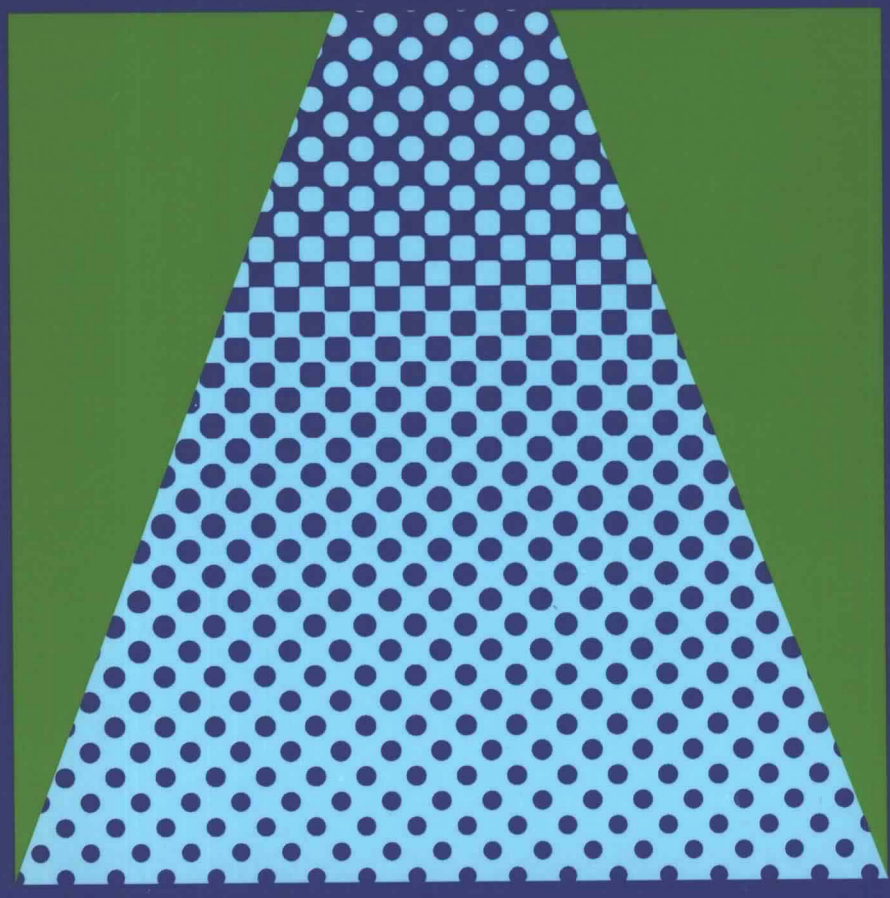
Installation of Sprinkler Systems

One- and Two-Family Dwellings and Manufactured Homes



NFPA 13D
1999 Edition

National Fire Protection Association
An International Codes and Standards Organization

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NFPA 13D

Standard for the

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

1999 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, released by the Technical Correlating Committee on Automatic Sprinkler Systems, and acted on by the National Fire Protection Association, Inc., at its May Meeting held May 17–20, 1999, in Baltimore, MD. It was issued by the Standards Council on July 22, 1999, with an effective date of August 13, 1999, and supersedes all previous editions.

Changes other than editorial are indicated by a vertical rule in the margin of the pages on which they appear. These lines are included as an aid to the user in identifying changes from the previous edition.

This edition of NFPA 13D was approved as an American National Standard on August 13, 1999.

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, IL, 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 $^1/_2$-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 revises criteria for certain types of multipurpose piping systems and adds requirements to mitigate the effect of water softeners and filters on system performance. Information on the application of solvent cement for nonmetallic piping systems has been provided and the exception for omitting sprinkler coverage in attics and crawl spaces has been modified.

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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: The 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 fire pumps, nor the construction and installation of gravity and pressure 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: The 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

NFPA 13D

Standard for the

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

1999 Edition

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

Information on referenced publications can be found in Chapter 6 and Appendix B.

Chapter 1 General Information

1-1* Scope. This standard covers 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 is 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 is 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.

