obstruction is not in the same plane and not capable of collecting heat. (AUT-SSI)

3.3.144* Non-Solid Obstruction. An obstruction that consists of openings that constitute at least 30 percent of the footprint of the obstruction. (AUT-SSI)

3.3.145 Nozzle. See 3.3.223.4.10.

3.3.146 Obstructed Construction. See 3.3.46.1.

3.3.147 Obstruction.

3.3.147.1 Continuous Obstruction. An obstruction located at or below the level of sprinkler deflectors that affect the discharge pattern of two or more adjacent sprinklers. (AUT-SSI)

3.3.147.2 Noncontinuous Obstruction. An obstruction at or below the level of the sprinkler deflector that affects the discharge pattern of a single sprinkler. (AUT-SSI)

3.3.148 Occupancies.

3.3.148.1 Extra Hazard (Group 1) (EH1). Occupancies or portions of other occupancies where the quantity and combustibility of contents are very high or dust, lint, or other materials are present, introducing the probability of rapidly developing fires with high rates of heat release but with little or no combustible or flammable liquids. (AUT-SSD)

3.3.148.2 Extra Hazard (Group 2) (EH2). Occupancies or portions of other occupancies with moderate to substantial amounts of flammable or combustible liquids or occupancies where shielding of combustibles is extensive. (AUT-SSD)

3.3.148.3 Light Hazard. Occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected. (AUT-SSD)

3.3.148.4 Ordinary Hazard (Group 1) (OH1). Occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stockpiles of contents do not exceed 8 ft (2.4 m), and fires with moderate rates of heat release are expected. (AUT-SSD)

3.3.148.5 Ordinary Hazard (Group 2) (OH2). Occupancies or portions of other occupancies where the quantity and combustibility of contents are moderate to high, stockpiles of contents with moderate rates of heat release do not exceed 12 ft (3.7 m), and stockpiles of contents with high rates of heat release do not exceed 8 ft (2.4 m). (AUT-SSD)

3.3.149 Old-Style/Conventional Sprinkler. See 3.3.223.4.11.

3.3.150 On-Side Tire Storage. Tires stored horizontally or flat. (AUT-SSD)

3.3.151 On-Tread Tire Storage. Tires stored vertically or on their treads. (AUT-SSD)

3.3.152 Open Array (Palletized, Solid-Piled, Bin Box, and Shelf Storage). See 3.3.10.3.

3.3.153 Open Array (Rolled Paper). See 3.3.10.4.

3.3.154 Open Rack. Racks without shelving or with shelving in racks that are fixed in place with shelves having a solid surface and a shelf area equal to or less than 20 ft² (1.9 m²) or with shelves having a wire mesh, slatted surface, or other material with openings representing at least 50 percent of the shelf area including the horizontal area of rack members and where the flue spaces are maintained. (AUT-SSD)

3.3.155 Open Sprinkler. See 3.3.223.4.12.

3.3.156* Open-Top Container. A container of any shape that is entirely or partially open on the top and arranged so as to allow for the collection of discharging sprinkler water cascading through the storage array. (AUT-SSD)

3.3.157 Ordinary Hazard (Group 1) (OH1). See 3.3.148.4.

3.3.158 Ordinary Hazard (Group 2) (OH2). See 3.3.148.5.

3.3.159 Ornamental/Decorative Sprinkler. See 3.3.223.4.13.

3.3.160 Packaging. A commodity wrapping, cushioning, or container. (AUT-SSD)

3.3.161 Pallet.

3.3.161.1* Conventional Pallet. A material-handling aid designed to support a unit load with openings to provide access for material-handling devices. (See Figure A.3.3.161.1.) (AUT-SSD)

3.3.161.2 Plastic Pallet. A pallet having any portion of its construction consisting of a plastic material. (AUT-SSD)

3.3.161.3* Reinforced Plastic Pallet. A plastic pallet incorporating a secondary reinforcing material (such as steel or fiberglass) within the pallet. (AUT-SSD)

3.3.161.4 Slave Pallet. A special pallet captive to a material-handling system. (See Figure A.3.3.161.1.) (AUT-SSD)

3.3.161.5 Wood Pallet. A pallet constructed entirely of wood with metal fasteners. (AUT-SSD)

3.3.162 Palletized Storage. Storage of commodities on pallets or other storage aids that form horizontal spaces between tiers of storage. (AUT-SSD)

3.3.163 Palletized Tire Storage. Storage on portable racks of various types utilizing a conventional pallet as a base. (AUT-SSD)

N 3.3.164 Panel Construction. Ceiling panels formed by members capable of trapping heat to aid the operation of sprinklers and limited to a maximum of 300 ft² (28 m²) in area. See A.3.3.46.1(4). (AUT-SSI)

3.3.165 Paper (General Term). The term for all kinds of felted sheets made from natural fibrous materials, usually vegetable but sometimes mineral or animal, and formed on a fine wire screen from water suspension. (AUT-SSD)

3.3.166 Pendent Sprinkler. See 3.3.223.3.3.

3.3.167* Pile Stability, Stable Piles. Those arrays where collapse, spillage of content, or leaning of stacks across flue spaces is not likely to occur soon after initial fire development. (AUT-SSD)

3.3.168* Pile Stability, Unstable Piles. Those arrays where collapse, spillage of contents, or leaning of stacks across flue spaces occurs soon after initial fire development. (AUT-SSD)

3.3.169 Pilot Line Detector. See 3.3.223.4.14.

3.3.170 Pipe Schedule System. See 3.3.224.8.

3.3.171 Plastic Pallet. See 3.3.161.2.

3.3.172 Portable Racks. Racks that are not fixed in place and can be arranged in any number of configurations. (AUT-SSD)

3.3.173* Post-Installed Anchors. A device used for fastening pipe to the building structure, installed in hardened concrete. (AUT-HBS)

3.3.174 Preaction Sprinkler System. See 3.3.224.9.

3.3.175 Premixed Antifreeze Solution. A mixture of an antifreeze material with water that is prepared and factory-mixed by the manufacturer with a quality control procedure in place that ensures that the antifreeze solution remains homogeneous and that the concentration is as specified. (AUT-SSI)

3.3.176 Pressure Regulating Device. A device designed for the purpose of reducing, regulating, controlling, or restricting water pressure. [24, 2025] (AUT-PRI)

3.3.177 Private Fire Hydrant. See 3.3.112.3.

3.3.178* Private Fire Service Main. Private fire service main, as used in this standard, is that pipe and its appurtenances on private property (1) between a source of water and the base of the system riser for water-based fire protection systems, (2) between a source of water and inlets to foam-making systems, (3) between a source of water and the base elbow of private hydrants or monitor nozzles, and (4) used as fire pump suction and discharge piping, (5) beginning at the inlet side of the check valve on a gravity or pressure tank. [24, 2025] (AUT-PRI)

3.3.179* Prying Factor. A factor based on fitting geometry and brace angle from vertical that results in an increase in tension load due to the effects of prying between the upper seismic brace attachment fitting and the structure. (AUT-HBS)

3.3.180 Public Hydrant. See 3.3.112.4.

3.3.181 Pumper Outlet. The hydrant outlet intended to be connected to a fire department pumper for use in taking supply from the hydrant for pumps. [24, 2025] (AUT-PRI)

3.3.182 Pyramid Tire Storage. On-floor storage in which tires are formed into a pyramid to provide pile stability. (AUT-SSD)

N 3.3.183 Qualified Personnel. Competent and capable individual(s) having met the requirements and training for a given field acceptable to the AHJ. [25, 2023] (AUT-SSI)

3.3.184 Quick-Response Extended Coverage Sprinkler. See 3.3.223.4.15.

3.3.185 Quick-Response (QR) Sprinkler. See 3.3.223.4.16.

3.3.186* Rack. Any combination of vertical, horizontal, and diagonal members that supports stored materials. [1, 2024] (AUT-SSD)

3.3.187 Rack Shelf Area. The area of the horizontal surface of a shelf in a rack defined by perimeter aisle(s) or nominal 6 in. (150 mm) flue spaces on all four sides, or by the placement of loads that block openings that would otherwise serve as the required flue spaces. (AUT-SSD)

3.3.188 Rated Capacity. The flow available from a hydrant at the designated residual pressure (rated pressure) either measured or calculated. [24, 2025] (AUT-PRI)

3.3.189* Raw Water Source. A water supply that has not been treated and could contain foreign material that could enter the sprinkler system. (AUT-SSD)

3.3.190 Recessed Sprinkler. See 3.3.223.3.4.

3.3.191 Reinforced Plastic Pallet. See 3.3.161.3.

3.3.192 Residential Sprinkler. See 3.3.223.4.17.

3.3.193 Residual Hydrant. See 3.3.112.5.

3.3.194 Residual Pressure. The pressure that exists in the distribution system, measured at the residual hydrant at the time the flow readings are taken at the flow hydrants. [24, 2025] (AUT-PRI)

3.3.195 Riser Nipple. A vertical pipe between the cross main and branch line. (AUT-SSI)

3.3.196 Risers. The vertical supply pipes in a sprinkler system. (AUT-SSI)

3.3.197 Roll Paper Storage.

3.3.197.1 Banded Roll Paper Storage. Rolls provided with a circumferential steel strap [$\frac{3}{8}$ in. (10 mm) or wider] at each end of the roll. (AUT-SSD)

3.3.197.2 Horizontal Roll Paper Storage. Rolls stored with the cores in the horizontal plane (on-side storage). (AUT-SSD)

3.3.197.3* Roll Paper Storage Height. The maximum vertical distance above the floor at which roll paper is normally stored. (AUT-SSD)

3.3.197.4 Vertical Roll Paper Storage. Rolls stored with the cores in the vertical plane (on-end storage). (AUT-SSD)

3.3.197.5* Wrapped Roll Paper Storage. Rolls provided with a complete heavy kraft covering around both sides and ends. (AUT-SSD)

3.3.198 Roll Paper Storage Height. See 3.3.197.3.

3.3.199 Roof Height. The distance between the floor and the underside of the roof deck within the storage area. (AUT-SSD)

3.3.200* Rubber Tire Rack Illustrations. See Figure A.3.3.200(a) through Figure A.3.3.200(g).

