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NFPA 13D

Standard for the

Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

2007 Edition

This edition of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes*, was prepared by the Technical Committee on Residential Sprinkler Systems and released by the Technical Correlating Committee on Automatic Sprinkler Systems. It was issued by the Standards Council on July 28, 2006, with an effective date of August 17, 2006, and supersedes all previous editions.

This edition of NFPA 13D was approved as an American National Standard on August 17, 2006.

Origin and Development of NFPA 13D

Recognizing the need to reduce the annual life loss from fire in residential occupancies (about 50 percent of total loss of life by fire), the Committee on Automatic Sprinklers appointed a subcommittee in May 1973 to prepare the *Standard on the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes.* The subcommittee was composed of members of the Committee on Automatic Sprinklers and other technically competent experts. The standard was submitted and adopted at the NFPA Annual Meeting in Chicago, Illinois, on May 12–16, 1975.

The 1980 edition was a complete rewrite of the 1975 edition, including SI units where appropriate. The 1980 edition incorporated the results of the residential sprinkler test program administered by the National Fire Protection Association and funded by a research grant from the United States Fire Administration. Factory Mutual Research Corporation and the Los Angeles City Fire Department conducted the dwelling tests. Factory Mutual Research Corporation, McNeary Insurance Consulting Services, and the Charlotte, North Carolina, Fire Department conducted the mobile home tests.

After gaining practical experience using the 1980 edition, modifications to the standard, including removal of design parameters for dry pipe systems, were made in the 1984 edition.

The 1989 and 1991 editions established criteria for the use of antifreeze systems as well as some of the installation criteria associated with specially listed piping materials.

The 1994 edition provided expanded information on nonmetallic pipe and introduced a new design option that reduced water storage requirements for limited area dwellings.

The 1996 edition of the standard included expanded information on the use and placement of residential sprinklers near heat sources. For the first time since 1941, the use of ½ in. (12.7 mm) piping material was permitted again for sprinkler systems under specific conditions. A number of appendix figures were also added to address methods for protecting pipe from freezing in unheated attics.

The 1999 edition revised criteria for certain types of multipurpose piping systems and added requirements to mitigate the effect of water softeners and filters on system performance. Information on the application of solvent cement for nonmetallic piping systems was provided, and the exception for omitting sprinkler coverage in attics and crawl spaces was modified.

The 2002 edition incorporated revisions to update the standard to comply with the 2000 edition of the *Manual of Style for NFPA Technical Committee Documents.* These revisions included editorially rewording any exceptions as requirements. The 2002 edition also included changes that established a minimum design discharge density. The requirements for multipurpose systems were changed to require a bypass valve for installations with water softeners or water filtration equipment installed and to update the requirements for network systems. The chapter specifically addressing Limited Area Dwelling Systems was no longer included in the standard.

The 2007 edition includes new spacing and obstruction rules addressing sloped ceilings, ceiling pockets, ceiling fans, and kitchen cabinets. Also new to this edition are installation, design, and acceptance requirements for pumps. The acceptability of insulation as a method of freeze protection and the acceptability of wells as a water source have been clarified for this edition. New requirements for listed dry pipe/preaction residential sprinkler systems, as well as clarified requirements for multi-purpose combined and networked sprinkler systems, have been incorporated. Finally, specific obstruction rules have been added for residential sprinklers.

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

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

Committee Scope: This Committee shall have 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.

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

Committee Scope: This Committee shall have primary responsibility for documents on the design and installation of automatic sprinkler systems in dwellings and residential occupancies up to and including four stories in height, including the character and adequacy of water supplies, and the selection of sprinklers, piping, valves, and all materials and accessories.

Contents

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Standard for the

Installation of Sprinkler Systems in One- and Two-Family Dwellings and Manufactured Homes

2007 Edition

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

Changes other than editorial are indicated by a vertical rule beside the paragraph, table, or figure in which the change occurred. These rules are included as an aid to the user in identifying changes from the previous edition. Where one or more complete paragraphs have been deleted, the deletion is indicated by a bullet (•) between the paragraphs that remain.

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

Chapter 1 Administration

1.1* Scope. This standard shall cover the design and installation of automatic sprinkler systems for protection against the fire hazards in one- and two-family dwellings and manufactured homes.

1.2* Purpose. The purpose of this standard shall be to provide a sprinkler system that aids in the detection and control of residential fires and thus provides improved protection against injury, life loss, and property damage. A sprinkler system designed and installed in accordance with this standard shall be expected to prevent flashover (total involvement) in the room of fire origin, where sprinklered, and to improve the chance for occupants to escape or be evacuated. The layout, calculation, and installation of systems installed in accordance with this standard shall only be performed by people knowledgeable and trained in such systems.

1.3 Retroactivity. The provisions of this standard reflect a consensus of what is necessary to provide an acceptable degree of protection from the hazards addressed in this standard at the time the standard was issued. 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. 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. The retroactive requirements of this standard shall be permitted to be modified if their application clearly would be impractical in the judgment of the authority having jurisdiction, and only where it is clearly evident that a reasonable degree of safety is provided.

1.4 Equivalency. Nothing in this standard is intended to restrict new technologies or alternative arrangements, provided that the level of safety prescribed by the standard is not reduced.

1.5 Units.

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

1.5.2 The liter and bar units shall be permitted to be used in this standard.

1.5.3 The conversion factors for liter, pascal, and bar shall be in accordance with Table 1.5.3.

Table 1.5.3 Metric Conversions

Name of Unit	Unit Symbol	Conversion Factor
liter	L	1 gal = 3.785 L
pascal	Pa	1 psi = 6894.757 Pa
bar	bar	1 psi = 0.0689 bar
bar	bar	1 bar = 10^5 Pa

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

1.5.5 The equivalent value for a measurement in SI shall be converted by multiplying the value by the conversion factor and then rounding the result to the appropriate number of significant digits.

Chapter 2 Referenced Publications

2.1 General. The documents or portions thereof listed in this chapter are referenced within this standard and shall be considered part of the requirements of this document.

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

NFPA 13, *Standard for the Installation of Sprinkler Systems,* 2007 edition.

NFPA 72®, National Fire Alarm Code®, 2007 edition.

NFPA 220, *Standard on Types of Building Construction,* 2006 edition.

2.3 Other Publications.

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

ANSI B36.10M, *Welded and Seamless Wrought Steel Pipe,* 1996.

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

ASME B16.1, *Cast Iron Pipe Flanges and Flanged Fittings,* 1989.

ASME B16.3, *Malleable Iron Threaded Fittings,* 1992.

ASME B16.4, *Gray Iron Threaded Fittings,* 1992.

ASME B16.5, *Pipe Flanges and Flanged Fittings,* 1996.

ASME B16.9, *Factory-Made Wrought Steel Buttwelding Fittings*, 1993.

ASME B16.11, *Forged Fittings, Socket-Welding and Threaded*, 1996.

ASME B16.18, *Cast Copper Alloy Solder Joint Pressure Fittings*, 1984.

ASME B16.22, *Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*, 1995.

ASME B16.25, *Buttwelding Ends*, 1997.

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

ASTM A 53, *Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*, 1998.

ASTM A 135, *Standard Specification for Electric-Resistance-Welded Steel Pipe*, 1997.

ASTM A 234, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures*, 1997.

ASTM A 795, *Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, 1997.

ASTM B 32, *Standard Specification for Solder Metal*, 1996.

ASTM B 75, *Standard Specification for Seamless Copper Tube*, 1999.

ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, 1999.

ASTM B 251, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*, 1997.

ASTM B 813, *Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube*, 2000.

ASTM B 828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings*, 2000.

ASTM D 3309, *Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems*, 1996.

ASTM F 437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 1996.

ASTM F 438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 1997.

ASTM F 439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 1997.

ASTM F 442, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 1997.

ASTM F 876, *Standard Specification for Cross-Linked Polyethylene (PEX) Tubing*, 2005.

ASTM F 1960, *Standard Specification for Cold-Expansion Fittings with PEX Reinforcing Rings for Use with Cross-Lined Polyethylene (PEX) Tubing*, 2005.

ASTM F 2080, *Standard Specification for Cold-Expansion Fittings with Metal Compression-Sleeves for Cross-Linked Polyethylene (PEX) Pipe*, 2005.

2.3.4 AWS Publications. American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

AWS A5.8, *Specification for Filler Metals for Brazing and Braze Welding*, 1992.

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

2.4 References for Extracts in Mandatory Sections. (Reserved)

Chapter 3 Definitions

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

3.2 NFPA Official Definitions.

3.2.1* Approved. Acceptable to the authority having jurisdiction.

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

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

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

3.2.5 Shall. Indicates a mandatory requirement.

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

3.2.7 Standard. A document, the main text of which contains only mandatory provisions using the word "shall" to indicate requirements and which is in a form generally suitable for mandatory reference by another standard or code or for adoption into law. Nonmandatory provisions shall be located in an appendix or annex, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

3.3 General Definitions.

3.3.1 Compartment. See Section 4.1.

3.3.2 Design Discharge. The rate of water discharged by an automatic sprinkler expressed in gpm (mm/min).

3.3.3 Dwelling. Any building that contains not more than one or two dwelling units intended to be used, rented, leased, let, or hired out to be occupied or that are occupied for habitation purposes.

3.3.4 Dwelling Unit. One or more rooms, arranged for the use of one or more individuals living together, as in a single housekeeping unit, that normally have cooking, living, sanitary, and sleeping facilities.

3.3.5* Manufactured Home. A structure, transportable in one or more sections, which, in the traveling mode, is 8 body-ft (2.4 m) or more in width or 40 body-ft (12.2 m) or more in length or, when erected on site, is 320 ft^2 (29.7 m^2) or more and which is built on a permanent chassis and designed to be used as a dwelling, with or without a permanent foundation, when connected to the required utilities, and includes plumbing, heating, air-conditioning, and electrical systems contained therein; except that such terms shall include any structure which meets all the requirements of this paragraph except the size requirements and with respect to which the manufacturer voluntarily files a certification required by the regulatory agency. Calculations used to determine the number of square feet in a structure are based on the structure's exterior dimensions, measured at the largest horizontal projections when erected on site. These dimensions include all expandable rooms, cabinets, and other projections containing interior space, but do not include bay windows.

3.3.6 Pressure.

3.3.6.1 ***Supply Pressure.*** The pressure within the supply (e.g., city or private supply water source).

3.3.6.2 ***System Pressure.*** The pressure within the system (e.g., above the control valve).

3.3.6.3 ***System Working Pressure.*** The maximum anticipated static (nonflowing) or flowing pressure applied to sprinkler system components exclusive of surge pressures.

3.3.7 Pump. A mechanical device that transfers or raises, or transfers and raises, the pressure of a fluid (water).

3.3.8 Sprinkler.

3.3.8.1 ***Automatic Sprinkler.*** A fire suppression or control device that operates automatically when its heat-actuated element is heated to its thermal rating or above, allowing water to discharge over a specific area.

3.3.8.2 ***Residential Sprinkler.*** A type of fast-response sprinkler having a thermal element with an RTI of 50 $(meters\text{-}seconds)^{1/2}$ 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.

3.3.9 Systems.

3.3.9.1 ***Antifreeze Sprinkler System.*** A wet pipe sprinkler system employing automatic sprinklers that are attached to a system that contains an antifreeze solution and that are connected to a water supply. The antifreeze solution, followed by water, discharges immediately from sprinklers opened by a fire.

3.3.9.2 ***Dry Pipe Sprinkler System.*** A sprinkler system employing automatic sprinklers that are attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry pipe valve, and the water then flows into the piping system and out the opened sprinkler.

3.3.9.3* ***Multipurpose Piping System.*** A piping system intended to serve both domestic and fire protection needs.

3.3.9.4* ***Network System.*** A type of multipurpose system utilizing a common piping system supplying domestic fixtures and fire sprinklers where each sprinkler is supplied by a minimum of three separate paths.

3.3.9.5 ***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.

3.3.9.6 ***Preengineered System.*** A packaged sprinkler system including all components connected to the water supply and designed to be installed according to pretested limitations.

3.3.9.7 ***Sprinkler System.*** For fire protection purposes, an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The installation includes one or more automatic water supplies. The portion of the sprinkler system aboveground is a network of specially sized or hydraulically designed piping installed in a building, structure, or area, generally overhead, and to which sprinklers are attached in a systematic pattern. The system is usually activated by heat from a fire and discharges water over the fire area.

3.3.9.8 ***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.

3.3.10 Valve.

3.3.10.1 ***Check Valve.*** A valve that allows flow in one direction only.

3.3.10.2* ***Control Valve.*** An indicating valve employed to control (shut) a supply of water to a sprinkler system.

3.3.11 Waterflow Alarm. A sounding device activated by a waterflow detector or alarm check valve.

3.3.12 Waterflow Detector. An electric signaling indicator or alarm check valve actuated by waterflow in one direction only.

Chapter 4 General Requirements

4.1 Compartments.

4.1.1 A compartment, for the purposes of this standard, shall be a space that is completely enclosed by walls and a ceiling.

4.1.2 A compartment enclosure shall be permitted to have openings in walls, provided the openings have a minimum lintel depth of 8 in. (203 mm) from the ceiling.

4.2 Maintenance.

4.2.1* The installer shall provide to the owner/occupant instructions on inspecting, testing, and maintaining the system.

4.2.2 Operated or damaged sprinklers shall be replaced with sprinklers having the same performance characteristics as the original equipment.

4.2.3 Any sprinklers that have been painted outside of the factory shall be replaced with a new listed sprinkler.

4.2.4* Antifreeze Systems. Before freezing weather each year, the following procedure shall be performed:

(1) Solution in the entire antifreeze system emptied into convenient containers
(2) Solution brought to the proper specific gravity by adding concentrated liquid as needed, or a new solution be prepared, in accordance with 8.3.3
(3) System refilled with the new or remixed solution

4.3* Hydrostatic Tests.

4.3.1 Where a fire department pumper connection is not provided, the system shall be hydrostatically tested for leakage at normal system operating pressure.

4.3.2 Where a fire department pumper connection is provided, the system shall pass a hydrostatic pressure test performed in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems.*

4.4 Sprinkler Temperature Ratings.

4.4.1 Sprinklers having a temperature rating of 135°F to 170°F (57°C to 77°C) shall be classified as ordinary temperature–rated sprinklers.

4.4.2 Sprinklers having a temperature rating of 175°F to 225°F (79°C to 107°C) shall be classified as intermediate temperature–rated sprinklers.

4.5 Tube. Wherever the word *pipe* is used in this standard, it shall also mean *tube.*

4.6 Listed or Labeled. Listed or labeled devices and materials shall be installed and used in accordance with the listing limitations and the manufacturers' instructions unless permitted by other sections of this document.

4.7 Smoke Alarms. Smoke alarms shall be provided in accordance with *NFPA 72, National Fire Alarm Code.*

4.8* Documentation. Documentation shall be available upon request to ensure adequate water supply, listed devices, and adequate sprinkler coverage have been addressed.

Chapter 5 System Components

5.1 General.

5.1.1* Only new sprinklers shall be installed in sprinkler systems.

5.1.2 Devices and materials used in sprinkler systems shall be listed unless permitted not to be by 5.1.3.

5.1.3 Tanks, expansion tanks, pumps, hangers, waterflow detection devices, and waterflow valves shall not be required to be listed.

5.2 Pipe.

5.2.1* Pipe or tube used in sprinkler systems shall be of the materials specified in Table 5.2.1.1 or shall be in accordance with 5.2.2.

5.2.1.1 The chemical properties, physical properties, and dimensions of pipe materials shall be at least equivalent to the standards cited in Table 5.2.1.1.

Table 5.2.1.1 Pipe or Tube Materials and Dimensions

Materials and Dimensions	Standard
Standard Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A 795
Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless	ASTM A 53
Welded and Seamless Wrought Steel Pipe	ANSI B 36.10M
Standard Specification for Electric-Resistance-Welded Steel Pipe	ASTM A 135
Standard Specification for Seamless Copper Tube [Copper Tube (Drawn, Seamless)]	ASTM B 75
Standard Specification for Seamless Copper Water Tube	ASTM B 88
Standard Specification for General Requirements for Wrought Steamless Copper and Copper-Alloy Tube	ASTM B 251
Standard Specification for Liquid and Paste Fluxes for Soldering Applications of Copper and Copper-Alloy Tube	ASTM B 813
Specification for Filler Metals for Brazing and Braze Welding (BCuP, copper-phosphorus, or copper-phosphorus-silver brazing filler metal)	AWS A5.8
Standard Specification for Solder Metal [alloy grades containing less than 0.2 percent lead as identified in ASTM B 32, Table 5, Section 1, and having a solidus temperature that exceeds 400°F (204°C)]	ASTM B 32

5.2.1.2 Pipe used in sprinkler systems other than those addressed in 5.2.1.3 shall be designed to withstand a working pressure of not less than 175 psi (12.1 bar).

5.2.1.3 Nonmetallic pipe used in multipurpose piping systems not equipped with a fire department connection shall be designed to withstand a working pressure of not less than 130 psi (8.9 bar) at 120°F (49°C).

5.2.2 Types of pipe other than those specified in Table 5.2.1.1 shall be permitted to be used where listed for sprinkler system use.

5.2.2.1 Pipe differing from those specified in Table 5.2.1.1 shall be installed in accordance with their listings and the manufacturers' installation instructions.

5.2.2.2* Chlorinated polyvinyl chloride (CPVC) and polybutylene (PB) pipe shall comply with the portions of the American Society for Testing and Materials (ASTM) standards specified in Table 5.2.2.2 that apply to fire protection service.

5.2.3 Schedule 10 steel pipe shall be permitted to be joined with mechanical groove couplings approved for service.

5.2.4* Where mechanical groove couplings are used to join pipe, grooves shall be rolled on the pipe by an approved groove-rolling machine.

Table 5.2.2.2 Specially Listed Pipe or Tube Materials and Dimensions

Materials and Dimensions	Standard
Nonmetallic Piping:	
Standard Specification for Chlorinated Poly (Vinyl) Chloride (CPVC) Pipe	ASTM F 442
Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems	ASTM D 3309

5.2.5 Fittings used in sprinkler systems shall be of the materials listed in Table 5.2.5 or shall be in accordance with 5.2.9.

5.2.5.1 The chemical properties, physical properties, and dimensions of fitting materials shall be at least equivalent to the standards cited in Table 5.2.5.

5.2.5.2 Fittings used in sprinkler systems other than those addressed in 5.2.5.3 shall be designed to withstand a working pressure of not less than 175 psi (12.1 bar).

5.2.5.3 Nonmetallic fittings used in multipurpose piping systems not equipped with a fire department connection shall be designed to withstand a working pressure of not less than 130 psi (8.9 bar) at 120°F (49°C).

5.2.6 Joints for the connection of copper tube shall be brazed on dry pipe and preaction systems.

5.2.7 Joints for the connection of copper tube for wet pipe systems and antifreeze systems shall be solder joints or be brazed.

Table 5.2.5 Fitting Materials and Dimensions

Materials and Dimensions	Standard
Cast Iron:	
Gray Iron Threaded Fittings	ASME B16.4
Cast Iron Pipe Flanges and Flanged Fittings	ASME B16.1
Malleable Iron:	
Malleable Iron Threaded Fittings	ASME B16.3
Steel:	
Factory-Made Wrought Steel Buttwelding Fittings	ASME B16.9
Buttwelding Ends	ASME B16.25
Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A 234
Pipe Flanges and Flanged Fittings	ASME B16.5
Forged Fittings, Socket-Welding and Threaded	ASME B16.11
Copper:	
Wrought Copper and Copper Alloy Solder Joint Pressure Fittings	ASME B16.22
Cast Copper Alloy Solder Joint Pressure Fittings	ASME B16.18

5.2.8 Solder joints, where permitted, shall be fabricated in accordance with the methods and procedures listed in ASTM B 828, *Standard Practice for Making Capillary Joints by Soldering of Copper and Copper Alloy Tube and Fittings.*

5.2.9 Types of fittings other than those specified in Table 5.2.5 shall be permitted to be used where listed for sprinkler system use.

5.2.9.1 Fittings differing from those specified in Table 5.2.5 shall be installed in accordance with their listings and the manufacturers' installation instructions.

5.2.9.2* Chlorinated polyvinyl chloride (CPVC) and polybutylene (PB) fittings shall comply with the portions of the American Society for Testing and Materials (ASTM) standards specified in Table 5.2.9.2 that apply to fire protection service.

Table 5.2.9.2 Specially Listed Fittings and Dimensions

Materials and Dimensions	Standard
Standard Specification for Schedule 80 CPVC Threaded Fittings	ASTM F 437
Standard Specification for Schedule 40 CPVC Socket-Type Fittings	ASTM F 438
Standard Specification for Schedule 80 CPVC Socket-Type Fittings	ASTM F 439

5.2.10 Other joining methods investigated for suitability in automatic sprinkler installations and listed for this service shall be permitted.

5.3 Pre-engineered Systems. Where listed pre-engineered systems are installed, they shall be installed within the limitations that have been established by the testing laboratories.

Chapter 6 Water Supply

6.1 General Provisions.

6.1.1 Every automatic sprinkler system shall have at least one automatic water supply.

6.1.2 Where stored water is used as the sole source of supply, the minimum quantity shall equal the water demand rate times 10 minutes unless permitted otherwise by 6.1.3.

6.1.3 Where stored water is used as the sole source of supply, the minimum quantity shall be permitted to equal the two-sprinkler water demand rate times 7 minutes where dwelling units meet the following criteria:

(1) One story in height
(2) Less than 2000 ft^2 (186 m^2) in area

6.2* Water Supply Sources. The following water supply sources shall be considered to be acceptable by this standard:

(1) A connection to a reliable waterworks system with or without an automatically operated pump
(2) An elevated tank
(3) A pressure tank designed to American Society of Mechanical Engineers (ASME) standards for a pressure vessel with a reliable pressure source
(4) A stored water source with an automatically operated pump

(5) A well with a pump of sufficient capacity and pressure to meet the sprinkler system demand. The stored water requirement of 6.1.2 or 6.1.3 shall be permitted to be a combination of the water in the well (including the refill rate) plus the water in the holding tank if such tank can supply the sprinkler system.

6.2.1* Prior to system acceptance, a system utilizing a pump shall be tested by opening the drain/test connection. The pump shall sense the flow, turn on, and flow water for the required duration of 6.1.2 or 6.1.3 (as appropriate) without interruption.

6.2.2 Where a pump and tank is the source of supply for a fire sprinkler system but is not a portion of the domestic water system, the following shall be met:

(1) A test connection shall be provided downstream of the pump that creates a flow of water equal to the smallest sprinkler on the system. The connection shall return water to the tank.
(2) Pump motors using ac power shall be connected to a 240 V normal circuit.
(3) Any disconnecting means for the pump shall be approved.
(4) A method for refilling the tank shall be piped to the tank.
(5) A method of seeing the water level in the tank shall be provided without having to open the tank.
(6) The pump shall not be permitted to sit directly on the floor.

6.3* Multipurpose Piping System. A piping system serving both sprinkler and domestic needs shall be considered to be acceptable by this standard where the following conditions are met:

(1) In common water supply connections serving more than one dwelling unit, 5 gpm (19 L/min) shall be added to the sprinkler system demand to determine the size of common piping and the size of the total water supply requirements where no provision is made to prevent flow into the domestic water system upon operation of a sprinkler.
(2) All piping in the system supplying sprinklers is listed and conforms to the piping specifications of this standard.
(3) Piping connected to the system that supplies only plumbing fixtures complies with local plumbing and health authority requirements but is not required to be listed.
(4) Permitted by the local plumbing or health authority.
(5) **Warning Sign.** A sign shall be affixed adjacent to the main shutoff valve that states in minimum ¼ in. (6.4 mm) letters, "Warning, the water system for this home supplies fire sprinklers that require certain flows and pressures to fight a fire. Devices that restrict the flow or decrease the pressure or automatically shut off the water to the fire sprinkler system, such as water softeners, filtration systems, and automatic shutoff valves, shall not be added to this system without a review of the fire sprinkler system by a fire protection specialist. Do not remove this sign."
(6) Where water treatment and filtration are installed, one of the following conditions shall be met:
    (a) The flow restriction and pressure loss through the water treatment equipment shall be taken into account in the hydraulic calculations.
    (b) An automatic bypass shall be installed around the water treatment equipment that directs all water directly to the system.

6.4 Manufactured Home Water Supply. For sprinklered buildings manufactured off-site, the minimum pressure needed to satisfy the system design criteria on the system side of the meter shall be specified on a data plate by the manufacturer.

Chapter 7 Installation

7.1 Valves.

7.1.1 A single control valve arranged to shut off both the domestic system and the sprinkler system shall be installed unless a separate shutoff valve for the sprinkler system is installed in accordance with 7.1.2.

7.1.2 The sprinkler system piping shall not have a separate control valve installed unless supervised by one of the following methods:

(1) Central station, proprietary, or remote station alarm service
(2) Local alarm service that causes the sounding of an audible signal at a constantly attended location
(3) Valves that are locked open

7.1.3 A separate shutoff valve shall be installed for the domestic water supply in installations other than those complying with Section 6.3.

7.2 Drains and Test Connections.

7.2.1 Each sprinkler system shall have a drain on the system side of the control valve.

7.2.2 A valve shall be installed in the drain piping.

7.2.3 A drain shall be installed for each trapped portion of a dry system that is subject to freezing temperatures.

7.2.4* Where waterflow alarms are provided, inspector's test connections shall be installed at locations that allow flow testing of water supplies, connections, and alarm mechanisms.

7.2.5 The inspector's test connections shall contain an orifice equal to or smaller than the smallest sprinkler installed in the system.

7.3 Pressure Gauges.

7.3.1 Where a dry system is installed, a pressure gauge shall be installed to indicate system air pressure.

7.3.2 Where a pressure tank is used for the water supply, a pressure gauge shall be installed to indicate tank pressure.

7.4 Piping Support.

7.4.1 Listed pipe shall be supported in accordance with any listing limitations.

7.4.2 Pipe that is not listed, and listed pipe with listing limitations that do not include piping support requirements, shall be supported from structural members using support methods comparable to those required by applicable local plumbing codes.

7.4.3 Piping laid on open joists or rafters shall be supported in a manner that prevents lateral movement.

7.4.4* Sprinkler piping shall be supported in a manner that prevents the movement of piping upon sprinkler operation.

7.5 Sprinklers.

7.5.1 Listed residential sprinklers shall be used unless another type is permitted by 7.5.3 or 7.5.4.

7.5.2 Residential sprinklers shall not be used on systems other than wet pipe systems unless specifically listed for use on that particular type of system.

7.5.3 Listed standard dry-pendent or dry-sidewall sprinklers shall be permitted to be extended into unheated areas not intended for living purposes.

7.5.4 Quick-response sprinklers shall be permitted to be used in mechanical closets.

7.5.5 Temperature Ratings.

7.5.5.1 Sprinklers installed where maximum ambient ceiling temperatures do not exceed 100°F (38°C) shall be ordinary temperature–rated sprinklers unless modified by the requirements of 7.5.5.3.

7.5.5.2 Sprinklers installed where maximum ambient ceiling temperatures are between 101°F and 150°F (39°C and 66°C) shall be intermediate temperature–rated sprinklers unless modified by 7.5.5.3.

7.5.5.3 The following practices shall be observed when installing residential sprinklers unless higher expected ambient temperatures require a higher temperature rating:

(1) Sprinklers under glass or plastic skylights exposed to direct rays of the sun shall be of intermediate temperature classification.

(2) Sprinklers in an unventilated concealed space under an uninsulated roof or in an unventilated attic shall be of intermediate temperature classification.

(3) Sprinklers installed near specific heat sources that are identified in Table 7.5.5.3 shall be of the temperature rating indicated in Table 7.5.5.3 unless sprinklers are listed for positioning closer to the heat source.

7.5.6* Painting and Ornamental Finishes. Sprinklers shall not be painted or enameled unless applied by the manufacturer and the sprinkler has been listed with such finishes.

7.5.7 Escutcheon Plates. Where nonmetallic sprinkler ceiling plates (escutcheons) or recessed escutcheons (metallic or nonmetallic) are used, they shall be listed based on testing of the assembly as a residential sprinkler.

7.5.8 Solvent Cement. Where solvent cement is used as the pipe and fittings bonding agent, sprinklers shall not be installed in the fittings prior to the fittings being cemented in place.

7.6* Alarms. Local waterflow alarms shall be provided on all sprinkler systems in homes not equipped with smoke alarms or smoke detectors in accordance with *NFPA 72, National Fire Alarm Code.*

7.7 Attics. When nonmetallic piping is installed in attics, adequate insulation shall be provided on the attic side of the piping to avoid exposure of the piping to temperatures in excess of the pipe's rated temperature.

Table 7.5.5.3 Minimum Distances for Ordinary and Intermediate Temperature Residential Sprinklers

Heat Source	Minimum Distance from Edge of Source to Ordinary Temperature Sprinkler		Minimum Distance from Edge of Source to Intermediate Temperature Sprinkler	
	in.	mm	in.	mm
Side of open or recessed fireplace	36	914	12	305
Front of recessed fireplace	60	1524	36	914
Coal- or wood-burning stove	42	1067	12	305
Kitchen range	18	457	9	229
Wall oven	18	457	9	229
Hot air flues	18	457	9	229
Uninsulated heat ducts	18	457	9	229
Uninsulated hot water pipes	12	305	6	152
Side of ceiling- or wall-mounted hot air diffusers	24	607	12	305
Front of wall-mounted hot air diffusers	36	914	18	457
Hot water heater or furnace	6	152	3	76
Light fixture				
0 W–250 W	6	152	3	76
250 W–499 W	12	305	6	152

Chapter 8 System Design

8.1 Design Criteria.

8.1.1 Design Discharge.

8.1.1.1 Sprinklers That Are Not Listed with Specific Discharge Criteria.

8.1.1.1.1 The system shall provide a discharge of not less than 13 gpm (49 L/min) per sprinkler simultaneously to all of the design sprinklers.

8.1.1.1.2 The system shall provide a discharge of not less than 18 gpm (68 L/min) to any sprinkler in the system.

8.1.1.2* Sprinklers That Are Listed with Specific Discharge Criteria.

8.1.1.2.1 The system shall provide at least the flow required for the multiple and single sprinkler operating criteria specified by the sprinkler listing.

8.1.1.2.2* The system shall provide at least the flow required to produce a minimum discharge density of 0.05 gpm/ft^2 (2.04 mm/min) to the design sprinklers.

8.1.2* Number of Design Sprinklers. The number of design sprinklers under flat, smooth, horizontal ceilings shall include all sprinklers within a compartment, up to a maximum of two sprinklers, that require the greatest hydraulic demand.

8.1.3 Sprinkler Coverage.

8.1.3.1 Residential Sprinklers.

8.1.3.1.1 Sprinklers shall be installed in accordance with their listing where the type of ceiling configuration is referenced in the listing.

8.1.3.1.2* Where construction features or other special conditions exist that are outside the scope of sprinkler listings, listed sprinklers shall be permitted to be installed beyond their listing limitations.

8.1.3.1.3 Sloped Ceilings.

8.1.3.1.3.1 Where the ceiling is sloped, the maximum *S* dimension shall be measured along the slope of the ceiling to the next sprinkler, as shown in Figure 8.1.3.1.3.1.

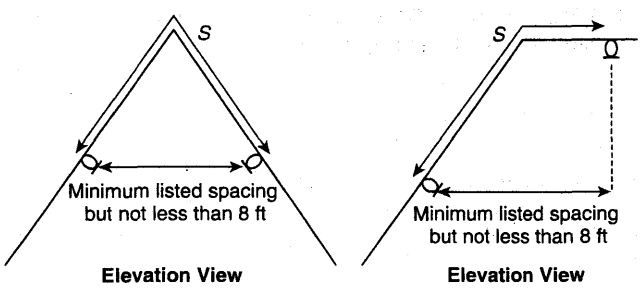


FIGURE 8.1.3.1.3.1 Measuring *S* Dimension.

8.1.3.1.3.2 The sprinklers shall maintain the minimum listed spacing, but no less than 8 ft (2.44 m), measured in the plan view from one sprinkler to another, as shown in Figure 8.1.3.1.3.1.