3.3.201 Rubber Tires. Pneumatic tires for passenger automobiles, aircraft, light and heavy trucks, trailers, farm equipment, construction equipment (off-the-road), and buses. (AUT-SSD)

3.3.202 Seismic Coefficient, C_p . The seismic coefficient that combines ground motion and seismic response factors from ASCE/SEI 7, *Minimum Design Loads and Associated Criteria for Buildings and Other Structures*. (AUT-HBS)

3.3.203* Seismic Separation Assembly. An assembly of fittings, pipe, flexible pipe, and/or couplings that permits movement in all directions to accommodate seismic differential movement across building seismic separation joints. (AUT-HBS)

3.3.204* Shadow Area. The floor area within the protection area of a sprinkler created by the portion of sprinkler discharge that is blocked by a wall, partition, or other obstruction. (AUT-SSI)

3.3.205* Shelf Storage. Storage on structures up to and including 30 in. (750 mm) deep and separated by aisles at least 30 in. (750 mm) wide. (AUT-SSD)

3.3.206 Shop-Welded. Materials welded in a sprinkler contractor's or fabricator's premise or in an area specifically designed or authorized for welding, such as a detached outside location, maintenance shop, or other area. (AUT-SSI)

3.3.207 Sidewall Sprinkler. See 3.3.223.3.5.

3.3.208* Single-Row Racks. Racks that have no longitudinal flue space and that have a depth up to 6 ft (1.8 m) with aisles having a width of at least 3.5 ft (1.1 m) between loads on racks. (AUT-SSD)

3.3.209 Site Class. A classification assigned to a site based on the types of soils present and their engineering properties as defined in Chapter 20 of ASCE/SEI 7, *Minimum Design Loads*

and Associated Criteria for Buildings and Other Structures. [ASCE/SEI 7:11.2] (AUT-HBS)

3.3.210 Slatted Shelf Rack. A rack where shelves are fixed in place with a series of narrow individual solid supports used as the shelf material and spaced apart with regular openings. (AUT-SSD)

3.3.211 Slave Pallet. See 3.3.161.4.

3.3.212 Sloped Ceiling. See 3.3.31.3.

3.3.213* Small Openings. Openings in the ceiling or construction features of a concealed space that allow limited amounts of heat to enter the concealed space. (AUT-SSI)

3.3.214 Small Room. A compartment of light hazard occupancy classification having unobstructed construction and a floor area not exceeding 800 ft² (74 m²). (AUT-SSI)

3.3.215 Smooth Ceiling. See 3.3.31.4.

3.3.216 Solid Shelf Rack. A rack that is not defined as an open rack where shelves are fixed in place with a solid, slatted, or wire mesh barrier used as the shelf material and having limited openings in the shelf area. (AUT-SSD)

3.3.217* Solid Shelving. Shelving that is fixed in place, slatted, wire mesh, or other type of shelves located within racks. The area of a solid shelf is defined by perimeter aisle or flue space on all four sides or by the placement of loads that block openings that would otherwise serve as the required flue spaces. Solid shelves having an area equal to or less than 20 ft² (1.9 m²) are defined as open racks. Shelves of wire mesh, slats, or other materials more than 50 percent open and where the flue spaces are maintained are defined as open racks. (AUT-SSD)

3.3.218 Solid Unit Load of Nonexpanded Plastic (Either Cartoned or Exposed). A load that does not have voids (air) within the load and that burns only on the exterior of the load; water from sprinklers might reach most surfaces available to burn. (AUT-SSD)

3.3.219 Solid-Piled Storage. Storage of commodities stacked on each other. (AUT-SSD)

3.3.220 Special Sprinkler. See 3.3.223.4.18.

3.3.221 Spray Sprinkler. See 3.3.223.4.19.

3.3.222 Sprig. A pipe that rises vertically and supplies a single sprinkler. (AUT-SSI)

3.3.223 Sprinkler Definitions.

3.3.223.1 Automatic Sprinkler. A fire suppression or control device that operates automatically when its heat-activated element is heated to its thermal rating or above, allowing water to discharge over a specified area. (AUT-SSI)

3.3.223.2* General Sprinkler Characteristics. The following are characteristics of a sprinkler that define its ability to control or extinguish a fire. (1) Thermal sensitivity. A measure of the rapidity with which the thermal element operates as installed in a specific sprinkler or sprinkler assembly. One measure of thermal sensitivity is the response time index (RTI) as measured under standardized test conditions. (a) Sprinklers defined as fast response have a thermal element with an RTI of 50 (meters-seconds)^{1/2} or less. (b) Sprinklers defined as standard response have a thermal element with

an RTI of 80 (meters-seconds)^{1/2} or more. (2) Temperature rating. (3) K-factor (*see Chapter 7*). (4) Installation orientation (*see 3.3.223.3*). (5) Water distribution characteristics (i.e., application rate, wall wetting). (6) Special service conditions. (AUT-SSI)

3.3.223.3 Installation Orientation. The following sprinklers are defined according to orientation. (AUT-SSI)

3.3.223.3.1 Concealed Sprinkler. A recessed sprinkler with cover plate. (AUT-SSI)

3.3.223.3.2 Flush Sprinkler. A sprinkler in which all or part of the body, including the shank thread, is mounted above the lower plane of the ceiling. (AUT-SSI)

3.3.223.3.3 Pendent Sprinkler. A sprinkler designed to be installed in such a way that the water stream is directed downward against the deflector. (AUT-SSI)

3.3.223.3.4 Recessed Sprinkler. A sprinkler in which all or part of the body, other than the shank thread, is mounted within a recessed housing. (AUT-SSI)

3.3.223.3.5 Sidewall Sprinkler. A sprinkler having special deflectors that are designed to discharge most of the water away from the nearby wall in a pattern resembling one-quarter of a sphere, with a small portion of the discharge directed at the wall behind the sprinkler. (AUT-SSI)

N 3.3.223.3.6 Supplemental Sprinkler. A sprinkler that is installed below an obstruction. (AUT-SSI)

3.3.223.3.7 Upright Sprinkler. A sprinkler designed to be installed in such a way that the water spray is directed upwards against the deflector. (AUT-SSI)

3.3.223.4 Sprinkler Types. The following sprinklers are defined according to design and/or performance characteristics. (AUT-SSI)

3.3.223.4.1* Control Mode Density/Area (CMDA) Sprinkler. A type of spray sprinkler intended to provide fire control in storage applications using the design density/area criteria described in this standard. (AUT-SSI)

3.3.223.4.2* Control Mode Specific Application (CMSA) Sprinkler. A type of spray sprinkler that is capable of producing characteristic large water droplets and that is listed for its capability to provide fire control of specific high-challenge fire hazards. (AUT-SSI)

3.3.223.4.3 Corrosion-Resistant Sprinkler. A sprinkler fabricated with corrosion-resistant material, or with special coatings or platings, to be used in an atmosphere that would normally corrode sprinklers. (AUT-SSI)

3.3.223.4.4* Dry Sprinkler. A sprinkler secured in an extension nipple that has a seal at the inlet end to prevent water from entering the nipple until the sprinkler operates. (AUT-SSI)

3.3.223.4.5* Early Suppression Fast-Response (ESFR) Sprinkler. A type of fast-response sprinkler that has a thermal element with an RTI of 50 (meters-seconds)^{1/2} or less and is listed for its capability to provide fire suppression of specific high-challenge fire hazards. (AUT-SSI)

3.3.223.4.6 Electrically Operated Sprinkler. A sprinkler equipped with an integral means of activation using electricity. (AUT-SSI)

3.3.223.4.7 Extended Coverage Sprinkler. A type of spray sprinkler with maximum coverage areas as specified in Sections 11.2 and 11.3. (AUT-SSI)

3.3.223.4.8 Institutional Sprinkler. A sprinkler specially designed for resistance to load-bearing purposes and with components not readily converted for use as weapons. (AUT-SSI)

3.3.223.4.9 Intermediate-Level Sprinkler/Rack Storage Sprinkler. A sprinkler equipped with integral shields to protect its operating elements from the discharge of sprinklers installed at higher elevations. (AUT-SSI)

3.3.223.4.10 Nozzle. A device for use in applications requiring special water discharge patterns, directional spray, or other unusual discharge characteristics. (AUT-SSI)

3.3.223.4.11 Old-Style/Conventional Sprinkler. A sprinkler that directs from 40 percent to 60 percent of the total water initially in a downward direction and that is designed to be installed with the deflector either upright or pendent. (AUT-SSI)

3.3.223.4.12 Open Sprinkler. A sprinkler that does not have actuators or heat-responsive elements. (AUT-SSI)

3.3.223.4.13 Ornamental/Decorative Sprinkler. A sprinkler that has been painted or plated by the manufacturer. (AUT-SSI)

3.3.223.4.14 Pilot Line Detector. A standard spray sprinkler or thermostatic fixed-temperature release device used as a detector to pneumatically or hydraulically release the main valve, controlling the flow of water into a fire protection system. (AUT-SSI)

3.3.223.4.15 Quick-Response Extended Coverage Sprinkler. A type of quick-response sprinkler that has a thermal element with an RTI of 50 (meter-seconds)^{1/2} or less and complies with the extended protection areas defined in Chapter 11. (AUT-SSI)

3.3.223.4.16* Quick-Response (QR) Sprinkler. A type of spray sprinkler that has a thermal element with an RTI of 50 (meter-seconds)^{1/2} or less and is listed as a quick-response sprinkler for its intended use. (AUT-SSI)

3.3.223.4.17 Residential Sprinkler. A type of fast-response sprinkler having a thermal element with an RTI of 50 (meters-seconds)^{1/2} or less that has been specifically investigated for its ability to enhance survivability in the room of fire origin and that is listed for use in the protection of dwelling units. (AUT-SSI)

3.3.223.4.18 Special Sprinkler. A sprinkler that has been tested and listed as prescribed in Section 15.2. (AUT-SSI)

3.3.223.4.19 Spray Sprinkler. A type of sprinkler listed for its capability to provide fire control for a wide range of fire hazards. (AUT-SSI)

3.3.223.4.20 Standard Spray Sprinkler. A spray sprinkler with maximum coverage areas as specified in Sections 10.2 and 10.3. (AUT-SSI)

3.3.224* Sprinkler System. A system that is commonly activated by heat from a fire and discharges water over the fire area, that consists of an integrated network of piping designed in accordance with fire protection engineering standards, and that includes a water supply source, a control valve, a waterflow alarm (where required), and a drain. The portion of the sprinkler system above ground is a network of specifically sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. (AUT-SSI)

3.3.224.1 Antifreeze Sprinkler System. A wet pipe system using automatic sprinklers that contains a liquid solution to prevent freezing of the system, intended to discharge the solution upon sprinkler operation, followed immediately by water from a water supply. (AUT-SSI)

3.3.224.2 Combined Dry Pipe Preaction Sprinkler System. A sprinkler system employing automatic sprinklers attached to a piping system containing air under pressure with a supplemental detection system installed in the same areas as the sprinklers. Operation of the detection system actuates tripping devices that open dry pipe valves simultaneously and without loss of air pressure in the system. The detection system also serves as an automatic fire alarm system. (AUT-SSI)

3.3.224.3 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. (AUT-SSI)

3.3.224.4 Dry Pipe Sprinkler System. A sprinkler system employing automatic sprinklers that are attached to a piping system containing air, nitrogen, or other approved gas 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. (AUT-SSI)

3.3.224.5* Gridded Sprinkler System. A sprinkler system in which parallel cross mains are connected by multiple branch lines, causing an operating sprinkler to receive water from both ends of its branch line while other branch lines help transfer water between cross mains. (AUT-SSD)