8.1.3.2 Nonresidential Sprinklers. Sprinklers other than residential sprinklers shall be installed in accordance with the coverage criteria specified by NFPA 13, *Standard for the Installation of Sprinkler Systems.*

8.1.4 Operating Pressure. The minimum operating pressure of any sprinkler shall be the higher of the minimum operating pressure specified by the listing or 7 psi (0.5 bar).

8.2 Position of Sprinklers.

8.2.1 Residential Pendent and Upright Sprinklers.

8.2.1.1 Pendent and upright sprinklers that have not been listed with specific positioning criteria shall be positioned so that the deflectors are within 1 in. to 4 in. (25.4 mm to 102 mm) from the ceiling unless otherwise permitted by 8.2.1.3.

8.2.1.2 Pendent and upright sprinklers that have been listed with specific positioning criteria shall be positioned in accordance with their listing unless permitted otherwise by 8.2.1.3.

8.2.1.3 Pendent and upright sprinklers in closets shall be permitted to be installed within 12 in. (305 mm) of the ceiling in order to avoid obstructions near the ceiling.

8.2.2 Residential Sidewall Sprinklers.

8.2.2.1 Sidewall sprinklers that have not been listed with specific positioning criteria shall be positioned so that the deflectors are within 4 in. to 6 in. (102 mm to 152 mm) from the ceiling.

8.2.2.2 Sidewall sprinklers that have been listed with specific positioning criteria shall be installed in accordance with their listing.

8.2.3 Nonresidential Sprinklers. Sprinklers other than residential sprinklers shall be positioned in accordance with the positioning criteria specified by NFPA 13, *Standard for the Installation of Sprinkler Systems.*

8.2.4 In basements where ceilings are not required for the protection of piping or where metallic pipe is installed, residential sprinklers shall be permitted to be positioned in a manner that anticipates future installation of a finished ceiling.

8.2.5* Obstructions to Residential Sprinklers.

8.2.5.1 Closets. In all closets, including those closets housing mechanical equipment, that are not larger than 400 ft^3 (11.3 m^3) in size, a single sprinkler at the highest ceiling space in the closet shall be sufficient without regard to obstructions.

8.2.5.2 Pendent Sprinklers.

8.2.5.2.1 Pendent sprinklers shall be located at least 3 ft (914 mm) away from obstructions such as ceiling fans and light fixtures unless the requirements of 8.2.5.4 are met.

8.2.5.2.2 The distance shall be measured from the center of the sprinkler to the center of the obstruction.

8.2.5.2.3 Where the sprinkler cannot be located 3 ft (914 mm) away from the obstruction (as measured from the center of the obstruction), an additional sprinkler shall be located on the other side of the obstruction.

8.2.5.2.4 Where the area of the fan blades encompass more than 50 percent of the area of the plan view, the sprinkler shall be installed in accordance with 8.2.5.4.

8.2.5.3 Sidewall Sprinklers.

8.2.5.3.1 Sidewall sprinklers shall be located at least 5 ft (1.52 m) away from obstructions such as ceiling fans and light fixtures unless the requirements of 8.2.5.5 are met.

8.2.5.3.2 The distance shall be measured from the center of the sprinkler to the center of the obstruction.

8.2.5.3.3 Where the sprinkler cannot be located 5 ft (1.52 m) away from the obstruction (as measured to the center of the obstruction), an additional sprinkler shall be installed on the other side of the obstruction.

8.2.5.3.4 Where the area of the fan blades encompasses more than 50 percent of the area of the plan view, the sprinkler shall be installed in accordance with 8.2.5.5.

8.2.5.4 Continuous Obstructions to Pendent Sprinklers.

8.2.5.4.1 Sprinklers shall be positioned with respect to continuous obstructions in accordance with 8.2.5.4.2, 8.2.5.4.3, or 8.2.5.4.4.

8.2.5.4.2 Sprinklers shall be positioned with respect to continuous obstructions in accordance with Table 8.2.5.4.2 and Figure 8.2.5.4.2.

Table 8.2.5.4.2 Position of Sprinklers to Avoid Obstructions to Discharge (Residential Upright and Pendent Spray Sprinklers)

Distance from Sprinklers to Side of Obstruction (*A*)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (in.) (*B*)
Less than 1 ft	0
1 ft to less than 1 ft 6 in.	0
1 ft 6 in. to less than 2 ft	1
2 ft to less than 2 ft 6 in.	1
2 ft 6 in. to less than 3 ft	1
3 ft to less than 3 ft 6 in.	3
3 ft 6 in. to less than 4 ft	3
4 ft to less than 4 ft 6 in.	5
4 ft 6 in. to less than 5 ft	7
5 ft to less than 5 ft 6 in.	7
5 ft 6 in. to less than 6 ft	7
6 ft to less than 6 ft 6 in.	9
6 ft 6 in. to less than 7 ft	11
7 ft and greater	14

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.
Note: For (*A*) and (*B*), refer to Figure 8.2.5.4.2.

8.2.5.4.3 Sprinklers shall be positioned with respect to an obstruction against a wall in accordance with Figure 8.2.5.4.3.

8.2.5.4.4 A sprinkler shall be installed on the other side of the obstruction.

8.2.5.5 Continuous Obstructions to Sidewall Sprinklers.

8.2.5.5.1 Sprinklers shall be positioned with respect to continuous obstructions in accordance with 8.2.5.5.2 or 8.2.5.5.3.

8.2.5.5.2 Sprinklers shall be positioned with respect to continuous obstructions in accordance with Table 8.2.5.5.2(a), Figure 8.2.5.5.2(a), Table 8.2.5.5.2(b), and Figure 8.2.5.5.2(b).

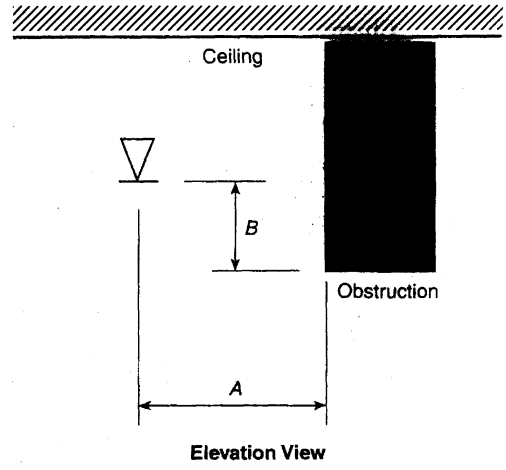


FIGURE 8.2.5.4.2 Position of Sprinkler to Avoid Obstructions to Discharge (Residential Upright and Pendent Spray Sprinklers).

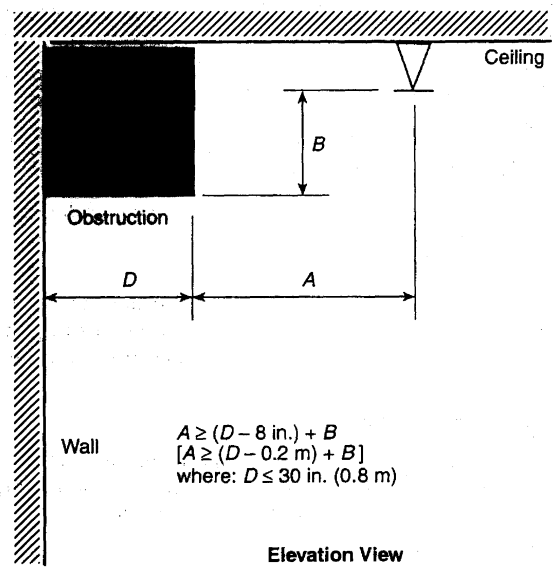


FIGURE 8.2.5.4.3 Obstructions Against Walls (Residential Upright and Pendent Spray Sprinklers).

8.2.5.5.3 A sprinkler shall be installed on the other side of the obstruction.

8.2.5.6 Soffits and Cabinets. Where soffits are used for the installation of sidewall sprinklers, the sprinklers and soffits shall be installed in accordance with 8.2.5.6.1, 8.2.5.6.2, or 8.2.5.6.3.

8.2.5.6.1 Where soffits exceed more than 8 in. (203 mm) in width or projection from the wall, sprinklers shall be installed under the soffit.

8.2.5.6.2 Sidewall sprinklers shall be permitted to be installed in the face of a soffit located directly over cabinets, without requiring additional sprinklers below the soffit or cabinets, where the soffit does not project horizontally more than 12 in. (305 mm) from the wall.

Table 8.2.5.5.2(a) Positioning of Sprinklers to Avoid Obstructions (Residential Sidewall Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction (*A*)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (in.) (*B*)
Less than 8 ft	Not Allowed
8 ft to less than 10 ft	1
10 ft to less than 11 ft	2
11 ft to less than 12 ft	3
12 ft to less than 13 ft	4
13 ft to less than 14 ft	6
14 ft to less than 15 ft	7
15 ft to less than 16 ft	9
16 ft to less than 17 ft	11
17 ft or greater	14

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.
Note: For (*A*) and (*B*), refer to Figure 8.2.5.5.2(a).

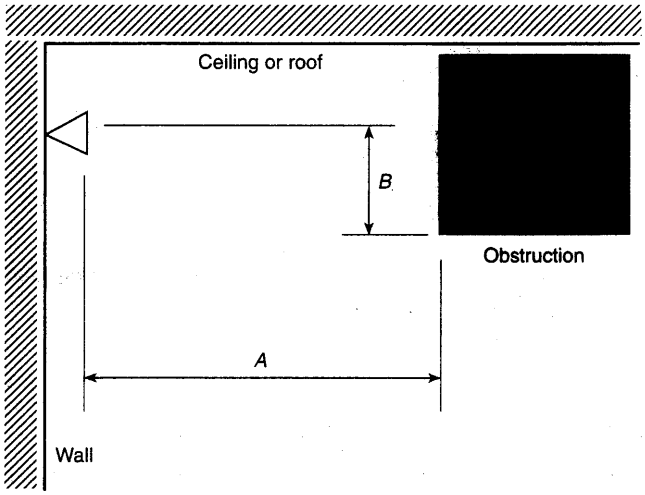


FIGURE 8.2.5.5.2(a) Positioning of Sprinklers to Avoid Obstructions (Residential Sidewall Sprinklers).

8.2.5.6.3 Where sidewall sprinklers are more than 3 ft (0.91 m) above the top of cabinets, the sprinkler shall be permitted to be installed on the wall above the cabinets where the cabinets are no greater than 12 in. (305 mm) from the wall.

8.3 System Types. Systems shall be permitted to be wet pipe, dry pipe, or preaction.

8.3.1* Wet Pipe Systems. A wet pipe system shall be permitted to be used where all piping is installed in areas maintained above 40°F (4°C), including areas properly insulated to maintain 40°F (4°C).

8.3.2 Where system piping is located in areas not maintained above 40°F (4°C), the pipe shall be protected against freezing by use of one of the following methods:

Table 8.2.5.5.2(b) Positioning of Sprinklers to Avoid Obstructions Along the Wall (Residential Sidewall Sprinklers)

Distance from Sidewall Sprinkler to Side of Obstruction (*A*)	Maximum Allowable Distance of Deflector Above Bottom of Obstruction (in.) (*B*)
Less than 1 ft 6 in.	0
1 ft 6 in. to less than 3 ft	1
3 ft to less than 4 ft	3
4 ft to less than 4 ft 6 in.	5
4 ft 6 in. to less than 6 ft	7
6 ft to less than 6 ft 6 in.	9
6 ft 6 in. to less than 7 ft	11
7 ft to less than 7 ft 6 in.	14

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.
Note: For (*A*) and (*B*), refer to Figure 8.2.5.5.2(b).

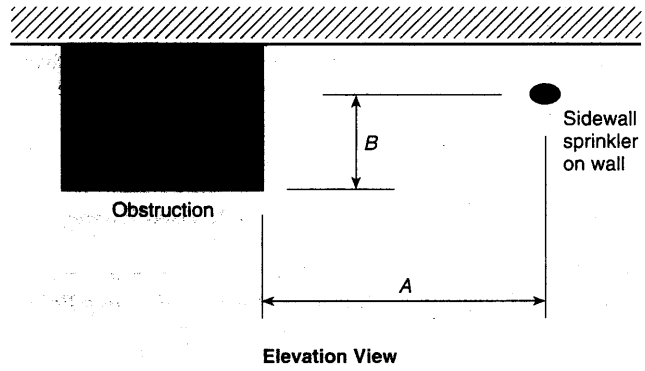


FIGURE 8.2.5.5.2(b) Positioning of Sprinklers to Avoid Obstructions Along the Wall (Residential Sidewall Sprinklers).

(1) Dry pipe system and preaction systems in accordance with 8.3.4
(2) Antifreeze system in accordance with 8.3.3
(3) Listed standard dry-pendent or dry-sidewall sprinklers extended from pipe in heated areas into unheated areas not intended for living purposes

8.3.3 Antifreeze Systems.

8.3.3.1* Conformity with Health Regulations. The use of antifreeze solutions shall be in conformity with any state or local health regulations.

8.3.3.2* Antifreeze Solutions.

8.3.3.2.1 For the purposes of this standard, pure glycerine shall mean chemically pure or United States Pharmacopeia 96.5 percent grade.

8.3.3.2.2 Where sprinkler systems are supplied by public water connections, the use of antifreeze solutions other than water solutions of pure glycerine or propylene glycol shall not be permitted.

8.3.3.2.3 Percent solution by volume of glycerine-water and propylene glycol–water mixtures shall be in accordance with Table 8.3.3.2.3.

Table 8.3.3.2.3 Antifreeze Solutions to Be Used Where Public Water Is Connected to Sprinklers

Material	Solution (by Volume)	Specific Gravity at 60°F (15.6°C)*	Freezing Point °F	Freezing Point °C
Glycerine	50% water	1.133	–15	–26.1
	40% water	1.151	–22	–30.0
	30% water	1.165	–40	–40.0
Propylene glycol	70% water	1.027	+9	–12.8
	60% water	1.034	–6	–21.1
	50% water	1.041	–26	–32.2
	40% water	1.045	–60	–51.1

* Measured with hydrometer having scale of 1.000 to 1.200.

8.3.3.2.4 Where public water is not connected to sprinklers, water solutions of glycerine, diethylene glycol, ethylene glycol, and propylene glycol shall be permitted to be used in antifreeze solutions.

8.3.3.2.5 Percent solution by volume of diethylene glycol–water and ethylene glycol–water shall be in accordance with Table 8.3.3.2.5.

Table 8.3.3.2.5 Antifreeze Solutions to Be Used Where Public Water Is Not Connected to Sprinklers

Material	Solution (by Volume)	Specific Gravity at 60°F (15.6°C)*	Freezing Point °F	Freezing Point °C
Glycerine	50% water	1.133	–15	–26.1
	40% water	1.151	–22	–30.0
	30% water	1.165	–40	–40.0
Diethylene glycol	50% water	1.078	–13	–25.0
	45% water	1.081	–27	–32.8
	40% water	1.086	–42	–41.1
Ethylene glycol	61% water	1.056	–10	–23.3
	56% water	1.063	–20	–28.9
	51% water	1.069	–30	–34.4
	47% water	1.073	–40	–40.0
Propylene glycol	70% water	1.027	+9	–12.8
	60% water	1.034	–6	–21.1
	50% water	1.041	–26	–32.2
	40% water	1.045	–60	–51.1

* Measured with hydrometer having scale of 1.0000 to 1.120.

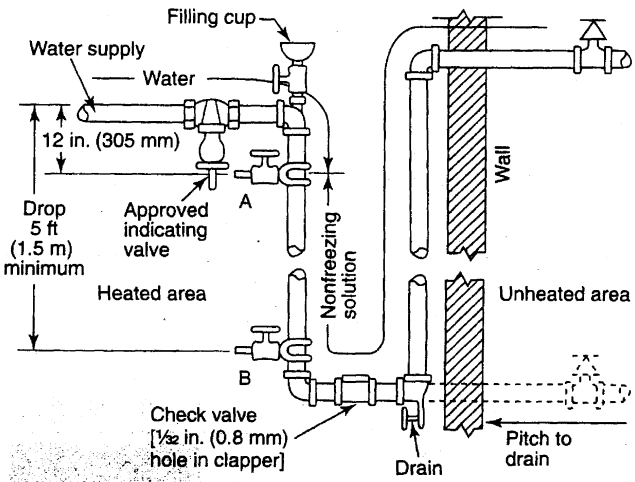
8.3.3.2.6* An antifreeze solution with a freezing point below the expected minimum temperature for the locality shall be installed.

8.3.3.2.7 The specific gravity of the antifreeze solution shall be checked by a hydrometer with a scale having 0.002 subdivisions.

8.3.3.3* Arrangement of Supply Piping and Valves.

8.3.3.3.1 Connections Between Antifreeze System and Wet Pipe System with No Backflow Prevention Device.

8.3.3.3.1.1 A 5 ft (1.5 m) drop pipe, or U-loop, shall be installed in the connection between the antifreeze system and the wet pipe system as illustrated in Figure 8.3.3.3.1.1.



Notes:
1. Check valve shall be permitted to be omitted where sprinklers are below the level of valve A.
2. The 1/32 in. (0.8 mm) hole in the check valve clapper is needed to allow for expansion of the solution during a temperature rise, thus preventing damage to sprinklers.

FIGURE 8.3.3.3.1.1 Arrangement of Supply Piping and Valves.

8.3.3.3.1.2 If sprinklers are above the level of the water supply to the antifreeze system, a check valve with a 1/32 in. (0.8 mm) hole in the clapper shall be provided in the U-loop.

8.3.3.3.1.3 Valves shall be provided as illustrated in Figure 8.3.3.3.1.1.

8.3.3.3.1.4 Arrangement of supply piping when the water supply comes from a storage tank or the water supply feeds through a check valve that does not have a 1/32 in. (0.8 mm) hole drilled in the clapper shall meet the requirements of 8.3.3.3.2.2.

8.3.3.3.2* Connections Between Antifreeze System and Wet Pipe System with Backflow Prevention Device Installed.

8.3.3.3.2.1 Valves shall be provided as illustrated in Figure 8.3.3.3.2.1.

8.3.3.3.2.2 An expansion chamber shall be provided as illustrated in Figure 8.3.3.3.2.1.

8.3.3.3.2.3 The expansion chamber shall be sized based on the minimum and maximum volume of the antifreeze solution over the life of the system.

8.3.4 Dry Pipe and Preaction Systems.

8.3.4.1 Sprinklers.

8.3.4.1.1 Sprinklers shall be specifically listed for use on dry pipe and double interlock preaction systems. The following

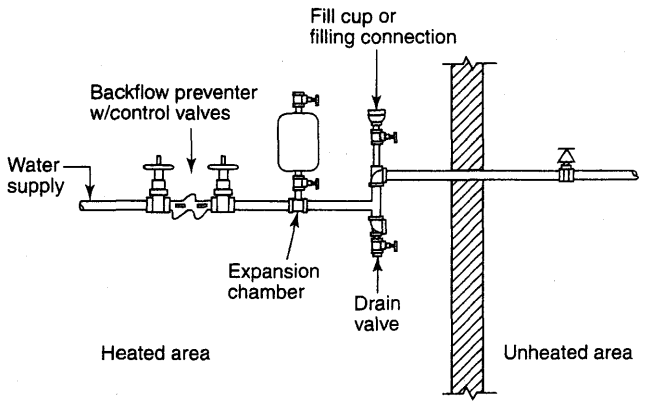


FIGURE 8.3.3.3.2.1 Arrangement of Supply Piping with Backflow Device.

types of sprinklers and arrangements shall be permitted for dry pipe and preaction systems:

(1) Residential upright sprinklers.
(2) Residential dry sprinklers.
(3) Residential pendent and sidewall sprinklers installed on return bends, where the sprinklers, return bends, and branch line piping are in an area maintained at or above 40°F (4°C). Return bends shall be permitted to be omitted when using potable water supplies combined with corrosion-resistant pipe.
(4) Residential horizontal sidewall sprinklers, installed so that water is not trapped.

8.3.4.1.2 Sprinklers with nominal K-factors greater than 4.0 and less than 5.6 shall be permitted to be installed on dry pipe systems where piping is corrosion resistant or internally galvanized.

8.3.4.1.3 Sprinklers with nominal K-factors of 5.6 or greater shall be permitted to be installed on pipe complying with the requirements of Section 5.2.

8.3.4.2 Preaction Systems. Preaction systems shall be one of the following types:

(1) A single interlock system, which admits water to sprinkler piping upon operation of detection devices
(2) A non-interlock system, which admits water to sprinkler piping upon operation of detection devices or automatic sprinklers
(3) A double interlock system, which admits water to sprinkler piping upon operation of both detection devices and automatic sprinklers

8.3.4.3 Dry Pipe and Double Interlock Preaction System Water Delivery.

8.3.4.3.1 Water delivery shall be based on the hazard shown in Table 8.3.4.3.1.

8.3.4.3.2 Water delivery shall be based on one of the following:

(1) Calculation program and method that shall be listed by a nationally recognized laboratory
(2) An inspector's test connection providing a flow equivalent to the smallest orifice sprinkler utilized, wherein the test orifice is located on the end of the most distant sprinkler pipe

Table 8.3.4.3.1 Water Delivery Time for Dry Pipe and Double Interlock Preaction Systems

Hazard	Number of Most Remote Sprinklers Initially Open	Maximum Time of Water Delivery
Residential	1	15 seconds

8.3.4.4 Location and Protection of Dry Pipe and Preaction Valves. The dry pipe valve, preaction valve, and supply pipe shall be protected against freezing and mechanical injury.

8.3.4.5* Detection Devices.

8.3.4.5.1 The detection system shall be designed to operate sooner than the first sprinkler.

8.3.4.5.2 Detectors shall be installed in all areas/compartments where sprinklers are installed.

8.3.4.6 System Configuration. Dry pipe systems and preaction systems of the type described in 8.3.4.2(3) shall not be gridded.

8.3.4.7 Drainage. Piping shall be pitched a minimum of ¼ in. per 10 ft (6.4 mm per 3.05 m) to facilitate draining.

8.3.4.8 Auxiliary Drains. Auxiliary drains shall be provided where a change in piping direction prevents drainage of system piping through the drain valve on the system side of the control valve. At a minimum, auxiliary drains shall be a nipple and cap or plug not less than ½ in. (12.7 mm).

8.3.4.9 Air Supply. The system air pressure shall be maintained by approved equipment.

8.4 Pipe Sizing.

8.4.1 The pipe sizes shall be verified for each of the single sprinkler and multiple sprinkler design discharge.

8.4.2 For specially listed piping products, friction loss for pipe and fittings shall be permitted to be calculated based on the manufacturer's data.

8.4.3 Minimum Pipe Size.

8.4.3.1 The minimum size of steel pipe shall be 1 in. (25.4 mm).

8.4.3.2 The minimum size of pipe other than steel pipe shall be ¾ in. (19 mm) unless smaller sizes are permitted by 8.4.3.3.

8.4.3.3* Along with listed special fittings, ½ in. (12.7 mm) nonmetallic pipe and ½ in. (12.7 mm) copper pipe shall be permitted to be used only in network systems under the following conditions:

(1)*Each sprinkler shall be supplied through a minimum of three separate paths from the supply manifold.
(2) Calculations shall clearly indicate the pipes that create the paths to each sprinkler.
(3) A water distribution pipe that supplies a sprinkler shall not terminate in a dead end.
(4) Hydraulic calculations shall be prepared for each sprinkler flowing individually within the system and for each pair of sprinklers within the same compartment.
(5) The location of the most demanding single sprinkler and pair of sprinklers, including their pressure and flow requirements, shall be indicated on the plan review documents.

(6) The system shall be hydraulically calculated in accordance with the provisions of NFPA 13, *Standard for the Installation of Sprinkler Systems*, except that the friction loss straight through a fitting shall be included.
(7) The method of joining the pipe to fittings or to other pipe shall be in accordance with the applicable plumbing code.
(8) A maximum of one insert tee shall be permitted in each pipe section between sprinklers to serve only domestic fixtures.
(9) When insert fittings are installed, each sprinkler shall have four separate paths from the water supply.
(10) The piping supplying only plumbing fixtures shall be in accordance with the applicable plumbing code.

8.4.4* Pipe shall be sized by hydraulic calculations in accordance with the methods described in NFPA 13, *Standard for the Installation of Sprinkler Systems*, in accordance with 8.4.5, or in accordance with the following general method for straight-run systems connected to a city water main of at least 4 in. (102 mm) in diameter *[see Table 8.4.4(a) through Table 8.4.4(g)]*:

(1) The system flow rate shall be established in accordance with Section 8.1, and it shall be determined that the flow allowed by the water meter is adequate to supply the system demand and that the total demand flow does not exceed the maximum flow allowed by the piping system components.
(2) The water pressure in the street shall be determined.
(3) Pipe sizes shall be selected.
(4) Meter pressure losses, if any, shall be deducted. *[See Table 8.4.4(g)]* Higher pressure losses specified by the manufacturer shall be used in place of those specified in Table 8.4.4(g). Lower pressure losses shall be permitted to be used where supporting data are provided by the meter manufacturer.
(5) Pressure loss for elevation shall be deducted as follows:
   (a) Building height above street (in ft) × 0.434 = pressure loss (in psi)
   (b) Building height above street (in m) × 0.098 = pressure loss (in bar)
(6) Pressure losses from the city main to the inside control valve shall be deducted by multiplying the factor from Table 8.4.4(a) or Table 8.4.4(b) by the total length(s) of pipe in feet (meters). [The total length includes equivalent length of fittings as determined by applying Table 8.4.4(c), Table 8.4.4(d), Table 8.4.4(e), or Table 8.4.4(f).]
(7) Pressure losses for piping within the building shall be deducted by multiplying the factor from Table 8.4.4(a) or Table 8.4.4(b) by the total length in feet (meters) of each size of pipe between the control valve and the farthest sprinkler.
(8) Valve and fitting pressure losses shall be deducted. The valves and fittings from the control valve to the farthest sprinkler shall be counted. The equivalent length for each valve and fitting as shown in Table 8.4.4(c), Table 8.4.4(d), Table 8.4.4(e), or Table 8.4.4(f) shall be determined and the values added to obtain the total equivalent length for each pipe size. The equivalent length for each size shall be multiplied by the factor from Table 8.4.4(a) or Table 8.4.4(b) and the values totaled.
(9) In multilevel buildings, the steps in 8.4.4(1) through 8.4.4(8) shall be repeated to size piping for each floor.
(10) If the remaining pressure is less than the operating pressure established by the testing laboratory for the sprinkler being used, the sprinkler system shall be redesigned. If the remaining pressure is higher than required, smaller piping shall be permitted to be used where justified by calculations.
(11) The remaining piping shall be sized the same as the piping up to and including the farthest sprinkler unless smaller pipe sizes are justified by calculations.

8.4.5 Smaller pipe sizes than those determined by 8.4.4 shall be permitted where justified by calculations for systems connected to city water mains of at least 4 in. (102 mm) in diameter.

8.4.6 To size piping for systems with an elevated tank, pump, or pump–tank combination, the pressure at the water supply outlet shall be determined and the steps in 8.4.4(3), (4), (7), (8), (9), (10), and (11) shall be followed.

8.4.7 Hydraulic calculation procedures in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be used for grid-type systems.

8.4.8 Hydraulic calculation procedures in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be used for looped-type systems.

8.4.9 Hydraulic calculation procedures in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be used for systems connected to city water mains of less than 4 in. (100 mm) in diameter.

8.5 Piping Configurations.

8.5.1 The piping configuration shall be permitted to be looped.

8.5.2 The piping configuration shall be permitted to be gridded.

8.5.3 The piping configuration shall be permitted to be straight run.

8.5.4 The piping configuration shall be permitted to be a combination of the configurations permitted in 8.5.1 through 8.5.3.

8.6 Location of Sprinklers.

8.6.1 Sprinklers shall be installed in all areas except where omission is permitted by 8.6.2 through 8.6.7.

8.6.2 Sprinklers shall not be required in bathrooms of 55 ft^2 (5.1 m^2) and less.

8.6.3 Sprinklers shall not be required in clothes closets, linen closets, and pantries that meet all of the following conditions:

(1) The area of the space does not exceed 24 ft^2 (2.2 m^2).
(2) The least dimension does not exceed 3 ft (0.9 m).
(3) The walls and ceilings are surfaced with noncombustible or limited-combustible materials as defined in NFPA 220, *Standard on Types of Building Construction.*

8.6.4* Sprinklers shall not be required in garages, open attached porches, carports, and similar structures.

8.6.5 Sprinklers shall not be required in attics, penthouse equipment rooms, elevator machine rooms, concealed spaces dedicated exclusively to and containing only dwelling unit ventilation equipment, floor/ceiling spaces, elevator shafts, crawl spaces, and other concealed spaces that are not used or intended for living purposes and do not contain fuel-fired equipment.

Table 8.4.4(a) Pressure Losses in psi/ft for Schedule 40 Steel Pipe ($C = 120$)

Pipe Size (in.)	Flow Rate (gpm)											
	10	12	14	16	18	20	25	30	35	40	45	50
1	0.04	0.05	0.07	0.09	0.11	0.13	0.20	0.28	0.37	0.47	0.58	0.71
1¼	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.10	0.12	0.15	0.19
1½	0.01	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.06	0.07	0.09
2	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02	0.03

For SI units, 1 gal = 3.785 L; 1 psi = 0.0689 bar; 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Table 8.4.4(b) Pressure Losses in psi/ft for Copper Tubing — Types K, L, and M ($C = 150$)

Tubing Size (in.)	Type	Flow Rate (gpm)											
		10	12	14	16	18	20	25	30	35	40	45	50
¾	M	0.08	0.12	0.16	0.20	0.25	0.30	0.46	0.64	0.85	—	—	—
	L	0.10	0.14	0.18	0.23	0.29	0.35	0.53	0.75	1.00	—	—	—
	K	0.13	0.18	0.24	0.30	0.38	0.46	0.69	0.97	1.28	—	—	—
1	M	0.02	0.03	0.04	0.06	0.07	0.08	0.13	0.18	0.24	0.30	0.38	0.46
	L	0.03	0.04	0.05	0.06	0.08	0.10	0.15	0.20	0.27	0.35	0.43	0.53
	K	0.03	0.04	0.06	0.07	0.09	0.11	0.17	0.24	0.31	0.40	0.50	0.61
1¼	M	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.09	0.11	0.15	0.17
	L	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.10	0.12	0.16	0.19
	K	0.01	0.01	0.02	0.02	0.03	0.04	0.06	0.08	0.11	0.13	0.17	0.20
1½	M	—	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.06	0.08
	L	—	0.01	0.01	0.01	0.01	0.01	0.02	0.03	0.04	0.05	0.07	0.08
	K	—	0.01	0.01	0.01	0.01	0.02	0.02	0.03	0.05	0.06	0.07	0.09
2	M	—	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02
	L	—	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02
	K	—	—	—	—	—	—	0.01	0.01	0.01	0.01	0.02	0.02

For SI units, 1 gal = 3.785 L; 1 psi = 0.0689 bar; 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Table 8.4.4(c) Equivalent Length of Fittings and Valves for Schedule 40 Steel Pipe, in Feet

Diameter (in.)	45 Degree Elbows	90 Degree Elbows	Long-Radius Elbows	Tee or Cross (flow turned 90 degrees)	Tee Run	Gate Valve	Angle Valve	Globe Valve	Globe "Y" Pattern Valve	Cock Valve	Check Valve
1	1	2	2	5	2	0	12	28	15	4	5
1¼	1	3	2	6	2	0	15	35	18	5	7
1½	2	4	2	8	3	0	18	43	22	6	9
2	2	5	3	10	3	1	24	57	28	7	11

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Table 8.4.4(d) Equivalent Length of Fittings and Valves for Type K Copper Tube, in Feet

Diameter (in.)	45 Degree Elbows	90 Degree Elbows	Long-Radius Elbows	Tee or Cross (flow turned 90 degrees)	Tee Run	Gate Valve	Angle Valve	Globe Valve	Globe "Y" Pattern Valve	Cock Valve	Check Valve
¾	0	1	0	3	1	0	7	14	7	2	0
1	1	2	2	6	2	0	14	33	18	5	6
1¼	1	3	2	5	2	0	14	32	16	5	6
1½	2	4	2	8	3	0	18	43	22	6	9
2	2	6	3	12	4	1	28	66	33	8	13

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Table 8.4.4(e) Equivalent Length of Fittings and Valves for Type L Copper Tube, in Feet

Diameter (in.)	45 Degree Elbows	90 Degree Elbows	Long-Radius Elbows	Tee or Cross (flow turned 90 degrees)	Tee Run	Gate Valve	Angle Valve	Globe Valve	Globe "Y" Pattern Valve	Cock Valve	Check Valve
¾	0	2	0	4	1	0	8	18	10	3	0
1	1	3	3	7	2	0	16	38	20	5	7
1¼	1	3	2	6	2	0	15	35	18	5	7
1½	2	4	2	9	3	0	20	47	24	7	10
2	2	6	4	12	4	1	30	71	35	9	14

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Table 8.4.4(f) Equivalent Length of Fittings and Valves for Type M Copper Tube, in Feet

Diameter (in.)	45 Degree Elbows	90 Degree Elbows	Long-Radius Elbows	Tee or Cross (flow turned 90 degrees)	Tee Run	Gate Valve	Angle Valve	Globe Valve	Globe "Y" Pattern Valve	Cock Valve	Check Valve
¾	0	2	0	4	1	0	10	21	11	3	0
1	2	3	3	8	3	0	19	43	23	6	8
1¼	1	3	2	7	2	0	16	38	20	5	8
1½	2	5	2	9	3	0	21	50	26	7	11
2	3	7	4	13	5	1	32	75	37	9	14

For SI units, 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Table 8.4.4(g) Pressure Losses in psi in Water Meters

Meter Size (in.)	Flow (gpm)					
	18	23	26	31	39	52
⅝	9	14	18	26	*	*
¾	4	8	9	13	*	*
1	2	3	3	4	6	10
1½	†	1	2	2	4	7
2	†	†	†	1	2	3

For SI units, 1 gpm = 3.785 L/min; 1 in. = 25.4 mm; 1 psi = 0.0689 bar.