3.3.224.6* Looped Sprinkler System. A sprinkler system in which multiple cross mains are tied together so as to provide more than one path for water to flow to an operating sprinkler and branch lines are not tied together. (AUT-SSD)

3.3.224.7 Multicycle System. A type of sprinkler system capable of repeated on-off flow cycles in response to heat. (AUT-SSI)

3.3.224.8 Pipe Schedule System. A sprinkler system in which the pipe sizing is selected from a schedule that is determined by the occupancy classification and in which a given number of sprinklers are allowed to be supplied from specific sizes of pipe. (AUT-SSD)

3.3.224.9* 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. (AUT-SSI)

N 3.3.224.10 Vacuum Dry System. A sprinkler system employing automatic sprinklers that are attached to a piping system containing air under negative gauge pressure, the release of which (as from the opening of a sprinkler) permits the air pressure detection to open the water flow valve, and the water then flows into the piping system and out the opened sprinklers. (AUT-SSI)

N 3.3.224.11 Vacuum Preaction System. A sprinkler system employing automatic sprinklers that are attached to a piping system containing air under negative gauge pressure, with a supplemental detection system installed in the same areas as the sprinklers. (AUT-SSI)

3.3.224.12 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. (AUT-SSI)

3.3.225 Sprinkler Types. See 3.3.223.4.

3.3.226 Standard Array (Rolled Paper). See 3.3.10.5.

3.3.227 Standard Spray Sprinkler. See 3.3.223.4.20.

3.3.228 Static Pressure. The pressure that exists at a given point under normal distribution system conditions measured at the residual hydrant with no hydrants flowing. [24, 2025] (AUT-PRI)

3.3.229 Storage Aids. Commodity storage devices, such as pallets, dunnage, separators, and skids. (AUT-SSD)

3.3.230 Supervision. See 3.3.130.11.

3.3.231 Supervisory Device. A device arranged to supervise the operative condition of automatic sprinkler systems. (AUT-SSI)

3.3.232 Survival Angle. See 3.3.130.12.

3.3.233 Sway Brace. An assembly intended to be attached to the system piping to resist horizontal earthquake loads in two directions. (AUT-HBS)

3.3.234 System Riser. The aboveground horizontal or vertical pipe between the water supply and the mains (cross or feed) that contains a control valve (either directly or within its supply pipe), a pressure gauge, a drain, and a waterflow alarm device. (AUT-SSI)

3.3.235 System Working Pressure. The maximum anticipated static (nonflowing) or flowing pressure applied to sprinkler system components exclusive of surge pressures and exclusive of pressure from the fire department connection. (AUT-SSI)

Δ 3.3.236 Thermal Barrier. A material that limits the average temperature rise of the unexposed surface to not more than 250°F (139°C) above ambient for a specified fire exposure duration using the standard time-temperature curve of ASTM E119, *Standard Test Methods for Fire Tests of Building Construction and Materials*, or UL 263, *Fire Tests of Building Construction and Materials*. (AUT-SSI)

3.3.237* Tiered Storage (Baled Cotton). An arrangement in which bales are stored directly on the floor, two or more bales high. (AUT-SSD)

3.3.238 Transverse Flue Space. The space between rows of storage parallel to the direction of loading. (See Figure A.3.3.127.) (AUT-SSD)

3.3.239 Type 1 Stair. See 3.3.130.13.

3.3.240 Unit Load. A pallet load or module held together in some manner and normally transported by material-handling equipment. (AUT-SSD)

3.3.241 Unobstructed Construction. See 3.3.46.2.

3.3.242 Upright Sprinkler. See 3.3.223.3.7.

3.3.243 Valve. A device for controlling the passage of fluid or gas through a pipe.

3.3.243.1 Check Valve. A valve that allows flow in one direction only. [24, 2025] (AUT-PRI)

N 3.3.243.2* Automatic Breach Control Valve. A hydraulic sensing device that detects abnormal water flow conditions and automatically isolates portions of a piping system when a catastrophic downstream breach or line break occurs. (AUT-SSI)

3.3.243.3* Control Valve. A valve capable of stopping the flow of water to water-based fire protection systems and devices. (AUT-SSI)

3.3.243.4* Indicating Valve. A valve that has components that provide the valve operating position, open or closed. [24, 2025] (AUT-PRI)

3.3.243.5* Water Control Valve. A valve that activates to allow water flow to a water-based fire protection system. (AUT-SSI)

3.3.243.5.1 Differential Dry Pipe Valve. A water control valve that is held in the closed position by the system pneumatic

pressure exposed to the surface area on the system side of the clapper where such surface area is larger than the surface area on the water supply side, with an intermediate chamber between the two surface areas that is open to atmosphere. (AUT-SSI)

3.3.243.5.2 Mechanical Dry Pipe Valve. A water control valve that uses a series of mechanical devices such as levers, springs, diaphragms, and latches to hold the valve in the closed position with pneumatic pressure and without using the clapper surface areas to provide a differential between system pneumatic and water pressures. (AUT-SSI)

N 3.3.243.5.3 Deluge Valve. A water control valve, used for deluge and preaction systems, that is held in the closed position by hydraulic pressure operating on a series of mechanical devices such as levers, pistons, springs, diaphragms, and latches, wherein the loss of hydraulic pressure due to automatic or manual operation of a releasing device or devices results in operation of the deluge valve. (AUT-SSI)

N 3.3.244* Vapor Corrosion Inhibitor (VCI). A chemical compound (substance) that emits rust-inhibiting vapor to protect ferrous and nonferrous metals against corrosion in air-filled dry pipe or preaction sprinkler systems. (AUT-SSI)

3.3.245 Vertical Roll Paper Storage. See 3.3.197.4.

3.3.246 Water Control Valve. See 3.3.243.5.

3.3.247 Waterflow Alarm Device. An attachment to the sprinkler system that detects a predetermined water flow and is connected to a fire alarm system to initiate an alarm condition or is used to mechanically or electrically initiate a fire pump or local audible or visual alarm. (AUT-SSI)

3.3.248 Wet Barrel Hydrant. See 3.3.112.6.

3.3.249 Wet Pipe Sprinkler System. See 3.3.224.12.

3.3.250 Wood Pallet. See 3.3.161.5.

3.3.251 Wrapped Roll Paper Storage. See 3.3.197.5.

Chapter 4 General Requirements

4.1 Level of Protection.

4.1.1 A building, where protected by an automatic sprinkler system installation, shall be provided with sprinklers in all areas except where specific sections of this standard permit the omission of sprinklers.

4.1.2 Limited Area Systems.

4.1.2.1 When partial sprinkler systems are installed, the requirements of this standard shall be used insofar as they are applicable.

4.1.2.2 The authority having jurisdiction shall be consulted in each case.

Δ 4.2* Basis of Design for the Owner's Certificate. The owner(s) of a building or structure where the fire sprinkler system is going to be installed or their authorized agent shall provide the sprinkler system installer with the following information prior to the layout and detailing of the fire sprinkler system [see Figure A.28.1(b)]:

- (1) Intended use of the building, including the materials within the building and the maximum height and arrangement of any storage configuration
- (2) Storage layout, including the maximum height, storage commodity, and arrangement of any storage configuration, where applicable
- (3) A preliminary plan of the building or structure along with the design concepts necessary to perform the layout and detail for the fire sprinkler system
- (4)* Determination and confirmation of the water supply including any necessary adjustments
- (5)* Any special knowledge of the water supply, including known environmental conditions that might be responsible for corrosion, including microbiologically influenced corrosion (MIC)
- (6) Whether seismic protection is required and the design spectral response acceleration at short periods, S_{DS}
- (7) Any special knowledge of the general environment in which the system will be installed that might be responsible for corrosion, including airborne chemicals that could contact system components or chemical solutions that might be exposed to the sprinkler system components

4.3* Classification of Hazard.

4.3.1 General.

4.3.1.1 Occupancy classifications for this standard shall relate to sprinkler design, installation, and water supply requirements only.

4.3.1.2 Occupancy classifications shall not be intended to be a general classification of occupancy hazards.

4.3.1.3 Commodity classification and storage arrangements for miscellaneous and low-piled storage specified in 4.3.1.5 through 4.3.1.8 shall be determined in accordance with Sections 20.3 through 20.5.

4.3.1.4* Miscellaneous Storage.

4.3.1.4.1 Miscellaneous storage shall not exceed 12 ft (3.7 m) in height.

4.3.1.4.2 Miscellaneous storage shall not constitute more than 10 percent of the building area or 4000 ft² (370 m²) of the sprinklered area, whichever is greater.

4.3.1.4.3 Miscellaneous storage shall not exceed 1000 ft² (93 m²) in one pile or area.

4.3.1.4.4 Miscellaneous storage shall be separated from other storage piles or areas by at least 25 ft (7.6 m).

4.3.1.4.5 Solid shelf racks in accordance with the requirements of Section 25.3 shall not apply to miscellaneous storage of Class I through Class IV commodities up to 12 ft (3.7 m) and Group A plastics up to 5 ft (1.5 m).

4.3.1.5 Low-Piled Storage.

4.3.1.5.1 Low-piled storage of Class I through Class IV commodities shall not exceed 12 ft (3.7 m) in height.

4.3.1.5.2 Low-piled storage of Group A plastics shall not exceed 5 ft (1.5 m) in height.

4.3.1.6 Miscellaneous Tire Storage.

4.3.1.6.1 Miscellaneous tire storage shall not exceed 2000 ft² (185 m²).

4.3.1.6.2 Miscellaneous tire storage piles on-tread, regardless of storage method, shall not exceed 25 ft (7.6 m) in the direction of the wheel holes.

4.3.1.7 Protection Criteria for Miscellaneous and Low-Piled Storage.

Δ 4.3.1.7.1 The protection criteria for miscellaneous storage protected by ceiling sprinklers only shall be selected from Table 4.3.1.7.1.

4.3.1.7.2 For miscellaneous storage with open frame racks where in-rack sprinklers are required by Table 4.3.1.7.1, one level of in-rack sprinkler protection and ceiling design shall be in accordance with 25.2.1.

N 4.3.1.7.3 For miscellaneous storage having solid shelf racks where in-rack sprinklers are required by Table 4.3.1.7.1, in-rack sprinklers shall be in accordance with Section 25.3 and the ceiling design shall be in accordance with 25.2.1.4.

N 4.3.1.7.4 The protection criteria for low-piled storage protected by ceiling sprinklers only shall be selected from Table 4.3.1.7.4.

N 4.3.1.7.5 For low-piled storage with open frame racks where in-rack sprinklers are required by Table 4.3.1.7.4, one level of in-rack sprinkler protection and ceiling sprinkler design shall be in accordance with 25.2.2.

N 4.3.1.7.6 For low-piled storage having solid shelf racks where in-rack sprinklers are required by Table 4.3.1.7.4, in-rack sprinklers shall be in accordance with Section 25.3 and the ceiling design shall be in accordance with 25.2.2.4.