* Above maximum rated flow of commonly available meters.

† Less than 1 psi (0.689 bar).

8.6.6 Sprinklers shall not be required in covered unheated projections of the building at entrances/exits as long as there is another means of egress from the dwelling unit.

8.6.7 Sprinklers shall not be required for ceiling pockets that meet the following conditions:

(1) The total volume of unprotected ceiling pocket does not exceed 100 ft^3 (2.83 m^3).
(2) The entire floor under the unprotected ceiling pocket is protected by the sprinklers at the lower ceiling elevation.
(3) Each unprotected ceiling pocket is separated from any adjacent unprotected ceiling pocket by a minimum 10 ft (3.05 m) horizontal distance.
(4) The interior finish of the unprotected ceiling pocket is noncombustible or limited-combustible material.
(5) Skylights not exceeding 32 ft^2 (2.97 m^2) shall be permitted to have a plastic cover.

Annex A Explanatory Material

Annex A is not a part of the requirements of this NFPA document but is included for informational purposes only. This annex contains explanatory material, numbered to correspond with the applicable text paragraphs.

A.1.1 NFPA 13D is appropriate for protection against fire hazards only in one- and two-family dwellings and manufactured homes. Residential portions of any other type of building or occupancy should be protected with residential sprinklers in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, or in accordance with NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.* Other portions of such buildings should be protected in accordance with NFPA 13 or NFPA 13R as appropriate for areas outside the dwelling unit.

The criteria in this standard are based on full-scale fire tests of rooms containing typical furnishings found in residential living rooms, kitchens, and bedrooms. The furnishings were arranged as typically found in dwelling units in a manner similar to that shown in Figure A.1.1(a), Figure A.1.1(b), and Figure A.1.1(c). Sixty full-scale fire tests were conducted in a two-story dwelling in Los Angeles, California, and 16 tests were conducted in a 14 ft (4.3 m) wide mobile home in Charlotte, North Carolina.

Sprinkler systems designed and installed according to this standard are expected to prevent flashover within the compartment of origin where sprinklers are installed in the compartment. A sprinkler system designed and installed according to this standard cannot, however, be expected to completely control a fire involving fuel loads that are significantly higher than average for dwelling units [10 lb/ft^2 (49 kg/m^2)] and where the interior finish has an unusually high flame spread index (greater than 225).

(For protection of multifamily dwellings, see NFPA 13 or NFPA 13R.)

A.1.2 Various levels of fire safety are available to dwelling occupants to provide life safety and property protection.

This standard recommends, but does not require, sprinklering of all areas in a dwelling; it permits sprinklers to be omitted in certain areas. These areas have been proved by NFPA statistics *[see Table A.1.2(a) and Table A.1.2(b)]* to be those where the incidence of life loss from fires in dwellings is low. Such an approach provides a reasonable degree of fire safety. Greater protection to both life and property is achieved by sprinklering all areas.

Guidance for the installation of smoke detectors and fire detection systems is found in *NFPA 72, National Fire Alarm Code.*

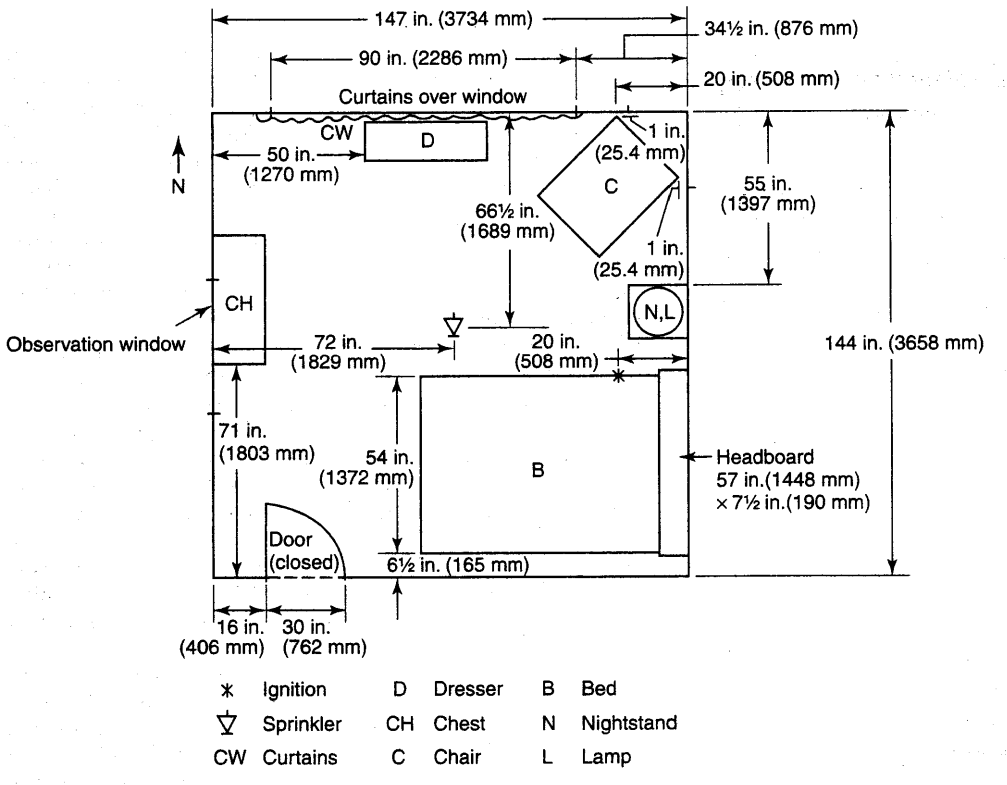


FIGURE A.1.1(a) Bedroom.

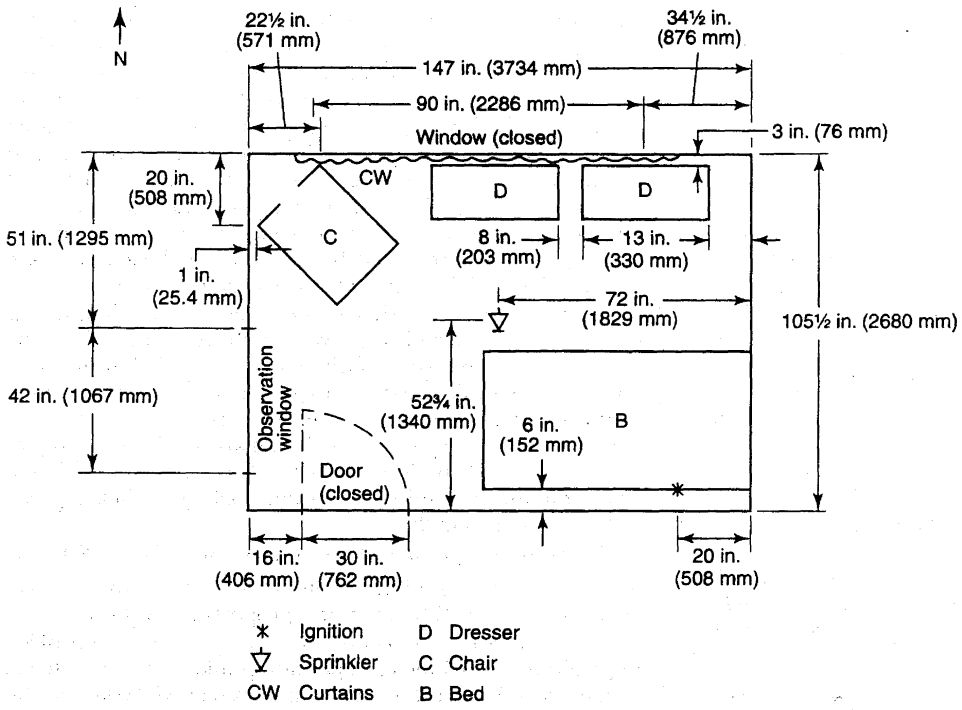


FIGURE A.1.1(b) Manufactured Home Bedroom.

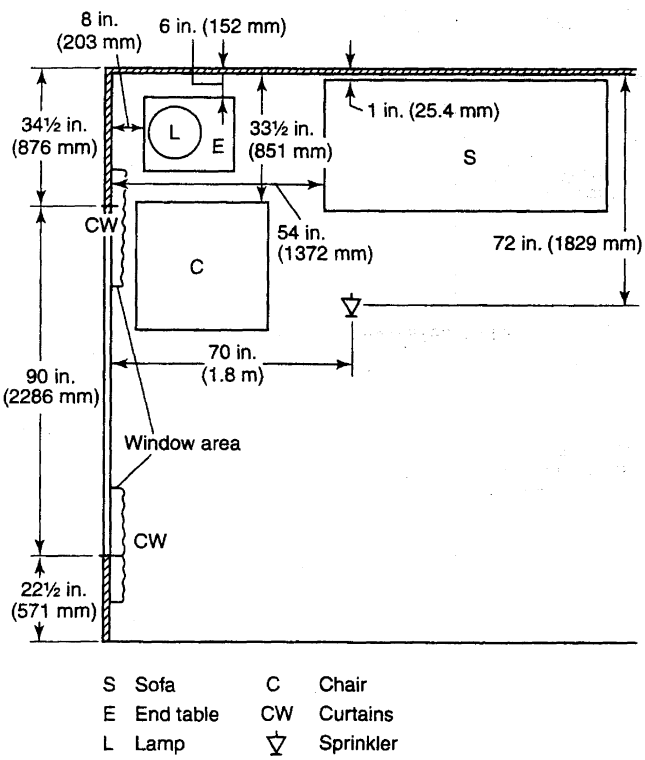


FIGURE A.1.1(c) Living Room.

A.1.5.1 For additional conversions and information, see IEEE/ASTM SI–10, *Standard for Use of the International System of Units (SI): The Modern Metric System.*

A.1.5.4 A given equivalent value is considered to be approximate.

A.3.2.1 Approved. The National Fire Protection Association does not approve, inspect, or certify any installations, procedures, equipment, or materials; nor does it approve or evaluate testing laboratories. In determining the acceptability of installations, procedures, equipment, or materials, the authority having jurisdiction may base acceptance on compliance with NFPA or other appropriate standards. In the absence of such standards, said authority may require evidence of proper installation, procedure, or use. The authority having jurisdiction may also refer to the listings or labeling practices of an organization that is concerned with product evaluations and is thus in a position to determine compliance with appropriate standards for the current production of listed items.

A.3.2.2 Authority Having Jurisdiction (AHJ). The phrase "authority having jurisdiction," or its acronym AHJ, is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

Table A.1.2(a) Causal Factors in One- and Two-Family Dwelling Fires That Caused One or More Deaths

Area of Origin	Percent Occurence[1]
Living room	41%
Bedroom	27%
Kitchen	15%
Storage area	4%
Heating equipment room	3%
Structural area	2%
Other areas	8%
Form of Materials Ignited	**Percent Occurence[2]**
Furniture	27%
Bedding	18%
Combustible liquid or gas	13%
Interior finish	9%
Structural member	9%
Waste, rubbish	4%
Clothing (on a person)	3%
Cooking materials	3%
Electrical insulation	2%
Curtains, draperies	2%
Other	10%
Form of Heat of Ignition	**Percent Occurence[3]**
Smoking materials	36%
Heat from fuel-fire or powered object	25%
Heat from miscellaneous open flame (including match)	15%
Heat from electrical equipment arcing or overload	14%
Hot objects, including properly operating electrical equipment	7%
Other	3%

Note: Total number of incidents reported: 10,194.

[1] Based on 6066 incidents where area of origin was reported.

[2] Based on 5080 incidents where form of material ignited was reported.

[3] Based on 5016 incidents where form of heat of ignition was reported.

(Source: FIDO Database 1973 to 1982, NFPA Fire Analysis Department.)

A.3.2.4 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A.3.3.5 Manufactured Home. Manufactured homes were formerly referred to as "mobile homes" or "trailer coaches."

A.3.3.9.3 Multipurpose Piping System. Examples of multipurpose piping systems are shown in Figure A.3.3.9.3(a), Figure A.3.3.9.3(b), and Figure A.3.3.9.3(c).

A.3.3.9.4 Network System. A network system is a type of multipurpose system that often uses ½ in. piping to serve both domestic and fire protection needs, providing an equivalent level of suppression capability as larger piping systems. To accomplish this protection, each sprinkler is supplied by water flowing to it from at least three separate paths. An example of a network system is shown in Figure A.3.3.9.4.

A.3.3.10.2 Control Valve. System control valves should be of the indicating type, such as plug valves, ball valves, butterfly valves, or OS&Y gate valves.

A.4.2.1 The responsibility for properly maintaining a sprinkler system is that of the owner or manager, who should understand the sprinkler system operation. A minimum monthly maintenance program should include the following:

(1) Visual inspection of all sprinklers to ensure against obstruction of spray.
(2) Inspection of all valves to ensure that they are open.
(3) Testing of all waterflow devices.
(4) Testing of the alarm system, where installed. Note that where it appears likely that the test will result in a fire department response, notification to the fire department should be made prior to the test.
(5) Operation of pumps, where employed. *(See NFPA 20, Standard for the Installation of Stationary Pumps for Fire Protection.)*
(6) Checking of the pressure of air used with dry systems.
(7) Checking of water level in tanks.
(8) Special attention to ensure that sprinklers are not painted either at the time of installation or during subsequent redecoration. When sprinkler piping or areas next to sprinklers are being painted, the sprinklers should be protected by covering them with a bag, which should be removed immediately after painting is finished.

(For further information, see NFPA 25, Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems.)

A.4.2.4 Tests should be made by drawing a sample of the solution from valve B, as shown in Figure 8.3.3.3.1.1, two or three times during the freezing season, especially if it has been necessary to drain the building sprinkler system for reasons such as repairs or changes. A small hydrometer should be used so that a small sample is sufficient. Where water appears at valve B or where the test sample indicates that the solution has become weakened, the entire system should be emptied and then recharged as previously described.

A.4.3 Testing of a system can be accomplished by filling the system with water and checking visually for leakage at each joint or coupling.

Fire department connections are not required for systems covered by this standard but can be installed at the discretion of the owner. In these cases, hydrostatic tests in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, are necessary.

Dry systems also should be tested by placing the system under air pressure. Any leak that results in a drop in system pressure greater than 2 psi (0.14 bar) in 24 hours should be corrected. Leaks should be identified using soapy water brushed on each joint or coupling. The presence of bubbles indicates a leak. This test should be made prior to concealing the piping.

A.4.8 A scaled drawing where required should show the following:

(1) Address (if known)
(2) Size and type of domestic line, including length to city connection
(3) Water meter size
(4) Current static water pressure
(5) Interior walls
(6) Model, manufacturer, temperature, orifice size, and spacing requirements of sprinklers
(7) Type of pipe
(8) Hanger spacing requirement per the pipe manufacturer

Table A.1.2(b) Fires and Associated Deaths and Injuries in Dwellings, Duplexes, and Manufactured Homes by Area of Origin: Annual Average of 1986–1990 Structure Fires Reported to U.S. Fire Departments

Area of Origin	Civilian Deaths	Civilian Percent	Fires	Percent	Injuries	Percent
Living room, family room, or den	1,330	37.1	42,600	10.5	2,546	18.6
Bedroom	919	25.6	50,200	12.4	3,250	23.7
Kitchen	541	15.1	92,670	22.9	3,987	29.1
Dining room	83	2.3	3,780	0.9	189	1.4
Heating equipment room or area	62	1.7	15,130	3.7	374	2.7
Hallway or corridor	48	1.3	3,690	0.9	155	1.1
Laundry room or area	47	1.3	15,370	3.8	363	2.7
Garage or carport*	45	1.2	14,580	3.6	524	3.8
Bathroom	44	1.2	8,040	2.0	271	2.0
Unclassified structural area	43	1.2	4,530	1.1	104	0.8
Crawl space or substructure space	41	1.2	11,200	2.8	317	2.3
Multiple areas	41	1.1	3,350	0.8	96	0.7
Ceiling/floor assembly or concealed space	32	0.9	3,470	0.9	64	0.5
Wall assembly or concealed space	27	0.8	7,090	1.8	93	0.7
Closet	23	0.6	5,020	1.2	186	1.4
Exterior balcony or open porch	22	0.6	5,570	1.4	121	0.9
Exterior wall surface	22	0.6	14,620	3.6	118	0.9
Unclassified area	21	0.6	2,590	0.6	87	0.6
Attic or ceiling/roof assembly or concealed space	21	0.6	10,740	2.7	98	0.7
Tool room or other supply storage room or area	20	0.5	4,160	1.0	133	1.0
Lobby or entrance way	17	0.5	1,410	0.3	44	0.3
Interior stairway	17	0.5	1,100	0.3	41	0.3
Chimney	17	0.5	60,530	14.9	75	0.5
Unclassified function area	17	0.5	1,090	0.3	43	0.3
Unclassified storage area	14	0.4	2,460	0.6	80	0.6
Area not applicable	11	0.3	1,180	0.3	22	0.2
Exterior stairway	8	0.2	1,090	0.3	25	0.2
Lawn or field	7	0.2	1,670	0.4	24	0.2
Trash room or area	5	0.1	1,140	0.3	14	0.1
Product storage area	5	0.1	780	0.2	23	0.2
Unclassified means of egress	5	0.1	610	0.2	15	0.1
Unclassified service or equipment area	4	0.1	380	0.1	12	0.1
Library	3	0.1	180	0.0	11	0.0
Other known area	26	0.7	12,880	3.2	195	1.4
Total	3,589	100.0	404,900	100.0	13,691	100.0

Note: Fires are estimated to the nearest 10; civilian deaths and injuries are estimated to the nearest 1.
* Does not include dwelling garages coded as a separate property, which averaged 19 deaths, 259 injuries, and 21,170 fires per year.
(Source: 1986–1990 NFIRS and NFPA survey.)

(9) Riser detail
(10) Installing contractor information
(11) Preliminary hydraulic calculations

A.5.1.1 Where fused sprinklers are replaced by the owner, fire department, or others, care should be taken to ensure that the replacement sprinkler has the same operating characteristics.

A.5.2.1 This standard anticipates the water supply for the system to be in compliance with the governing plumbing code for the jurisdiction. It is intended that any pipe material or diameter permitted by a plumbing code for one- or two-family dwellings and satisfying the hydraulic criteria of NFPA 13D is considered to be in compliance.

A.5.2.2.2 Not all pipe or tube made to ASTM D 3309, *Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems*, and ASTM F 442, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, as described in 5.2.2.2 is listed for fire sprinkler service. Listed pipe is identified by the logo of the listing agency.

A.5.2.4 Compatible thread sealant or Teflon tape can be used in a CPVC sprinkler head adapter. The combination of the two cannot be used together. The manufacturer of the sprinkler head adapter installation instructions must be followed for each sprinkler head adapter used.

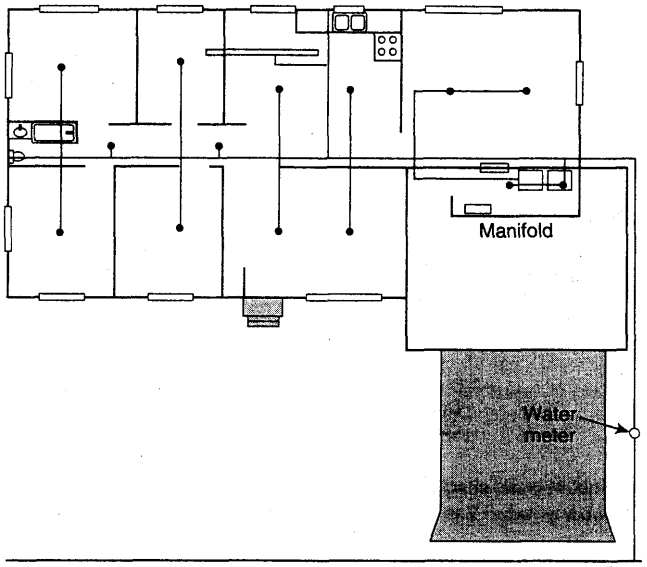


FIGURE A.3.3.9.3(a) Multipurpose Piping System — Example 1.

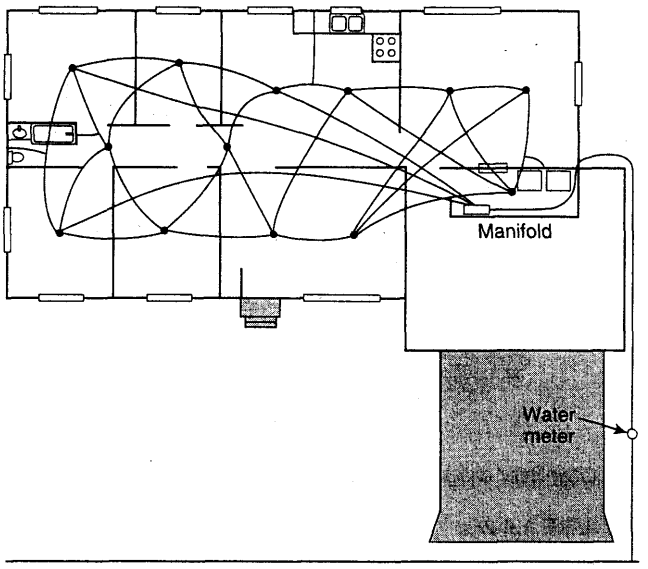


FIGURE A.3.3.9.3(c) Multipurpose Piping System — Example 3 (Network System).

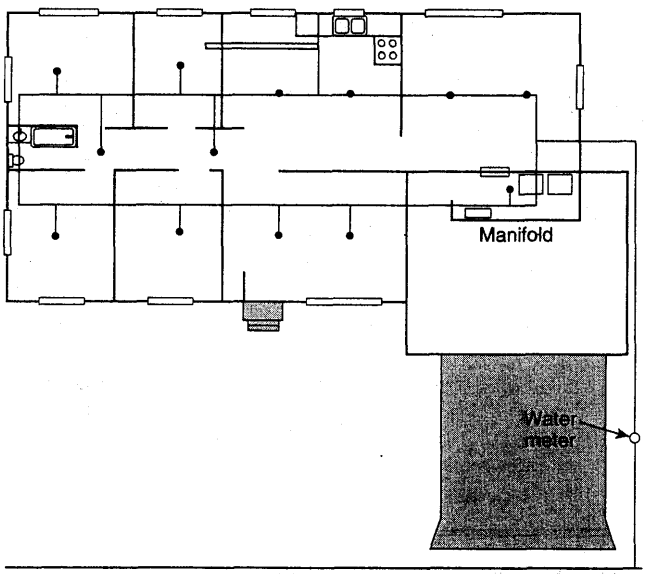


FIGURE A.3.3.9.3(b) Multipurpose Piping System — Example 2.

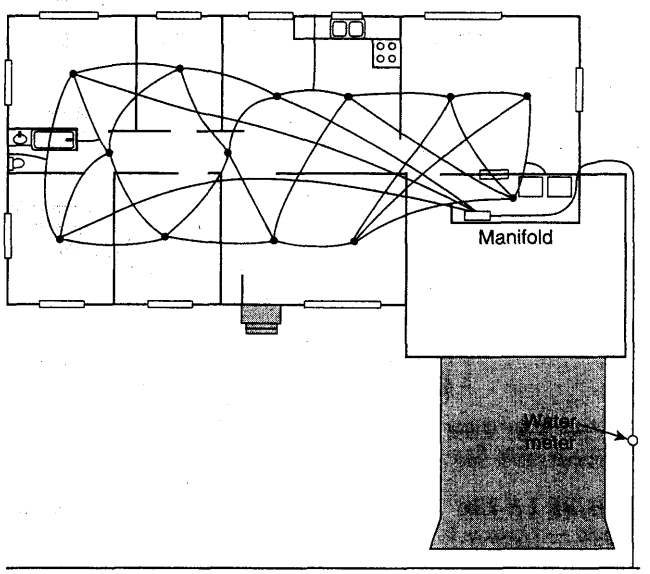
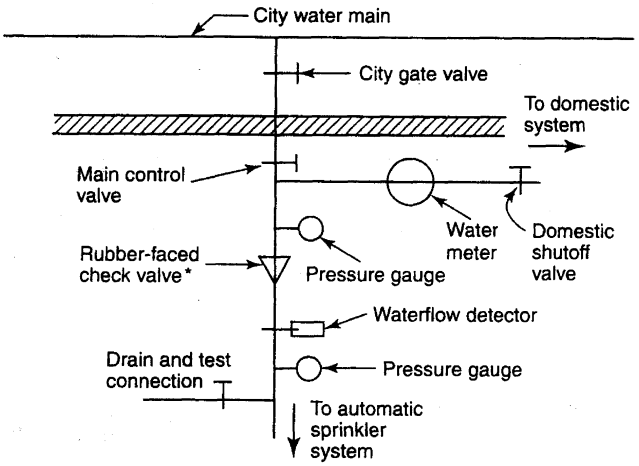


FIGURE A.3.3.9.4 Network System.

A.5.2.9.2 Not all fittings made to ASTM F 437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*; ASTM F 438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*; and ASTM F 439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, as described in 5.2.9.2 are listed for fire sprinkler service. Listed fittings are identified by the logo of the listing agency.

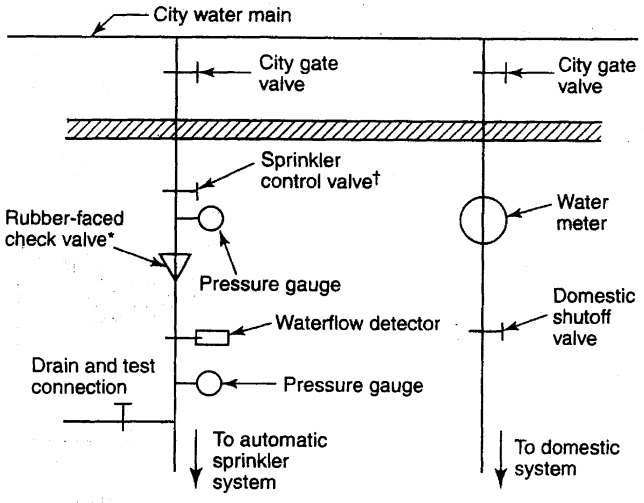
A.6.2 The connection to city mains for fire protection is often subject to local regulation of metering and backflow prevention requirements. Preferred and acceptable water supply arrangements are shown in Figure A.6.2(a), Figure A.6.2(b), and Figure A.6.2(c). Where it is necessary to use a meter between the city water main and the sprinkler system supply, an acceptable arrangement as shown in Figure A.6.2(c) can be used. Under these circumstances, the flow characteristics of the meter are to be included in the hydraulic calculation of the system [*see Table 8.4.4(g)*]. Where a tank is used for both domestic and fire protection purposes, a low water alarm that actuates when the water level falls below 110 percent of the minimum quantity specified in 6.1.2 should be provided.

The effect of pressure-reducing valves on the system should be considered in the hydraulic calculation procedures.



* Rubber-faced check valves are optional.

FIGURE A.6.2(a) Preferable Arrangement.

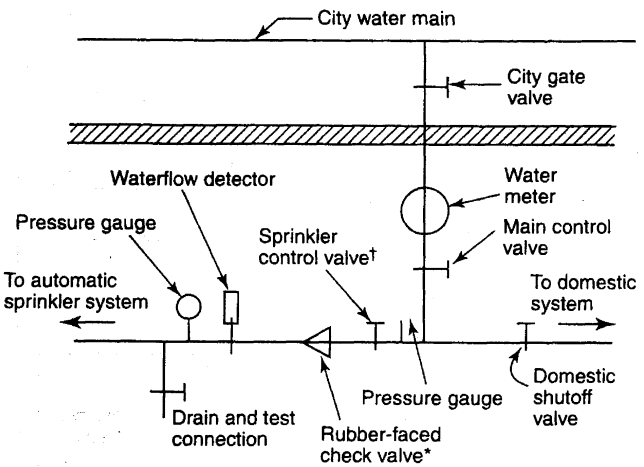


* Rubber-faced check valves are optional.
† Optional valve: See 7.1.2.

FIGURE A.6.2(b) Acceptable Arrangement with Valve Supervision — Option 1.

A.6.2.1 The flow of water is necessary to make sure that the pump does not get damaged during testing. Use of a timer to keep the pump running is not recommended because the timer will allow the pump to run when no water is flowing. The pump needs to run for the entire duration without interruption, including not tripping the circuit breaker.

A.6.3 Multipurpose piping systems consist of a single piping system within a residential occupancy that is intended to serve both domestic and fire protection needs. Basic forms of this system are shown in Figure A.6.3(a), Figure A.6.3(b), Figure A.6.3(c), and Figure A.6.3(d). A network system, as defined in 3.3.9.4, is a type of multipurpose system that utilizes a common piping system supplying domestic fixtures and fire sprinklers where each sprinkler is supplied by a minimum of three separate paths. In dwellings where long-term use of lawn sprinklers is common, provision should be made for such usage.



* Rubber-faced check valves are optional.
† Optional valve: See 7.1.2.

FIGURE A.6.2(c) Acceptable Arrangement with Valve Supervision — Option 2.

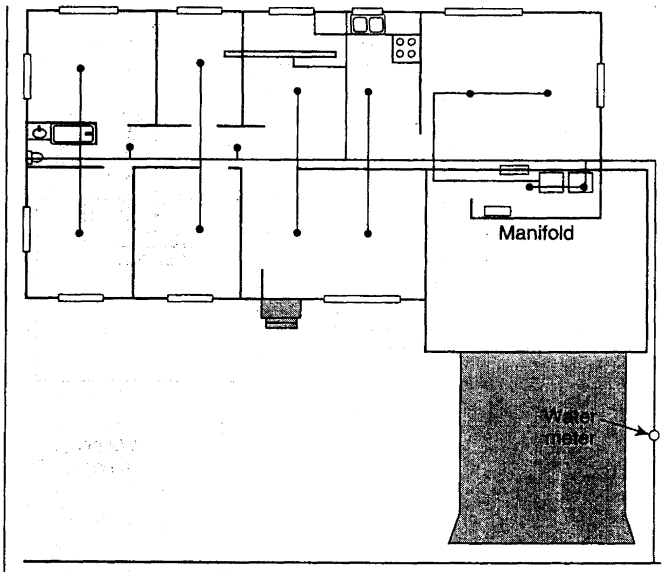


FIGURE A.6.3(a) Multipurpose Piping System — Example 1.