N 4.3.1.7.7 Ceiling sprinkler design shall be in accordance with Section 19.2.

4.3.1.7.8 The maximum design area for miscellaneous and low-piled storage shall not exceed 3000 ft² (280 m²).

Δ 4.3.1.7.9 Hose connections shall not be required for the protection of miscellaneous storage.

Table 4.3.1.7.1 Discharge Criteria for Miscellaneous Storage

Commodity	Type of Storage	Storage Height		Maximum Ceiling Height		Design from 19.2.3.1.1	In-Rack Sprinklers Required	Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
		ft	m	ft	m			gpm	L/min	gpm	L/min	
Class I to Class IV												
Class I	Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	≤12	≤3.7	—	—	OH1	No	0, 50, 100	0, 190, 380	250	950	90
Class II		≤10	≤3.0	—	—	OH1	No	0, 50, 100	0, 190, 380	250	950	90
Class II		>10 to ≤12	>3.0 to ≤3.7	—	—	OH2	No	0, 50, 100	0, 190, 380	250	950	90
Class III		≤12	≤3.7	—	—	OH2	No	0, 50, 100	0, 190, 380	250	950	90
Class IV		≤10	≤3.0	—	—	OH2	No	0, 50, 100	0, 190, 380	250	950	90
Class IV	Palletized, bin box, shelf, and solid-piled	>10 to ≤12	>3.0 to ≤3.7	32	9.8	OH2	No	0, 50, 100	0, 190, 380	250	950	90
	Single-, double-, or multiple-row rack, and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	32	9.8	EH1	No	0, 50, 100	0, 190, 380	500	1900	120
	Single-, double-, or multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	32	9.8	See 25.2.1.	Yes	0, 50, 100	0, 190, 380	250	950	90
Group A Plastic Storage												
Cartoned Nonexpanded and expanded	Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	≤5	≤1.5	—	—	OH2	No	0, 50, 100	0, 190, 380	250	950	90
		>5 to ≤10	>1.5 to ≤3.0	15	4.6	EH1	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
		>5 to ≤10	>1.5 to ≤3.0	20	6.1	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
		>10 to ≤12	>3.0 to ≤3.7	17	5.2	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
	Solid-piled, palletized, bin box, shelf, and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	32	9.8	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
	Single-, double-, or multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	32	9.8	See 25.2.1.	Yes	0, 50, 100	0, 190, 380	250	950	90

(continues)

Table 4.3.1.7.1 *Continued*

Commodity		Type of Storage	Storage Height		Maximum Ceiling Height		Design from 19.2.3.1.1	In-Rack Sprinklers Required	Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
			ft	m	ft	m			gpm	L/min	gpm	L/min	
Exposed	Nonexpanded and expanded	Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	≤5	≤1.5	—	—	OH2	No	0, 50, 100	0, 190, 380	250	950	90
		Solid-piled, palletized, bin box, shelf, and back-to-back shelf storage	>5 to ≤8	>1.5 to ≤2.4	28	8.5	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
		Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	>5 to ≤10	>1.5 to ≤3.0	15	4.6	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
	Nonexpanded	Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	>5 to ≤10	>1.5 to ≤3.0	20	6.1	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
	Expanded	Single-, double-, or multiple-row rack	>5 to ≤10	>1.5 to ≤3.0	20	6.1	See 25.2.1.	Yes	0, 50, 100	0, 190, 380	250	950	90
	Nonexpanded and expanded	Solid-piled, palletized, bin box, shelf, and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	17	5.2	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
		Single-, double-, or multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	17	5.2	EH2	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
			>10 to ≤12	>3.0 to ≤3.7	32	9.8	See 25.2.1.	Yes	0, 50, 100	0, 190, 380	250	950	90
Tire Storage													
Tires	On floor or on side	>5 to ≤12	>1.5 to ≤3.7	32	9.8	EH1	N/A	0, 50, 100	0, 190, 380	500	1900	120	
	On floor, on tread, or on side	≤5	≤1.5	—	—	OH2	N/A	0, 50, 100	0, 190, 380	250	950	90	
	Single-, double-, or multiple-row racks, on tread or on side	≤5	≤1.5	—	—	OH2	No	0, 50, 100	0, 190, 380	250	950	90	
	Single-row rack, portable, on tread or on side	>5 to ≤12	>1.5 to ≤3.7	32	9.8	EH1	No	0, 50, 100	0, 190, 380	500	1900	120	
	Single-row rack, fixed, on tread or on side	>5 to ≤12	>1.5 to ≤3.7	32	9.8	EH1	No	0, 50, 100	0, 190, 380	500	950	120	
		>5 to ≤12	>1.5 to ≤3.7	32	9.8	See 25.2.1.	Yes	0, 50, 100	0, 190, 380	250	950	90	
	Rolled Paper Storage												
Heavyweight and mediumweight	On end	≤10	≤3.0	30	9.1	OH2	N/A	0, 50, 100	0, 190, 380	250	950	90	
Tissue and lightweight	On end	≤10	≤3.0	30	9.1	EH1	N/A	0, 50, 100	0, 190, 380	250	950	120	

N Table 4.3.1.7.4 Discharge Criteria for Low-Piled Storage

Commodity	Type of Storage	Storage Height		Maximum Ceiling Height		Design from 19.2.3.1.1	In-Rack Sprinklers Required	Inside Hose		Total Combined Inside and Outside Hose		Duration (minutes)
		ft	m	ft	m			gpm	L/min	gpm	L/min	
Class I to Class IV												
Class I	Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	≤12	≤3.7	—	—	OH1	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90
Class II		≤10	≤3.0	—	—	OH1	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90
Class II		>10 to ≤12	>3.0 to ≤3.7	—	—	OH2	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90
Class III		≤12	≤3.7	—	—	OH2	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90
Class IV		≤10	≤3.0	—	—	OH2	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90
Class IV	Palletized, bin box, shelf, and solid-piled	>10 to ≤12	>3.0 to ≤3.7	32	9.8	OH2	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90
	Single-, double-, or multiple-row rack, and back-to-back shelf storage	>10 to ≤12	>3.0 to ≤3.7	32	9.8	EH1	No, unless solid shelf	0, 50, 100	0, 190, 380	500	1900	120
	Single-, double-, or multiple-row rack	>10 to ≤12	>3.0 to ≤3.7	32	9.8	See 25.2.2	Yes	0, 50, 100	0, 190, 380	250	950	90
Group A Plastic Storage												
Group A Plastic (All)	Solid-piled, palletized, bin box, shelf, single-, double-, or multiple-row rack, and back-to-back shelf storage	≤5	≤1.5	—	—	OH2	No, unless solid shelf	0, 50, 100	0, 190, 380	250	950	90

4.3.1.8 In-Rack Sprinklers. Miscellaneous and low-piled storage in accordance with 4.3.1.4 through 4.3.1.7 that require in-rack sprinklers shall follow Chapter 25 for their installation and design requirements.

Δ 4.3.2* Light Hazard. Spaces with low quantity and combustibility of contents shall be protected with light hazard occupancy criteria in this standard.

4.3.3* Ordinary Hazard Occupancies.

4.3.3.1* Ordinary Hazard (Group 1). The following shall be protected with OH1 occupancy criteria in this standard:

- (1) Spaces with moderate quantity and low combustibility of contents
- (2) Stockpiles of contents with low combustibility that do not exceed 8 ft (2.4 m)

4.3.3.2* Ordinary Hazard (Group 2). The following shall be protected with OH2 occupancy criteria in this standard:

- (1) Spaces with moderate to high quantity and combustibility of contents
- (2) Stockpiles of contents with moderate rates of heat release rate that do not exceed 12 ft (3.7 m) and stockpiles of contents with high rates of heat release that do not exceed 8 ft (2.4 m)

N 4.3.4 Extra Hazard Occupancies.

4.3.4.1* Extra Hazard (Group 1) (EH1). The following shall be protected with EH1 occupancy criteria in this standard:

- (1) Spaces with very high quantity and combustibility of contents
- (2) Spaces where dust, lint, or other materials are present, introducing the probability of rapidly developing fires

4.3.4.2* Extra Hazard (Group 2) (EH2). The following shall be protected with EH2 occupancy criteria in this standard:

- (1) Spaces with very high quantity and combustibility of contents
- (2) Spaces with substantial amounts of combustible or flammable liquids
- (3) Spaces where shielding of combustibles is extensive

4.3.5 High-Piled Storage. Storage arrangements that do not meet the requirements of 4.3.1.4 through 4.3.1.8 shall be protected in accordance with Chapters 20 through 25.

4.3.6* Special Occupancy Hazards. Special occupancies shall be in accordance with Chapter 27.

4.4 System Protection Area Limitations.

Δ 4.4.1 The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be as follows:

- (1) Light hazard — 52,000 ft² (4830 m²)
- (2)* Light hazard protected with a wet pipe system and the system water flow and supervisory alarms are transmitted to a supervising station in accordance with *NFPA 72* — 78,000 ft² (7250 m²)
- (3) Ordinary hazard — 52,000 ft² (4830 m²)
- (4) Extra hazard, hydraulically calculated — 40,000 ft² (3720 m²)
- (5) High-piled storage (as defined in 3.3.105) and storage covered by other NFPA standards — 40,000 ft² (3720 m²)
- (6) In-rack storage — 40,000 ft² (3720 m²)

4.4.2 The floor area occupied by mezzanines shall comply with 4.4.2.1, 4.4.2.2, or 4.4.2.3.

4.4.2.1 In a building with only one sprinkler system, the floor area occupied by mezzanines shall not be included in the area limits of 4.4.1.

4.4.2.2 In a building with more than one sprinkler system, if a mezzanine is located entirely within the same sprinkler system boundary as the sprinklers protecting the ceiling above, the floor area occupied by mezzanine(s) shall not be included in the area limits of 4.4.1.

4.4.2.3 In a building with more than one sprinkler system, if any portion of the mezzanine floor area is located outside the system boundary of the riser supplying the sprinklers under the mezzanine, the area of the mezzanine outside the boundary of the overhead system shall be added to the system area from which it is supplied, and the total system area shall meet the limits of 4.4.1.

4.4.3 Where single systems protect extra hazard, high-piled storage, or storage covered by other NFPA standards, and ordinary or light hazard areas, the extra hazard or storage area coverage shall not exceed the floor area specified for that hazard and the total area coverage shall not exceed the area specified for the lesser hazard.

4.4.4 The area protected by a single in-rack system includes all of the floor area occupied by the racks, including aisles, regardless of the number of levels of in-rack sprinklers.

4.4.5 Multiple buildings attached by canopies, covered breezeways, common roofs, or a common wall(s) shall be permitted to be supplied by a single fire sprinkler riser.

4.4.6* Detached Buildings.

4.4.6.1 Unless the requirements of 4.4.6.2 apply, detached buildings, regardless of separation distance, that do not meet the criteria of 4.4.4 shall be provided with separate fire sprinkler systems.