A.7.2.4 These connections should be installed so that the valve can be opened fully and for a sufficient time period to ensure a proper test without causing water damage. The test connection should be designed and sized to verify the sufficiency of the water supply and alarm mechanisms.

A.7.4.4 The reaction forces caused by the flow of water through the sprinkler could result in displacement of the sprinkler, thereby adversely affecting sprinkler discharge.

A.7.5.6 Decorative painting of a residential sprinkler is not to be confused with the temperature identification colors as specified in 6.2.5 of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

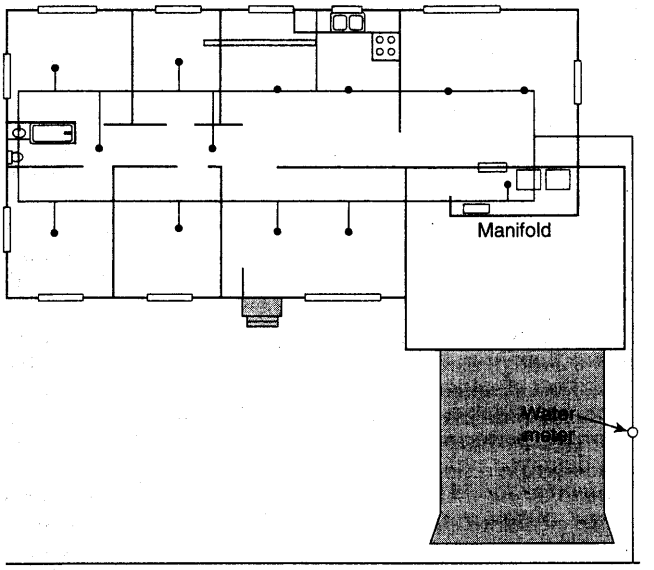


FIGURE A.6.3(b) Multipurpose Piping System — Example 2.

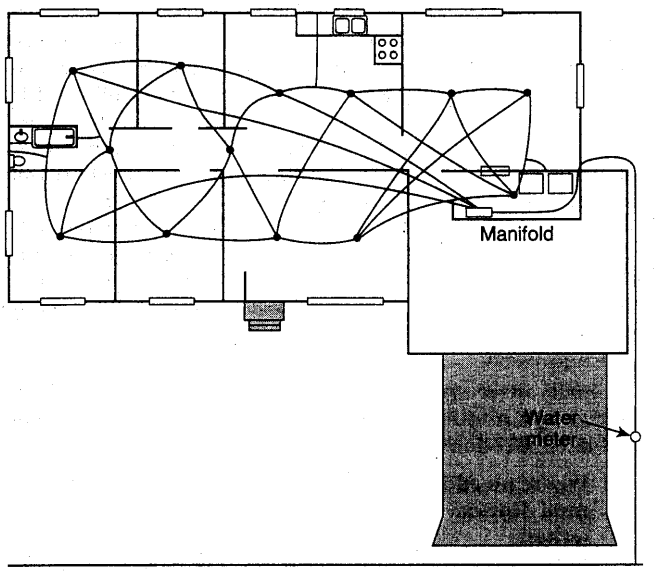


FIGURE A.6.3(c) Multipurpose Piping System — Example 3 (Network System).

A.7.6 Alarms should be of sufficient intensity to be clearly audible in all bedrooms over background noise levels while all intervening doors are closed. The tests of audibility level should be conducted with all household equipment that operates at night in full operation. Examples of such equipment are window air conditioners and room humidifiers. Where off-premises alarms are provided, the waterflow and the control valve position, as a minimum, should be monitored.

An exterior alarm can be of benefit in areas where a neighbor could alert the fire department or to enhance the ability for an assisted rescue by a passerby.

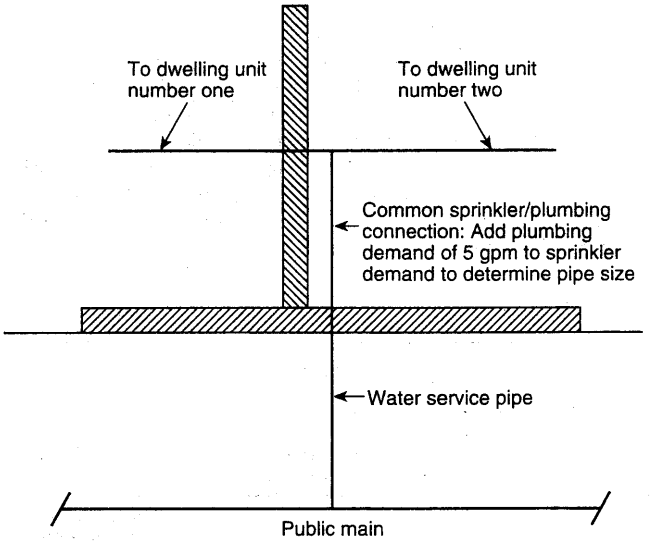


FIGURE A.6.3(d) Common Water Supply Connection Serving More Than One Dwelling Unit.

A waterflow test is normally conducted using the system drain. Figure A.6.2(a), Figure A.6.2(b), and Figure A.6.2(c) show examples of this arrangement.

A.8.1.1.2 The minimum pressure and flow requirements need to be satisfied while also meeting the requirements of the formula $q = K(p)^{0.5}$. If a sprinkler with a K-factor of 4.3 is listed to cover an area of 18 ft × 18 ft (5.5 m × 5.5 m) at 16.2 gpm (61.3 L/min), the minimum pressure is required to be 14.2 psi (0.98 bar) so that the flow is achieved. Likewise, if a sprinkler with a K-factor of 5.6 is covering an area 12 ft × 12 ft (3.66 m × 3.66 m), the minimum flow is required to be 14.8 gpm (56 L/min) [the flow at 7 psi (0.48 bar)] even though a flow of 7.2 gpm (27.3 L/min) will satisfy the density criteria.

A.8.1.1.2.2 Sprinklers need to be used in accordance with their listed areas and density. *(See Figure A.8.1.1.2.2).*

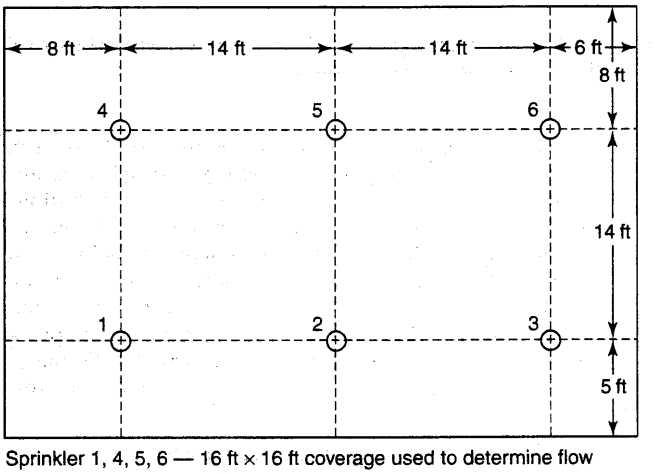


FIGURE A.8.1.1.2.2 Determining Required Flow.

A.8.1.2 All residential sprinklers have been investigated and are currently listed for use under flat, smooth, horizontal ceilings. Some residential sprinklers have been investigated and listed for use under specific smooth sloped or horizontal beamed ceilings. Where ceilings have configurations outside the scope of current listings, special sprinkler system design features such as larger flows, a design of three or more sprinklers to operate in a compartment, or both may be required. Figure A.8.1.2(a) and Figure A.8.1.2(b) show examples of design configurations.

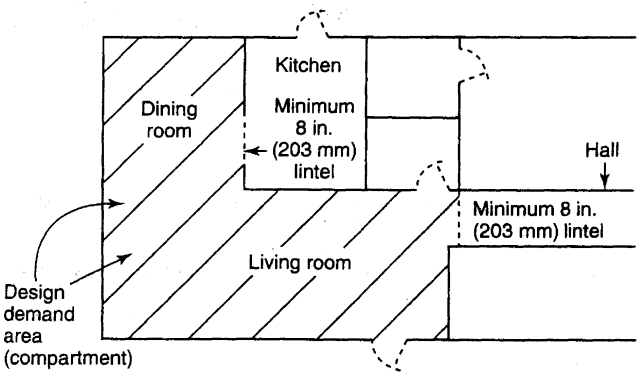


FIGURE A.8.1.2(a) Sprinkler Design Areas for Typical Residential Occupancy — Without Lintel.

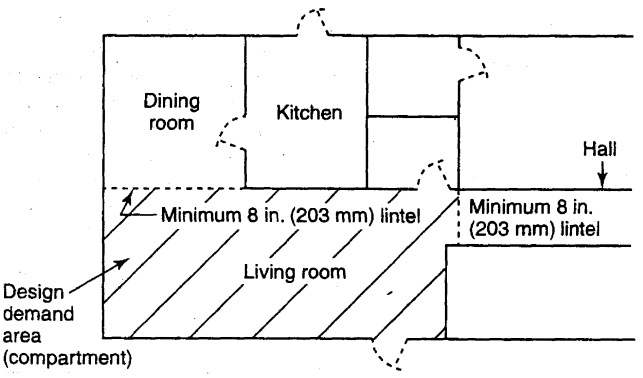


FIGURE A.8.1.2(b) Sprinkler Design Areas for Typical Residential Occupancy — With Lintel.

A.8.1.3.1.2 There are construction features such as large horizontal beamed ceilings, sloped ceilings having beams, and steeply sloped ceilings that are outside of the current listings. In these situations, sprinklers can be installed in a manner acceptable to the authority having jurisdiction to achieve the results specified in this standard. In making these determinations, consideration should be given to factors influencing sprinkler system performance, such as sprinkler response characteristics, impact of obstructions on sprinkler discharge, and number of sprinklers anticipated to operate in the event of a fire.

A.8.2.5 The objective is to position sprinklers so that the response time and discharge are not unduly affected by obstructions such as ceiling slope, beams, light fixtures, or ceiling fans. The rules in this section, while different from the obstruction rules of NFPA 13, *Standard for the Installation of Sprinkler Systems*, provide a reasonable level of life safety while maintaining the philosophy of keeping NFPA 13D relatively simple to apply and enforce.

Fire testing has indicated the need to wet walls in the area protected by residential sprinklers at a level closer to the ceiling than that accomplished by standard sprinkler distribution. Where beams, light fixtures, sloped ceilings, and other obstructions occur, additional residential sprinklers are necessary to achieve proper response and distribution. In addition, for sloped ceilings, higher flow rates could be needed. Guidance should be obtained from the manufacturer.

A series of 33 full-scale tests were conducted in a test room with a floor area of 12 ft × 24 ft (3.6 m × 7.2 m) to determine the effect of cathedral (sloped) and beamed ceiling construction, and combinations of both, on fast-response residential sprinkler performance. The testing was performed using one pendent-type residential sprinkler model, two ceiling slopes (0 degrees and 14 degrees), and two beam configurations on a single enclosure size. In order to judge the effectiveness of sprinklers in controlling fires, two baseline tests, in which the ceiling was smooth and horizontal, were conducted with the pendent sprinklers installed and with a total water supply of 26 gpm (98 L/min) as required by this standard. The results of the baseline tests were compared with tests in which the ceiling was beamed or sloped, or both, and two pendent sprinklers were installed with the same water supply. Under the limited conditions used for testing, the comparison indicates that sloped or beamed ceilings, or a combination of both, represent a serious challenge to the fire protection afforded by fast-response residential sprinklers. However, further tests with beamed ceilings indicated that fire control equivalent to that obtained in the baseline tests can be obtained where one sprinkler is centered in each bay formed by the beams and a total water supply of 36 gpm (136 L/min) is available. Fire control equivalent to that obtained in the baseline tests was obtained for the smooth, sloped ceiling tests where three sprinklers were installed with a total water supply of 54 gpm (200 L/min). In a single smoldering-started fire test, the fire was suppressed.

Small areas created by architectural features such as planter box windows, bay windows, and similar features can be evaluated as follows:

(1) Where no additional floor area is created by the architectural feature, no additional sprinkler protection is required.
(2) Where additional floor area is created by an architectural feature, no additional sprinkler protection is required, provided all of the following conditions are met:
   (a) The floor area does not exceed 18 ft^2 (1.7 m^2).
   (b) The floor area is not greater than 2 ft (0.65 m) in depth at the deepest point of the architectural feature to the plane of the primary wall where measured along the finished floor.
   (c) The floor area is not greater than 9 ft (2.9 m) in length where measured along the plane of the primary wall.

Measurement from the deepest point of the architectural feature to the sprinkler should not exceed the maximum listed spacing of the sprinkler. The hydraulic design is not required to consider the area created by the architectural feature.

Where the obstruction criteria established by this standard are followed, sprinkler spray patterns will not necessarily get

water to every square foot of space within a room. As such, a sprinkler in a room with acceptable obstructions as outlined in this standard may not be capable of passing the fire test (specified by UL 1626, *Residential Sprinklers for Fire-Protection Service*, and other similar laboratory standards) if the fire is started in one of these dry areas. This is not to be interpreted as a failure of the sprinkler. The laboratory fire tests are sufficiently challenging to the sprinkler without additional obstructions as a safety factor to account for the variables that actually occur in dwellings, including acceptable obstructions to spray patterns.

The rules on 8.2.5.2 and 8.2.5.3 were developed from a testing series conducted by the National Fire Sprinkler Association and The Viking Corporation that included fire modeling, sprinkler response tests, sprinkler distribution tests, and full-scale fire tests (Valentine and Isman, Interaction of Residential Sprinklers, Ceiling Fans and Similar Obstructions, National Fire Sprinkler Association, November 2005). This test series, along with additional industry experience, shows that there is a difference between obstructions that are tight to the ceiling and obstructions that hang down from the ceiling, allowing spray over the top. Residential sprinklers require high wall wetting, which means that they tend to spray over obstructions that hang down from the ceiling. The test series showed that the fan blades were not significant obstructions and that as long as the sprinkler was far enough from the fan motor housing (measured from the center of the housing), the sprinkler could control a fire on the other side of the fan in a small room. In larger rooms, the sprinkler will need to be augmented by additional sprinklers on the other side of the fan. The test series showed that the fan on low or medium speed did not make a significant difference in sprinkler performance. On high speed (pushing air down), the fan did impact sprinkler performance, but fire control was still achieved in small rooms. In larger rooms, it is expected that additional sprinklers would be installed. The test series also showed that the fan blowing down was more significant than the fan pulling air up.

The rules in 8.2.5.6 were developed from years of experience with NFPA 13 obstruction rules and an additional test series conducted by the National Fire Sprinkler Association with the help of Tyco International (Valentine and Isman, Kitchen Cabinets and Residential Sprinklers, National Fire Sprinkler Association, November 2005), which included fire modeling, distribution tests, and full-scale fire tests. The test series showed that pendent sprinklers definitely provide protection for kitchens, even for fires that start under the cabinets. The information in the series was less than definitive for sidewall sprinklers, but distribution data show that sprinklers in the positions in this standard provide adequate water distribution in front of the cabinets and that sidewall sprinklers should be able to control a fire that starts under the cabinets. When protecting kitchens or similar rooms with cabinets, the pendent sprinkler should be the first option. If pendent sprinklers cannot be installed, the next best option is a sidewall sprinkler on the opposite wall from the cabinets, spraying in the direction of the cabinets. The third best option is the sidewall sprinkler on the same wall as the cabinets on a soffit flush with the face of the cabinet. The last option should be putting sprinklers on the wall back behind the face of the cabinet because this location is subject to being blocked by items placed on top of the cabinets. It is not the intent of the committee to require sprinklers to be installed under kitchen cabinets.

A.8.3.1 In areas subject to freezing, care should be taken in unheated attic spaces to cover sprinkler piping completely with insulation. Installation should follow the guidelines of the insulation manufacturer. Figure A.8.3.1(a) through Figure A.8.3.1(e) show several methods that can be considered.