4.4.6.2 When acceptable to the authority having jurisdiction, detached structures shall be permitted to be supplied by the fire sprinkler system of an adjacent building.

4.5 Water Supply Information.

4.5.1 Water Supply Capacity Information. The following information shall be included:

- (1) Location and elevation of static and residual test gauge with relation to the riser reference point
- (2) Flow location
- (3) Static pressure, psi (bar)
- (4) Residual pressure, psi (bar)
- (5) Flow, gpm (L/min)
- (6) Date
- (7) Time
- (8) Name of person who conducted the test or supplied the information
- (9) Other sources of water supply, with pressure or elevation

4.5.1.1* Where a waterflow test is used for the purposes of system design, the test shall be conducted no more than 12 months prior to working plan submittal unless otherwise approved by the authority having jurisdiction.

4.5.2 Water Supply Treatment Information. The following information shall be included when water supply treatment is provided in accordance with 5.1.4:

- (1) Type of condition that requires treatment
- (2) Type of treatment needed to address the problem
- (3) Details of treatment plan

4.6* Additives. Additives or chemicals intended to stop leaks, such as sodium silicate or derivatives of sodium silicate, brine, or similar acting chemicals, shall not be used in sprinkler systems.

4.7 Air, Nitrogen, or Other Approved Gas. Where air is used to charge, maintain, or supervise sprinkler systems, nitrogen or other approved gas shall also be permitted to be used.

4.8* Support of Nonsprinkler System Components. Sprinkler system components shall not be used to support nonsprinkler system components unless expressly permitted by this standard.

4.9 Noncombustible Materials and Limited-Combustible Materials.

4.9.1* Noncombustible Material.

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

- (1)* The material, 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 is reported as passing ASTM E136, *Standard Test Method for Assessing Combustibility of Materials Using a Vertical Tube Furnace at 750°C*.
- (3) The material is reported as complying with the pass/fail criteria of ASTM E136 when tested in accordance with

the test method and procedure in ASTM E2652, *Standard Test Method for Assessing Combustibility of Materials Using a Tube Furnace with a Cone-shaped Airflow Stabilizer*, at 750°C.

[5000:7.1.4.1.1]

4.9.1.2 Where the term *limited-combustible* is used in this standard, it shall also include the term *noncombustible*. [5000:7.1.4.1.2]

Δ 4.9.2* Limited-Combustible Material. A material shall be considered a limited-combustible material where **one** of the following is met:

- (1) The conditions of 7.1.4.2.1 and 7.1.4.2.2 of *NFPA 5000*, and the conditions of either 4.9.2.1 or 4.9.2.2, shall be met.
- (2) The conditions of 4.9.2.3 shall be met.

[5000:7.1.4.2]

Δ 4.9.2.1 The material shall have a structural base of noncombustible material with a surfacing not exceeding a thickness of 1/8 in. (3.2 mm) where the surfacing exhibits a flame spread index not greater than 50 when tested in accordance with ASTM E84, *Standard Test Method for Surface Burning Characteristics of Building Materials*, or UL 723, *Test for Surface Burning Characteristics of Building Materials*. [5000:7.1.4.2.3]

4.9.2.2 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 E84 or 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 E84 or UL 723. [5000:7.1.4.2.4]

4.9.2.3 Materials shall be considered limited-combustible materials where tested in accordance with ASTM E2965, *Standard Test Method for Determination of Low Levels of Heat Release Rate for Materials and Products Using an Oxygen Consumption Calorimeter*, at an incident flux of 75 kW/m² for a 20-minute exposure, and both the following conditions are met:

- (1) The peak heat release rate shall not exceed 150 kW/m² for longer than 10 seconds.
- (2) The total heat released shall not exceed 8 MJ/m².

[5000:7.1.4.2.5]

4.9.2.4 Where the term *limited-combustible* is used in this standard, it shall also include the term *noncombustible*. [5000:7.1.4.2.6]

Chapter 5 Water Supplies

5.1 General.

5.1.1 Number of Supplies. Every automatic sprinkler system shall have at least one automatic water supply.

5.1.2 Capacity. Water supplies shall be capable of providing the required flow and pressure for the remote design area determined using the requirements and procedures as specified in Chapters 19 through 27 including hose stream allowance where applicable for the required duration.

5.1.3* Size of Fire Mains.

5.1.3.1 Except as provided in 5.1.3.2 or 5.1.3.3, no pipe smaller than 6 in. (150 mm) in diameter shall be installed as a private service main.

5.1.3.2 Sizes smaller than 6 in. (150 mm) for fire mains that do not supply hydrants shall be permitted, provided that hydraulic calculations show the main will supply the total demand at the appropriate pressure.

5.1.3.3 Where a single main less than 4 in. (100 mm) in diameter serves both fire systems and other uses, the non-fire demand shall be added to the hydraulic calculations for the fire system at the point of connection unless provisions have been made to automatically isolate the non-fire demand during a fire event.

5.1.3.4 For pipe schedule systems, the underground supply pipe shall be at least as large as the system riser.

▲ 5.1.4* Water.

▲ **5.1.4.1** Water supplies and environmental conditions shall be evaluated for the existence of microbes and conditions that contribute to microbiologically influenced corrosion (MIC).

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▲ **5.1.4.2** Water supplies and environmental conditions shall be evaluated for conditions that contribute to unusual corrosive properties.

• 5.1.4.3* Inhibitors.

5.1.4.3.1 Where used, listed bacterial inhibitors and/or corrosion inhibitors shall be compatible with system components.

5.1.4.3.2 Where used together, listed bacterial inhibitors and corrosion inhibitors shall be compatible with each other.

5.1.5 Arrangement.

5.1.5.1 Connection Between Underground and Aboveground Piping.

5.1.5.1.1 The connection between the system piping and underground piping shall be made with a transition piece in accordance with 6.3.3 or 6.3.3.1 that is properly strapped or fastened by approved devices.

5.1.5.1.2 Where required due to specific mechanical or environmental conditions, the transition piece shall be protected against possible damage from corrosive agents, solvent attack, or mechanical damage.

5.1.5.2* Connection Passing Through or Under Foundation Walls. When system piping pierces a foundation wall below grade or is located under the foundation wall, clearance shall be provided to prevent breakage of the piping due to building settlement.

5.1.6* Meters. Where meters are required by other authorities, they shall be listed.

5.1.7* Connection from Waterworks System.

5.1.7.1 The requirements of the public health authority having jurisdiction shall be determined and followed.

5.1.7.2 Where equipment is installed to guard against possible contamination of the public water system, such equipment and devices shall be listed for fire protection service.

5.2 Types.

5.2.1* Water supplies for sprinkler systems shall be one of the following or any combination:

- (1) A connection to an approved public or private waterworks system in accordance with 5.2.2
- (2) A connection including a fire pump in accordance with 5.2.3
- (3) A connection to a water storage tank at grade or below grade installed in accordance with NFPA 22 and filled from an approved source
- (4) A connection to a pressure tank in accordance with 5.2.4 and filled from an approved source
- (5) A connection to a gravity tank in accordance with 5.2.5 and filled from an approved source
- (6) A penstock, flume, river, lake, pond, or reservoir in accordance with 5.2.6
- (7)* A source of recycled or reclaimed water where the building owner (or their agent) has analyzed the source of the water and the treatment process (if any) that the water undergoes before being made available to the sprinkler system and determined that any materials, chemicals, or contaminants in the water will not be detrimental to the components of the sprinkler system it comes in contact with

5.2.2* Connections to Waterworks Systems.

5.2.2.1 A connection to a reliable waterworks system shall be an acceptable water supply source.

5.2.2.2* The volume and pressure of a public water supply shall be determined from waterflow test data or other approved method.

■ **5.2.2.3*** Where a waterflow test was conducted to provide the water supply information, the date, day of the week, and time of day that the test was conducted shall be recorded with the data.

5.2.3* Pumps. A single automatically controlled fire pump installed in accordance with NFPA 20 shall be an acceptable water supply source.

5.2.4 Pressure Tanks.

5.2.4.1 Acceptability.

5.2.4.1.1 A pressure tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

5.2.4.1.2 Pressure tanks shall be provided with an approved means for automatically maintaining the required air pressure.

5.2.4.1.3 Where a pressure tank is the sole water supply, an approved supervisory signal(s) shall be provided to indicate low air pressure and low water level with the signal supplied from an electrical branch circuit independent of the air compressor

or, if the building has a fire alarm system, connected to the building's fire alarm system.

5.2.4.1.4 Pressure tanks shall not be used to supply other than sprinklers and hand hose attached to sprinkler piping.

5.2.4.2 Capacity.

5.2.4.2.1 In addition to the requirements of 5.1.2, the water capacity of a pressure tank shall include the extra capacity needed to fill dry pipe or preaction systems where installed.

5.2.4.2.2 The total volume shall be based on the water capacity plus the air capacity required by 5.2.4.3.

5.2.4.3* Water Level and Air Pressure.

5.2.4.3.1 Pressure tanks shall be kept with a sufficient supply of water to meet the demand of the fire protection system as

calculated in Chapter 28 for the duration required by Chapter 19, Chapter 20, or Chapter 27.

5.2.4.3.2 The pressure shall be sufficient to push all of the water out of the tank while maintaining the necessary residual pressure (required by Chapter 28) at the top of the system.

5.2.5 Gravity Tanks. An elevated tank installed in accordance with NFPA 22 shall be an acceptable water supply source.

5.2.6 Penstocks, Flumes, Rivers, or Lakes. Water supply connections from penstocks, flumes, rivers, lakes, or reservoirs shall be arranged to avoid mud and sediment and shall be provided with approved double removable screens or approved strainers installed in an approved manner.

Chapter 6 Installation of Underground Piping

6.1 General. The requirements of Chapter 6 shall apply to the installation of underground piping used for private fire service mains and any underground piping installed in a sprinkler system.

6.2* Piping. [24:10.1]

6.2.1* All piping used in private fire service mains shall be in accordance with 6.2.1.1, 6.2.1.2, or 6.2.1.3.

6.2.1.1 Use. Piping manufactured in accordance with Table 6.2.1.1 shall be permitted to be used. [24:10.1.1.1]

6.2.1.2 Piping specifically listed for use in private fire service mains shall be permitted to be used. [24:10.1.1.2]

6.2.1.2.1 Where listed pipe is used, it shall be installed in accordance with the listing limitations including installation instructions. [24:10.1.1.2.1]

6.2.1.2.2 Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [24:10.1.1.2.2]

6.2.1.3 Steel piping manufactured in accordance with Table 6.2.1.3 that is externally coated and wrapped and internally galvanized shall be permitted to be used between the hose coupling(s) on the fire department connection and the check valve installed in the fire department connection piping. [24:10.1.1.3]

6.2.1.3.1 External coating and wrapping as required by 6.2.1.3 shall be approved. [24:10.1.1.3.1]

6.2.1.3.2 The requirements of 6.2.1.3 shall not apply to listed stainless steel piping. [24:10.1.1.3.2]

6.2.1.4 Dry Pipe Underground.

6.2.1.4.1 Where necessary to place pipe that will be under air pressure underground, the pipe shall be protected against corrosion.

Table 6.2.1.1 Manufacturing Standards for Underground Pipe

Materials and Dimensions	Standard
Ductile Iron	
Cement-mortar lining for ductile-iron pipe and fittings	AWWA C104/A21.4
Polyethylene encasement for ductile-iron pipe systems	AWWA C105/A21.5
Rubber-gasket joints for ductile-iron pressure pipe and fittings	AWWA C111/A21.11
Flanged ductile-iron pipe with ductile-iron or gray-iron threaded flanges	AWWA C115/A21.15
Thickness design of ductile-iron pipe	AWWA C150/A21.50
Ductile-iron pipe, centrifugally cast	AWWA C151/A21.51
Ductile iron water mains and their appurtenances	AWWA C600
Concrete	
Reinforced concrete pressure pipe, steel-cylinder type	AWWA C300
Prestressed concrete pressure pipe, steel-cylinder type	AWWA C301
Reinforced concrete pressure pipe, non-cylinder type	AWWA C302
Reinforced concrete pressure pipe, steel-cylinder type, pretensioned	AWWA C303
Cement-mortar lining of water pipe lines in place, 4 in. (100 mm) and larger	AWWA C602
Plastic	
Polyvinyl chloride (PVC) pressure pipe and fabricated fittings, 4 in. through 60 in. (100 mm through 1500 mm)	AWWA C900
Polyethylene (PE) pressure pipe and fittings, 4 in. (100 mm) through 63 in. (1575 mm) for waterworks	AWWA C906
Molecularly oriented polyvinyl chloride (PVCO), 4 in. through 24 in. (100 mm through 600 mm) for water, wastewater, and reclaimed water service	AWWA C909
Brass	
Seamless red brass pipe, standard sizes	ASTM B43
Copper	
Seamless copper tube	ASTM B75/B75M
Seamless copper water tube	ASTM B88
Wrought seamless copper and copper-alloy tube	ASTM B251/B251M
Stainless Steel	
Seamless, welded, and heavily cold worked austenitic stainless steel pipes	ASTM A312/312M

[24:Table 10.1.1.1]

Table 6.2.1.3 Steel Piping for Fire Department Connections

Materials and Dimensions	Standard
Black and hot-dipped zinc-coated (galvanized) welded and seamless steel pipe for fire protection use	ASTM A795/A795M
Pipe, steel, black and hot-dipped, zinc-coated, welded and seamless	ASTM A53/A53M
Electric-resistance-welded steel pipe	ASTM A135/A135M

[24:Table 10.1.1.3]

6.2.1.4.2 Unprotected cast-iron or ductile-iron pipe shall be permitted where joined with a gasketed joint listed for air service underground.

6.2.2* All piping used in private fire service mains shall be rated for the maximum system working pressure to which the piping is exposed to but shall not be rated at less than 150 psi (10.3 bar). [24:10.1.2]

6.2.3* When lined piping is used, the manufacturer's literature for internal diameter shall be used for all hydraulic calculations. [24:10.1.3]

6.2.4* Regardless of pipe type, underground piping shall be permitted to extend into the building through the slab or wall not more than 24 in. (600 mm). [24:10.1.4]

6.2.4.1 Underground piping extended vertically into the building through the slab shall be installed plumb. [24:10.1.4.1]

▲ 6.3 Fittings. [24:10.2]

6.3.1 All fittings used in private fire service mains shall be in accordance with 6.3.1.1 or 6.3.1.2. [24:10.2.1]

6.3.1.1 Fittings manufactured in accordance with Table 6.3.1.1 shall be permitted to be used. [24:10.2.1.1]

6.3.1.2 Special Listed Fittings. Fittings specifically listed for use in private fire service mains shall be permitted to be used. [24:10.2.1.2]

6.3.1.2.1 Where listed fittings are used, they shall be installed in accordance with their listing limitations including installation instructions. [24:10.2.1.2.1]

6.3.1.2.2 Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [24:10.2.1.2.2]

6.3.2 All fittings used in private fire service mains shall be rated for the maximum system working pressure to which the fittings are exposed, but shall not be rated at less than 150 psi (10.3 bar). [24:10.2.2]

6.3.3 Where fittings installed in a private fire service main must be installed above grade, the fittings shall conform to NFPA 13. [24:10.2.3]

6.3.3.1 Fittings in accordance with 6.3.1 shall be permitted for the transition to the above ground piping or fittings. [24:10.2.3.1]

Table 6.3.1.1 Fittings Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron	
Gray iron threaded fittings, classes 125 and 250	ASME B16.4
Gray iron pipe flanges and flanged fittings, classes 25, 125, and 250	ASME B16.1
Ductile Iron	
Ductile-iron and gray-iron fittings	AWWA C110/A21.10
Ductile-iron compact fittings	AWWA C153/A21.53
Malleable Iron	
Malleable iron threaded fittings, classes 150 and 300	ASME B16.3
Copper	
Wrought copper and copper alloy solder joint pressure fittings	ASME B16.22
Cast copper alloy solder joint pressure fitting	ASME B16.18
Bronze Fittings	
Cast copper alloy threaded fittings, classes 125 and 250	ASME B16.15
Stainless Steel	
Wrought austenitic stainless steel pipe fittings	ASTM A403/A403M

[24:Table 10.2.1.1]

6.4 Connection of Pipe, Fittings, and Appurtenances. [24:10.3]

6.4.1* Connection of all fittings and appurtenances to piping shall be in accordance with Section 6.4. [24:10.3.1]

6.4.2 Connections of pipe and fittings indicated in Table 6.2.1.1 and Table 6.3.1.1 shall be in accordance with the referenced standard in the table. [24:10.3.2]

6.4.3 Listed Connections. Connections utilizing listed products shall be in accordance with the listing limitations and the manufacturer's installation instructions. [24:10.3.3]

6.4.3.1 Where listing limitations or installation instructions differ from the requirements of this standard, the listing limitations and installation instructions shall apply. [24:10.3.3.1]

6.4.4 Threaded Pipe and Fittings. Where pipe, fittings or appurtenances are connected using threads, all threads shall be in accordance with ASME B1.20.1, *Pipe Threads, General Purpose, Inch*. [24:10.3.4]

6.4.5 Grooved Connections. Where pipe, fittings, or appurtenances are connected using grooves, they shall be connected in accordance with 6.4.5.1 through 6.4.5.3. [24:10.3.5]

6.4.5.1 Pipe, fittings, and appurtenances to be joined with grooved couplings shall contain cut, rolled, or cast grooves that are dimensionally compatible with the couplings. [24:10.3.5.1]

6.4.5.2 Pipe, fittings, and appurtenances that are connected with grooved couplings and are part of a listed assembly shall be permitted to be used. [24:10.3.5.2]

6.4.5.3* Pipe joined with grooved fittings shall be joined by a listed combination of fittings, gaskets, and grooves. [24:10.3.5.3]

6.4.6 Connection of Plain End Pipe. Plain end pipe, fittings, and appurtenances joined with couplings shall be joined by a listed combination of fittings, gaskets, and couplings. [24:10.3.6]

6.4.7 Copper Tube. All joints for the connection of copper tube shall be brazed or joined using pressure fittings as specified in Table 6.3.1.1. [24:10.3.7]

6.5 Protection of Private Fire Service Mains. [24:10.4]

6.5.1 Protection from Corrosion. [24:10.4.1]

6.5.1.1 Coatings. All bolted joint accessories shall be cleaned and thoroughly coated with asphalt, bituminous, or other corrosion-retarding material after installation. [24:10.4.1.1]

6.5.1.2 The requirements of 6.5.1.1 shall not apply to stainless steel or epoxy-coated fittings, valves, glands, or other accessories. [24:10.4.1.2]

6.5.1.3* Where it is necessary to join metal pipe with pipe of dissimilar metal, the joint shall be insulated against the passage of an electric current using an approved method. [24:10.4.1.3]

6.5.2* Protection of Piping. [24:10.4.2]

6.5.2.1 Protection from Freezing. The depth of cover for private fire service mains and their appurtenances to protect against freezing shall be in accordance with 6.5.2. [24:10.4.2.1]

6.5.2.1.1* The top of the pipe shall be buried not less than 1 ft (300 mm) below the frost line for the locality. [24:10.4.2.1.1]

6.5.2.1.2 The depth of piping shall be measured from the top of the piping to the final grade. [24:10.4.2.1.2]

6.5.2.1.3 Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [24:10.4.2.1.3]

6.5.2.1.4 Where private fire service mains are installed above ground, they shall be protected from freezing in accordance with NFPA 13. [24:10.4.2.1.4]

6.5.2.1.5 Private fire service mains installed in water raceways or shallow streams shall be installed so that the piping will remain in the running water throughout the year. [24:10.4.2.1.5]

6.5.2.1.6 Where piping is installed adjacent to a vertical face, it shall be installed from the vertical face at the same distance as if the piping were buried. [24:10.4.2.1.6]

6.5.2.1.7 Protection of private fire service mains from freezing using heat tracing shall be permitted when the heat tracing is specifically listed for underground use. [24:10.4.2.1.7]

6.5.2.1.7.1 Heat tracing not listed for underground use shall be permitted when piping is installed in accordance with 6.2.4. [24:10.4.2.1.7.1]

6.5.2.2 Protection from Mechanical Damage. The depth of cover for private fire service mains and their appurtenances to protect against mechanical damage shall be in accordance with 6.5.2.2. [24:10.4.2.2]

6.5.2.2.1 The depth of piping shall be measured from the top of the piping to the final grade. [24:10.4.2.2.1]

6.5.2.2.2 In locations where freezing is not a factor, the depth of cover shall not be less than 30 in. (750 mm) below grade to prevent mechanical damage. [24:10.4.2.2.2]

6.5.2.2.2.1 Where listed piping is used and the bury depth differs from this standard, the listing limitations shall apply. [24:10.4.2.2.2.1]

6.5.2.2.3 Private fire service mains installed under driveways or roadways shall be buried at a minimum depth of 36 in. (900 mm). [24:10.4.2.2.3]

6.5.2.2.3.1 Sidewalks, walkways, and other paved or concrete pedestrian passageways shall not be required to comply with 6.5.2.2.3. [24:10.4.2.2.3.1]

6.5.2.2.4 Private fire service mains installed under railroad tracks shall be buried at a minimum depth of 4 ft (1.2 m). [24:10.4.2.2.4]

6.5.2.2.4.1 Where railroad operators require a greater depth of bury, the greater depth shall apply. [24:10.4.2.2.4.1]

6.5.2.2.5 Private fire service mains installed under large piles of heavy commodities or subject to heavy shock and vibrations shall be buried at a minimum depth of 4 ft (1.2 m). [24:10.4.2.2.5]