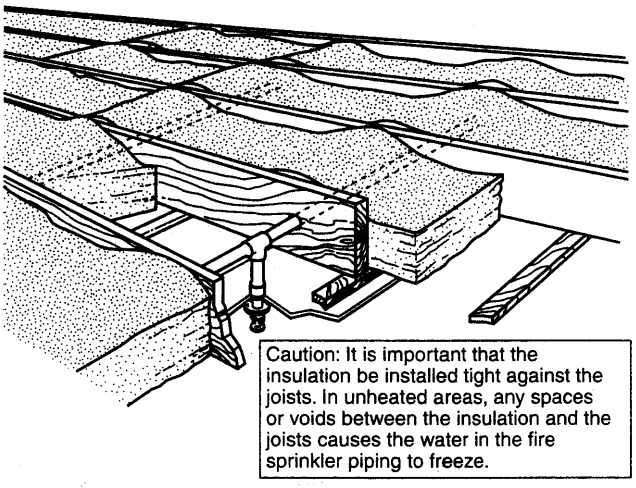


FIGURE A.8.3.1(a) Insulation Recommendations — Arrangement 1.

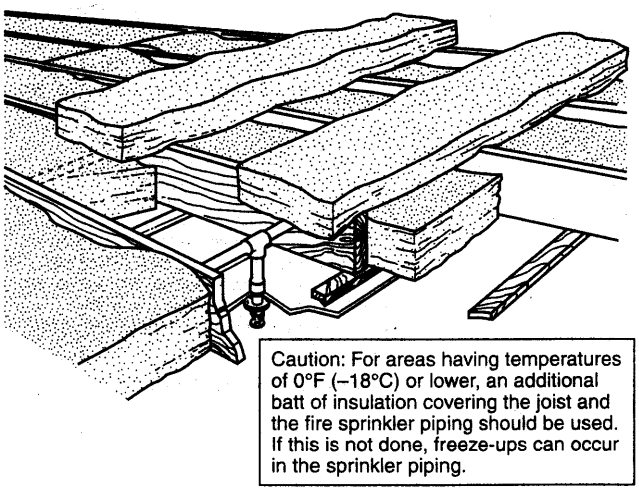


FIGURE A.8.3.1(b) Insulation Recommendations — Arrangement 2.

A.8.3.3.1 Antifreeze solutions can be used for maintaining automatic sprinkler protection in small, unheated areas. Antifreeze solutions are recommended only for systems not exceeding 40 gal (151 L).

Because of the cost of refilling the system or replenishing small leaks, small, dry valves should be used where more than 40 gal (151 L) are to be supplied.

Propylene glycol or other suitable material can be used as a substitute for priming water to prevent evaporation of the priming fluid and thus reduce ice formation within the system.

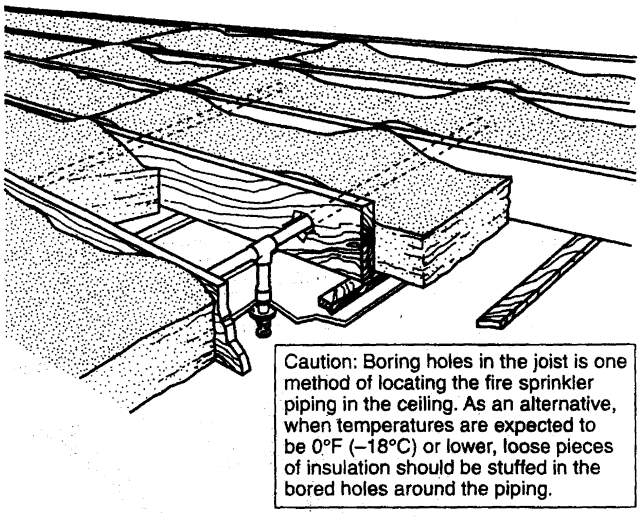


FIGURE A.8.3.1(c) Insulation Recommendations — Arrangement 3.

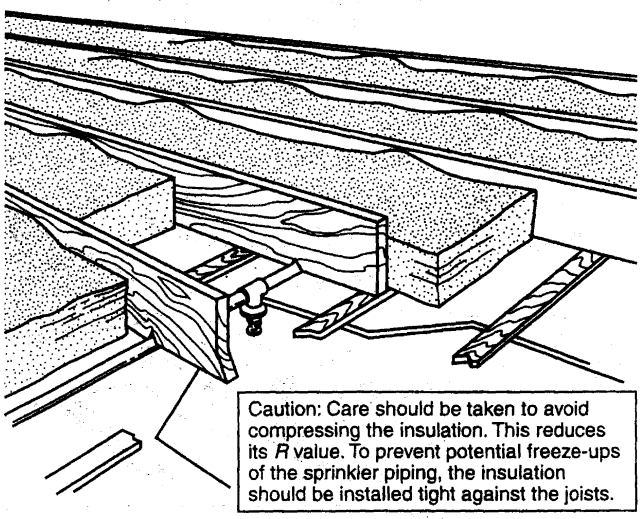


FIGURE A.8.3.1(d) Insulation Recommendations — Arrangement 4.

A.8.3.3.2 Listed CPVC sprinkler pipe and fittings should be protected from freezing with glycerine only. The use of diethylene glycol, ethylene glycol, or propylene glycol is specifically prohibited. Laboratory testing shows that glycol-based antifreeze solutions present a chemical environment detrimental to CPVC. Listed PB sprinkler pipe and fittings can be protected with glycerine, diethylene glycol, ethylene glycol, or propylene glycol.

A.8.3.3.2.6 Beyond certain limits, an increased proportion of antifreeze does not lower the freezing point of the solution (*see Figure A.8.3.3.2.6*). Glycerine, diethylene glycol, ethylene glycol, and propylene glycol never should be used without mixing with water in the proper proportions, because these materials tend to thicken near 32°F (0°C).

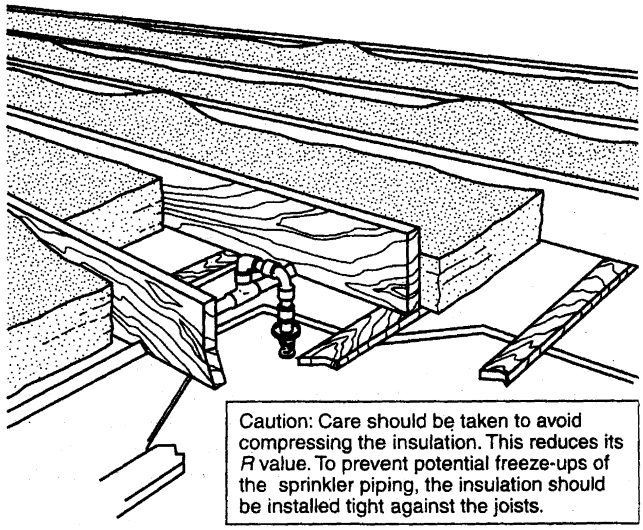


FIGURE A.8.3.1(e) Insulation Recommendations — Arrangement 5.

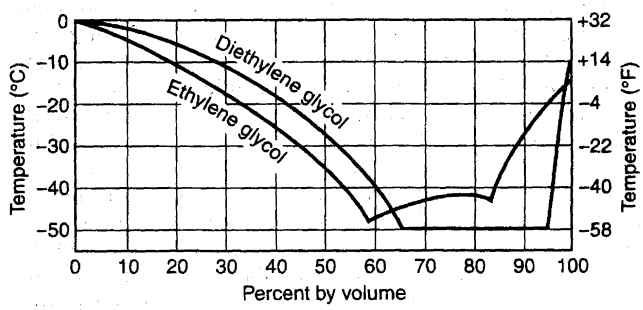


FIGURE A.8.3.3.2.6 Freezing Points of Water Solutions of Ethylene Glycol and Diethylene Glycol.

A.8.3.3.3 All permitted antifreeze solutions are heavier than water. At the point of contact (interface), provisions are required by 8.3.3.3 to prevent the diffusion of water into unheated areas.

To avoid leakage, the quality of materials and workmanship should be superior, the threads should be clean and sharp, and the joints should be tight. Only metal-faced valves should be used.

A.8.3.3.3.2 One formula for sizing the chamber is as follows. Other methods also exist.

$$\Delta L = S_V \left(\frac{D_L}{D_H} - 1 \right)$$

where:

ΔL = change in antifreeze solution volume (gal) due to thermal expansion
S_V = volume (gal) of antifreeze system, not including the expansion chamber
D_L = density (gm/ml) of antifreeze solution at lowest expected temperature
D_H = density (gm/ml) of antifreeze solution at highest expected temperature

This method is based on the following information:

$$\frac{P_0 \cdot V_0}{T_0} = \frac{P_1 \cdot V_1}{T_1} = \frac{P_2 \cdot V_2}{T_2}$$

where:

V_{EC} = minimum required volume (gal) of expansion chamber
V_0 = air volume (gal) in expansion chamber at precharge (before installation)
V_1 = air volume (gal) in expansion chamber at normal static pressure
V_2 = air volume (gal) in expansion chamber at post-expansion pressure (antifreeze at high temperature)
P_0 = absolute precharge pressure (psia) on expansion chamber before installation
P_1 = absolute static pressure (psi) on water (supply) side of backflow preventer
P_2 = absolute maximum allowable working pressure (psi) for antifreeze system
T_0 = temperature (°R) of air in expansion chamber at precharge
T_1 = temperature (°R) of air in expansion chamber when antifreeze system piping is at lowest expected temperature
T_2 = temperature (°R) of air in expansion chamber when antifreeze system piping is at highest expected temperature

This equation is one formulation of the ideal gas law from basic chemistry. The amount of air in the expansion chamber will not change over time. The pressure, temperature, and volume of the air at different times will be related in accordance with this formula:

$$V_2 = V_1 - \Delta L$$

The antifreeze in the system is essentially incompressible, so the air volume in the expansion chamber will decrease by an amount equal to the expansion of the antifreeze.

It is assumed that there is no trapped air in the system piping, so the only air in the system is in the expansion chamber. This is a conservative assumption, since more air is better. In reality, there will be at least some trapped air. However, only the air in the expansion chamber can be relied upon to be available when needed:

$$V_{EC} = V_0$$

At precharge, the chamber will be completely full of air:

$$V_{EC} = \frac{P_1 \cdot T_0 \cdot P_2 \cdot \Delta L \cdot T_1}{P_0 \cdot T_1 (P_2 \cdot T_1 - P_1 \cdot T_2)}$$

In cases where the normal static pressure on the sprinkler system is close to the maximum working pressure, antifreeze systems are not advisable if the connection to the wet pipe system will incorporate a backflow device. In these cases, expansion of the antifreeze solution during warm weather will cause the antifreeze system to exceed the maximum working pressure, regardless of the size of the expansion chamber. The normal static pressure is too close to the maximum working pressure if the preceding formula for V_{EC} yields a negative result. If this occurs, use a dry pipe system instead or install a pressure reducing valve before the backflow preventer.

A.8.3.4.5 With regard to preaction systems, it is assumed that the release system will activate before the sprinklers. It is generally accepted that smoke detectors and rate-of-rise detectors are more sensitive than sprinklers and that fixed-temperature-release devices with RTIs lower than that of sprinklers will react faster than sprinklers at similar spacings and locations.

A.8.4.3.3 Any special listing of products covered in 8.4.3.3 should include certification by the manufacturer of personnel involved in the layout, calculation, and installation of their product.

A.8.4.3.3(1) Where a four-port fitting is used, and one of the ports is not being used to satisfy this requirement or to feed a domestic fixture, the extra port should be connected to another open port at a sprinkler or should be connected to the water supply pipe (manifold). *[See Figure A.8.4.3.3(1).]*

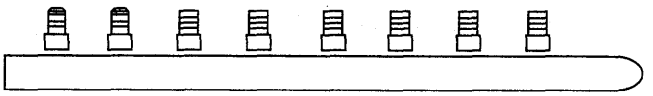


FIGURE A.8.4.3.3(1) Water Supply Manifold.

A.8.4.4 The determination of public water supply pressure should take into account the probable minimum pressure conditions prevailing during such periods as during the night or during the summer months when heavy usage can occur; the possibility of interruption by floods or ice conditions in winter also should be considered. *[See Figure A.8.4.4(a) and Figure A.8.4.4(b).]*

A.8.6.4 Although NFPA 13D does not require garages to be sprinklered, some authorities having jurisdiction take it upon themselves to add this requirement locally. In such circumstances, residential or quick-response sprinklers with a two-sprinkler design in the garage with the same piping used in the rest of the dwelling may be used. It is recognized that residential sprinklers have not been tested specifically for fires in garages, but field experience has shown that the sprinklers help to alert occupants to the fact that there is a fire, can reduce the possibility of flashover, and can improve the chances for occupants to escape.

	Individual Loss	Net Total
Water pressure at supply outlet		
(1) Deduct head loss for elevation	_____	_____
(_____ ft × 0.434)	_____	_____
(2) Deduct pressure loss from piping within building*	_____	_____
Remaining pressure for sprinkler operation	_____	_____

For SI units, 1 ft = 0.3048 m; 1 psi = 0.0689 bar.

* Factors from Table 8.4.4(a) through 8.4.4(g).

FIGURE A.8.4.4(b) Calculation Sheet — Elevated Tank, Booster Pump, Pump Tank Supply.

	Individual Loss	Net Total
(1) Water pressure in street _____	_____	_____
(2) Arbitrarily select pipe size _____		
(3) Deduct meter loss (size) _____	_____	_____
(4) Deduct head loss for elevation		
(_____ ft × 0.434) _____		
(5) Deduct pressure loss from city main to sprinkler system		
control valve* _____		
___ Pipe _____ ft	_____	_____
___ Valves _____ ft	_____	_____
___ Elbows _____ ft	_____	_____
___ Tee _____ ft	_____	_____
___ Total _____ ft × _____	_____	_____
(6) Deduct pressure loss for piping-control valve to farthest sprinkler*		

Size	Quantity	Description	Total Equivalent (ft)
_____	_____	90 degree elbow	_____
_____	_____	45 degree elbow	_____
_____	_____	Tee	_____
_____	_____	Check valve	_____
_____	_____	Valve (_____)	_____
_____	_____	Total	___ ft × ___ = ___

Size	Quantity	Description	Total Equivalent (ft)
_____	_____	90 degree elbow	_____
_____	_____	45 degree elbow	_____
_____	_____	Tee	_____
_____	_____	Check valve	_____
_____	_____	Valve (_____)	_____
_____	_____	Total	___ ft × ___ = ___

Remaining pressure for sprinkler operation _____

For SI units, 1 ft = 0.3048 m; 1 psi = 0.0689 bar.

* Factors from Table 8.4.4(a) through Table 8.4.4(e).

FIGURE A.8.4.4(a) Calculation Sheet.

Annex B Informational References

B.1 Referenced Publications. The documents or portions thereof listed in this annex are referenced within the informational sections of this standard and are not part of the requirements of this document unless also listed in Chapter 2 for other reasons.

B.1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, Quincy, MA 02169-7471.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 2007 edition.

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height*, 2007 edition.

NFPA 20, *Standard for the Installation of Stationary Pumps for Fire Protection*, 2007 edition.

NFPA 25, *Standard for the Inspection, Testing, and Maintenance of Water-Based Fire Protection Systems*, 2002 edition.

NFPA 72®, National Fire Alarm Code®, 2007 edition.

B.1.2 Other Publications.

B.1.2.1 ASTM Publications. ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA 19428-2959.

ASTM D 3309, *Standard Specification for Polybutylene (PB) Plastic Hot- and Cold-Water Distribution Systems*, 1996.

ASTM F 437, *Standard Specification for Threaded Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 1996.

ASTM F 438, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 40*, 1997.

ASTM F 439, *Standard Specification for Socket-Type Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe Fittings, Schedule 80*, 1997.

ASTM F 442, *Standard Specification for Chlorinated Poly (Vinyl Chloride) (CPVC) Plastic Pipe (SDR-PR)*, 1997.

IEEE/ASTM SI–10, *Standard for Use of the International System of Units (SI): The Modern Metric System*, 1997.

B.1.2.2 NFSA Publications. National Fire Sprinkler Association, P.O. Box 1000, Patterson, NY 12563.

Kitchen Cabinets and Residential Sprinklers, by Valentine and Isman, November 2005.

Interaction of Residential Sprinklers, Ceiling Fans and Similar Obstructions, by Valentine and Isman, November 2005.

B.1.2.3 UL Publications. Underwriters Laboratories Inc., 333 Pfingsten Road, Northbrook, IL 60062-2096.

UL 1626, *Residential Sprinklers for Fire-Protection Service*, 1994.

B.2 Informational References. (Reserved)

B.3 References for Extracts in Informational Sections. (Reserved)

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