6.5.2.2.6 Where private fire service mains are installed above ground, they shall be protected with bollards or other means as approved by the AHJ when subject to mechanical damage. [24:10.4.2.2.6]

6.5.3 Private Fire Service Mains Beneath Buildings. Except as permitted by 6.5.3, private fire service mains shall not be installed beneath buildings. [24:10.4.3]

6.5.3.1* Private fire service mains supplying fire protection systems within the building shall be permitted to extend horizontally no more than 10 ft (3.0 m) cumulatively, as measured from the outside of the building, under the building to the riser location. [24:10.4.3.1]

6.5.3.1.1* Pipe joints shall not be located directly under foundation footings. [24:10.4.3.1.1]

6.5.3.1.2* Piping shall be installed a minimum of 12 in. (300 mm) below the bottom of building foundations or footers. [24:10.4.3.1.2]

6.5.3.1.2.1 The requirements of 6.5.3.1.2 shall not apply when the piping is sleeved with an approved material. [24:10.4.3.1.2.1]

6.5.3.2* Private fire service mains shall not be permitted to extend more than 10 ft (3 m) under the building except as allowed in 6.5.3.2.1. [24:10.4.3.2]

6.5.3.2.1* Where private fire service mains extend more than 10 ft (3 m) into the building, they shall be run in a covered trench. [24:10.4.3.2.1]

6.5.3.2.1.1* The trench shall be accessible from within the building. [24:10.4.3.2.1.1]

6.5.3.2.1.2 The trench shall have rigid walls and a base. [24:10.4.3.2.1.2]

6.5.3.2.1.3 The trench shall be constructed of noncombustible materials. [24:10.4.3.2.1.3]

6.5.3.2.1.4* Provisions for draining water shall be provided for the trench. [24:10.4.3.2.1.4]

6.5.3.2.1.5 Where the piping in the trench is installed under foundations or footers, clearance shall be provided in accordance with 6.5.3.1.2 or 6.5.3.1.2.1. [24:10.4.3.2.1.5]

6.5.3.2.2 Piping in the trench shall be permitted to be in accordance with 6.2.1. [24:10.4.3.2.2]

6.5.3.2.2.1 Aboveground piping in accordance with NFPA 13 shall be permitted to be used. [24:10.4.3.2.2.1]

6.5.3.2.2.2 Where piping installed in the trench is in accordance with 6.2.1, all joints shall be restrained in accordance with 6.7.2 or 6.7.3. [24:10.4.3.2.2.2]

6.5.3.2.3* Where piping is installed in a trench as permitted by 6.5.3.2.1, a valve shall be provided where the underground piping enters the trench. [24:10.4.3.2.3]

6.5.3.2.4 When piping is installed in a trench, bury depths of 6.5.2.2 shall not apply. [24:10.4.3.2.4]

6.5.3.2.4.1 Piping in the trench shall be protected from freezing in accordance with 6.5.2.1.4. [24:10.4.3.2.4.1]

▲ 6.6 Grounding and Bonding. [24:10.5]

6.6.1* In no case shall the underground piping be used as a grounding electrode for electrical systems. [24:10.5.1]

6.6.1.1* The requirement of 6.6.1 shall not preclude the bonding of the underground piping to the lightning protection grounding system as required by NFPA 780 in those cases where lightning protection is provided for the structure. [24:10.5.1.1]

6.7* Restraint. Private fire service mains shall be restrained against movement at changes in direction in accordance with 6.7.1, 6.7.2, or 6.7.3. [24:10.6]

6.7.1* Thrust Blocks.

6.7.1.1 Thrust blocks shall be permitted where soil is stable and capable of resisting the anticipated thrust forces. [24:10.6.1.1]

N 6.7.1.1.1 The anticipated thrust forces shall be based on the test pressure. [24:10.6.1.1.1]

6.7.1.2 Thrust blocks shall be concrete of a mix not leaner than one part cement, two and one-half parts sand, and five parts stone. [24:10.6.1.2]

6.7.1.3 Thrust blocks shall be placed between undisturbed earth and the fitting to be restrained and shall be capable of resisting the calculated thrust forces. [24:10.6.1.3]

6.7.1.4 Wherever possible, thrust blocks shall be located so that the joints are accessible for repair. [24:10.6.1.4]

6.7.2* Restrained Joint Systems. Private fire service mains using restrained joint systems shall include one or more of the following:

- (1) Listed locking mechanical or push-on joints
- (2) Listed mechanical joints utilizing setscrew retainer glands
- (3) Listed bell joint restraints
- (4) Bolted flange joints

- (5) Pipe clamps and tie rods in accordance with 6.7.2.1
- (6) Other approved methods or devices [24:10.6.2]

▲ 6.7.2.1* Sizing Clamps, Rods, Bolts, and Washers. [24:10.6.2.1]

▲ 6.7.2.1.1 Clamps. [24:10.6.2.1.1]

6.7.2.1.1.1 Clamps shall have the following dimensions:

- (1) $\frac{1}{2}$ in. $\times$ 2 in. (13 mm $\times$ 50 mm) for 4 in. (100 mm) to 6 in. (150 mm) pipe
- (2) $\frac{5}{8}$ in. $\times$ 2 $\frac{1}{2}$ in. (16 mm $\times$ 65 mm) for 8 in. (200 mm) to 10 in. (250 mm) pipe
- (3) $\frac{3}{4}$ in. $\times$ 3 in. (16 mm $\times$ 75 mm) for 12 in. (300 mm) pipe [24:10.6.2.1.1.1]

6.7.2.1.1.2 The diameter of a bolt hole shall be $\frac{1}{8}$ in. (3.2 mm) larger than that of the corresponding bolt. [24:10.6.2.1.1.2]

▲ 6.7.2.1.2 Rods. [24:10.6.2.1.2]

6.7.2.1.2.1 Rods shall be not less than $\frac{5}{8}$ in. (16 mm) in diameter. [24:10.6.2.1.2.1]

6.7.2.1.2.2 Table 6.7.2.1.2.2 provides the numbers of various diameter rods that shall be used for a given pipe size. [24:10.6.2.1.2.2]

6.7.2.1.2.3 When using bolting rods, the diameter of mechanical joint bolts shall limit the diameter of rods to $\frac{3}{4}$ in. (20 mm). [24:10.6.2.1.2.3]

6.7.2.1.2.4 Threaded sections of rods shall not be formed or bent. [24:10.6.2.1.2.4]

6.7.2.1.2.5 Where using clamps, rods shall be used in pairs for each clamp. [24:10.6.2.1.2.5]

6.7.2.1.2.6 Assemblies in which a restraint is made by means of two clamps canted on the barrel of the pipe shall be permitted to use one rod per clamp if approved for the specific installation by the AHJ. [24:10.6.2.1.2.6]

6.7.2.1.2.7 Where using combinations of rods, the rods shall be symmetrically spaced. [24:10.6.2.1.2.7]

Table 6.7.2.1.2.2 Rod Number — Diameter Combinations

Nominal Pipe Size		$\frac{5}{8}$ in.	$\frac{3}{4}$ in.	$\frac{7}{8}$ in.	1 in.
in.	mm	(16 mm)	(20 mm)	(22 mm)	(25 mm)
4	100	2	—	—	—
6	150	2	—	—	—
8	200	3	2	—	—
10	250	4	3	2	—
12	300	6	4	3	2
14	350	8	5	4	3
16	400	10	7	5	4

Note: This table has been derived using pressure of 225 psi (15.5 bar) and design stress of 25,000 psi (172.4 MPa). [24:Table 10.6.2.1.2.2]

6.7.2.1.3 Clamp Bolts. Clamp bolts shall have the following diameters:

- (1) $\frac{5}{8}$ in. (16 mm) for pipe 4 in. (100 mm), 6 in. (150 mm), and 8 in. (200 mm)
- (2) $\frac{3}{4}$ in. (20 mm) for 10 in. (250 mm) pipe
- (3) $\frac{7}{8}$ in. (22 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.3]

Δ 6.7.2.1.4 Washers. [24:10.6.2.1.4]

6.7.2.1.4.1 Washers shall be permitted to be cast iron or steel and round or square. [24:10.6.2.1.4.1]

6.7.2.1.4.2 Cast-iron washers shall have the following dimensions:

- (1) $\frac{5}{8}$ in. $\times$ 3 in. (16 mm $\times$ 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe
- (2) $\frac{3}{4}$ in. $\times$ 3 $\frac{1}{2}$ in. (20 mm $\times$ 90 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.4.2]

6.7.2.1.4.3 Steel washers shall have the following dimensions:

- (1) $\frac{1}{2}$ in. $\times$ 3 in. (12 mm $\times$ 75 mm) for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe
- (2) $\frac{1}{2}$ in. $\times$ 3 $\frac{1}{2}$ in. (12 mm $\times$ 90 mm) for 12 in. (300 mm) pipe

[24:10.6.2.1.4.3]

6.7.2.1.4.4 The diameter of holes shall be $\frac{1}{8}$ in. (3 mm) larger than that of bolts or rods. [24:10.6.2.1.4.4]

Δ 6.7.2.2 Sizes of Restraint Straps for Tees. [24:10.6.2.2]

6.7.2.2.1 Restraint straps for tees shall have the following dimensions:

- (1) $\frac{5}{8}$ in. (16 mm) thick and 2 $\frac{1}{2}$ in. (65 mm) wide for 4 in. (100 mm), 6 in. (150 mm), 8 in. (200 mm), and 10 in. (250 mm) pipe
- (2) $\frac{5}{8}$ in. (16 mm) thick and 3 in. (75 mm) wide for 12 in. (300 mm) pipe

[24:10.6.2.2.1]

6.7.2.2.2 The diameter of rod holes shall be $\frac{1}{16}$ in. (1.6 mm) larger than that of rods. [24:10.6.2.2.2]

6.7.2.2.3 Figure 6.7.2.2.3 and Table 6.7.2.2.3 shall be used in sizing the restraint straps for both mechanical and push-on joint tee fittings. [24:10.6.2.2.3]

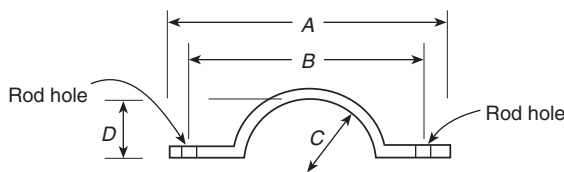


FIGURE 6.7.2.2.3 Restraint Straps for Tees. [24:Figure 10.6.2.2.3]

Δ 6.7.2.3 Sizes of Plug Strap for Bell End of Pipe. [24:10.6.2.3]

6.7.2.3.1 The strap shall be $\frac{3}{4}$ in. (20 mm) thick and 2 $\frac{1}{2}$ in. (65 mm) wide. [24:10.6.2.3.1]

6.7.2.3.2 The strap length shall be the same as dimension A for tee straps as shown in Figure 6.7.2.2.3. [24:10.6.2.3.2]

6.7.2.3.3 The distance between the centers of rod holes shall be the same as dimension B for tee straps as shown in Figure 6.7.2.2.3. [24:10.6.2.3.3]

6.7.2.4 Material. Clamps, rods, rod couplings or turnbuckles, bolts, washers, restraint straps, and plug straps shall be of a material that has physical and chemical characteristics that indicate its deterioration under stress can be predicted with reliability. [24:10.6.2.4]

6.7.2.5 Corrosion Resistance. After installation, rods, nuts, bolts, washers, clamps, and other restraining devices shall be cleaned and thoroughly coated with a corrosion-retarding material. [24:10.6.2.5]

6.7.2.5.1 The requirements of 6.7.2.5 shall not apply to stainless steel or epoxy-coated fittings, valves, glands, or other accessories. [24:10.6.2.5.1]

6.7.3* Private fire service mains utilizing one or more of the following connection methods shall not require additional restraint, provided that such joints can pass the hydrostatic test of 6.11.2.2 without shifting of piping.

- (1) Threaded connections
- (2) Grooved connections
- (3) Welded connections
- (4) Heat-fused connections
- (5) Chemical or solvent cemented connections

[24:10.6.3]

Δ Table 6.7.2.2.3 Restraint Straps for Tees

Nominal Pipe Size		A		B		C		D	
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm
4	100	12 $\frac{1}{2}$	315	10 $\frac{3}{8}$	255	2 $\frac{1}{2}$	65	1 $\frac{3}{4}$	45
6	150	14 $\frac{1}{2}$	365	12 $\frac{1}{8}$	305	3 $\frac{9}{16}$	90	2 $\frac{13}{16}$	70
8	200	16 $\frac{3}{4}$	420	14 $\frac{3}{8}$	360	4 $\frac{21}{32}$	115	3 $\frac{29}{32}$	100
10	250	19 $\frac{1}{16}$	475	16 $\frac{11}{16}$	415	5 $\frac{3}{4}$	145	5	125
12	300	22 $\frac{5}{16}$	560	19 $\frac{3}{16}$	480	6 $\frac{3}{4}$	170	5 $\frac{7}{8}$	145

[24:Table 10.6.2.2.3]

Δ 6.8 Steep Grades. [24:10.7]

6.8.1 On steep grades, mains shall be additionally restrained to prevent slipping. [24:10.7.1]

6.8.1.1 Pipe shall be restrained at the bottom of a hill and at any turns (lateral or vertical). [24:10.7.1.1]

6.8.1.1.1 The restraint specified in 6.8.1.1 shall be to natural rock or to piles or piers built on the downhill side of the bell. [24:10.7.1.1.1]

6.8.1.2 Bell ends shall be installed facing uphill. [24:10.7.1.2]

6.8.1.3 Straight runs on hills shall be restrained as determined by a design professional. [24:10.7.1.3]

Δ 6.9 Installation Requirements. [24:10.8]

6.9.1 Piping, valves, hydrants, gaskets, and fittings shall be inspected for damage when received and shall be inspected prior to installation. [24:10.8.1]

6.9.2 The tightness of bolted joints shall be verified by the bolt torque or by the method described in the listing information or manufacturer's installation instructions. [24:10.8.2]

6.9.3 Pipe, valves, hydrants, and fittings shall be clean and free from internal debris. [24:10.8.3]

6.9.4 When work is stopped, the open ends of piping, valves, hydrants, and fittings shall be plugged or covered to prevent foreign materials from entering. [24:10.8.4]

6.9.5 All piping, fittings, valves, and hydrants shall be examined for cracks or other defects while suspended above the trench and lowered into the trench using equipment designed for such use. [24:10.8.5]

6.9.6 Plain ends shall be inspected for signs of damage prior to installation. [24:10.8.6]

6.9.7 Piping, fittings, valves, hydrants, and appurtenances shall not be dropped, dumped or rolled or skidded against other materials. [24:10.8.7]

6.9.8 Pipes shall be supported in the trench throughout their full length and shall not be supported by the bell ends only or by blocks. [24:10.8.8]

6.9.9 If the ground is soft, other means shall be provided to support the pipe. [24:10.8.9]

6.9.10 Valves and fittings used with nonmetallic pipe shall be supported and restrained in accordance with the manufacturer's installation instructions. [24:10.8.10]

Δ 6.10 Backfilling. [24:10.9]

6.10.1 Backfill material shall be tamped in layers or in puddles under and around pipes to prevent settlement or lateral movement and shall contain no ashes, cinders, refuse, organic matter, or other corrosive materials. [24:10.9.1]

6.10.2 Backfill material shall not contain ash, cinders, refuse, organic matter or other corrosive materials. [24:10.9.2]

6.10.3* In the absence of specific guidelines or specifications, the maximum allowable particle size for backfill within 1 ft (300 mm) of the pipe shall not be larger than 1½ in. (40 mm). [24:10.9.3]

6.10.3.1 Nominal pipe sizes of 4 in. (100 mm) or smaller shall not exceed ½ in. (13 mm) maximum particle size. [24:10.9.3.1]

6.10.3.2 Nominal pipe sizes of 6 in. to 12 in. (150 mm to 300 mm) shall not exceed ¾ in. (19 mm) maximum particle size. [24:10.9.3.2]

6.10.4 Frozen earth shall not be used as backfill material. [24:10.9.4]

6.10.5 In trenches cut through rock, tamped backfill shall be used for at least 6 in. (150 mm) under and around the pipe and for at least 2 ft (600 mm) above the pipe. [24:10.9.5]

6.10.6 Where using piping listed for private fire service mains, the manufacturer's installation instructions for backfill shall be followed. [24:10.9.6]

Δ 6.11 Testing and Acceptance. [24:10.10]**Δ 6.11.1 Approval of Underground Piping. [24:10.10.1]**

6.11.1.1 The installing contractor shall be responsible for the following:

- (1) Notifying the AHJ and the owner's representative of the time and date testing is to be performed
- (2) Performing all required acceptance tests
- (3) Completing and signing a contractor's material and test certificate(s) shown in Figure 6.11.1.1

[24:10.10.1.1]

6.11.1.2 Alternate forms or electronic records providing at minimum the required information found in Figure 6.11.1.1 shall be permitted. [24:10.10.1.2]

Δ 6.11.2 Acceptance Requirements. [24:10.10.2]**Δ 6.11.2.1* Flushing of Piping. [24:10.10.2.1]**

6.11.2.1.1 Underground piping, from the water supply to the system riser, and lead-in connections to the system riser, including all hydrants, shall be completely flushed before connection is made to downstream fire protection system piping. [24:10.10.2.1.1]

6.11.2.1.2 The flushing operation shall continue until water flow is verified to be clear of debris. [24:10.10.2.1.2]

6.11.2.1.3* The minimum rate of flow shall be in accordance with Table 6.11.2.1.3. [24:10.10.2.1.3]

6.11.2.1.3.1 Where the flow rates established in Table 6.11.2.1.3 are not attainable, the maximum allowable flow rate at the minimum allowable residual pressure to the system shall be acceptable. [24:10.10.2.1.3.1]

Contractor's Material and Test Certificate for Underground Piping			
PROCEDURE Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job. A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners, and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.			
Property name			Date
Property address			
Plans	Accepted by approving authorities (names)		
	Address		
	Installation conforms to accepted plans ☐ Yes ☐ No		
	Equipment used is approved ☐ Yes ☐ No If no, state deviations		
Instructions	Has person in charge of fire equipment been instructed as to location of control valves and care and maintenance of this new equipment? ☐ Yes ☐ No If no, explain		
	Have copies of appropriate instructions and care and maintenance charts been provided to the owner or owner's representative? ☐ Yes ☐ No If no, explain		
Location	Supplies buildings		
Underground pipes and joints	Pipe types and class		Type joint
	Pipe conforms to _____ standard ☐ Yes ☐ No		
	Fittings conform to _____ standard ☐ Yes ☐ No		
	If no, explain		
Test description	Joints needing anchorage clamped, strapped, or blocked in accordance with _____ standard ☐ Yes ☐ No		
	If no, explain		
Flushing tests	Flushing: Flow the required rate until water is verified to be clear of debris at outlets such as hydrants and blow-offs. Flush at one of the flow rates as specified in 6.11.2.1.3. Hydrostatic: All piping and attached appurtenances subjected to system working pressure shall be hydrostatically tested at 200 psi (13.8 bar) or 50 psi (3.4 bar) in excess of the system working pressure, whichever is greater, and shall maintain that pressure $\pm$ 5 psi (0.34 bar) for 2 hours. Hydrostatic Testing Allowance: Where additional water is added to the system to maintain the test pressures required by 6.11.2.2.1, the amount of water shall be measured and shall not exceed the limits of the following equation (for metric equation, see 6.11.2.2.6):		
	$L = \frac{SD\sqrt{P}}{148,000}$ L = testing allowance (makeup water), in gallons per hour (lpm) S = length of pipe tested, in feet (m) D = nominal diameter of the pipe, in inches (mm) P = average test pressure during the hydrostatic test, in pounds per square inch (gauge) (bar)		
Flushing tests	New underground piping flushed according to _____ standard by (company) ☐ Yes ☐ No If no, explain		
	How flushing flow was obtained		Through what type opening
	☐ Public water ☐ Tank or reservoir ☐ Fire pump		☐ Hydrant butt ☐ Open pipe
	Lead-ins flushed according to _____ standard by (company) ☐ Yes ☐ No If no, explain		
Flushing tests	How flushing flow was obtained		Through what type opening
	☐ Public water ☐ Tank or reservoir ☐ Fire pump		☐ Y connection to flange and spigot ☐ Open pipe

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FIGURE 6.11.1.1 Sample of Contractor's Material and Test Certificate for Underground Piping. [24:Figure 10.10.1.1]

Hydrostatic test	All new underground piping hydrostatically tested at _____ psi (bar) for _____ hours		Joints covered ☐ Yes ☐ No
Leakage test	Total amount of leakage measured _____ gallons (liters) _____ hours		
	Allowable leakage _____ gallons (liters) _____ hours		
Forward flow test of backflow preventer	Forward flow test performed in accordance with 6.11.2.5.2: ☐ Yes ☐ No		
Hydrants	Number installed	Type and make	All operate satisfactorily ☐ Yes ☐ No
	Water control valves left wide open If no, state reason		☐ Yes ☐ No
Control valves	Hose threads of fire department connections and hydrants interchangeable with those of fire department answering alarm		☐ Yes ☐ No
Remarks	Date left in service		
Signatures	Name of installing contractor		
	Tests witnessed by		
	For property owner (signed)	Title	Date
	For installing contractor (signed)	Title	Date
Additional explanation and notes			
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Δ FIGURE 6.11.1.1 Continued