Guidelines have been established for the design and installation of sprinkler systems for one- and two-family dwellings and manufactured homes. 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.

1-3 Definitions.

Approved.* Acceptable to the authority having jurisdiction.

Authority Having Jurisdiction.* The organization, office, or individual responsible for approving equipment, materials, an installation, or a procedure.

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

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

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

Dry System. A system employing automatic sprinklers attached to a piping system containing air under atmospheric or higher pressures. Loss of pressure from the opening of a sprinkler or detection of a fire condition causes the release of water into the piping system and out the opened sprinkler.

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.

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.

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.

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.

Manufactured Home.* A structure, transportable in one or more sections, that in the traveling mode is 8 body ft (2.4 m) or more in width and 40 body ft (12 m) or more in length or, where erected on-site, is 320 ft^2 (28 m^2) or more, and that is built on a permanent chassis and designed to be used as a dwelling with or without a permanent foundation where connected to the required utilities, and includes the plumbing, heating, air conditioning, and electrical systems contained therein.

Multipurpose Piping System. A piping system within dwellings and manufactured homes intended to serve both domestic and fire protection needs.

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

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

Residential Sprinkler. A type of sprinkler that meets the definition of fast response as defined by NFPA 13, *Standard for the Installation of Sprinkler Systems*, and 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.

Shall. Indicates a mandatory requirement.

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

Sprinkler, Automatic. 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.

Sprinkler System. An integrated system of piping, connected to a water supply, with listed sprinklers that automatically initiate water discharge over a fire area. Where required, the sprinkler system also includes a control valve and a device for actuating an alarm when the system operates.

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, footnote, or fine-print note and are not to be considered a part of the requirements of a standard.

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

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

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

Waterflow Alarm. A sounding device activated by a waterflow detector or alarm check valve and arranged to sound an alarm that is audible in all living areas over background noise levels with all intervening doors closed.

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

Wet System. A system employing automatic sprinklers that are attached to a piping system containing water and connected to a water supply so that water discharges immediately from sprinklers opened by a fire.

1-4* Maintenance. The owner is responsible for the condition of a sprinkler system and shall keep the system in normal operating condition.

1-5 Devices, Materials, Design, and Installation.

1-5.1* Only new residential sprinklers shall be employed in the installation of sprinkler systems.

1-5.2 Only listed and approved devices and approved materials shall be used in sprinkler systems.

Exception: Listing shall be permitted to be waived for tanks, pumps, hangers, waterflow detection devices, and waterflow valves.

1-5.3 Where listed, preengineered systems shall be installed within the limitations that have been established by the testing laboratories.

1-5.4* All systems shall be tested for leakage at normal system operating water pressure.

Exception: Where a fire department pumper connection is provided, hydrostatic pressure tests shall be provided in accordance with NFPA 13, Standard for the Installation of Sprinkler Systems.

1-5.5 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.

1-6* Units. Metric units of measurement in this standard shall be in accordance with the modernized metric system known as the International System of Units (SI). The liter and bar units are outside of, but recognized by, SI and are commonly used in international fire protection. These units are provided in Table 1-6 with their conversion factors.

Table 1-6 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 = 105 Pa

1-6.1 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. A given equivalent value shall be considered to be approximate.

1-6.2 SI units have been converted by multiplying the quantity by the conversion factor and then rounding the result to the appropriate number of significant digits.

Chapter 2 Water Supply

2-1 General Provisions. Every automatic sprinkler system shall have at least one automatic water supply. Where stored water is used as the sole source of supply, the minimum quantity shall equal the water demand rate times 10 minutes. *(See 4-1.3.)*

Exception: For dwelling units that are one story in height and less than 2000 ft² (186 m²) in area, the water supply shall be at least 7 minutes for the two-sprinkler demand.

2-2* 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

2-3* 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.

(a) * In common water supply connections serving more than one dwelling unit, 5 gpm (19 L/min) are added to the sprinkler system demand to determine the size of common piping and the size of the total water supply requirements.

Exception: Domestic design demand shall not be required to be added where provision is made to prevent flow into the domestic water system upon operation of a sprinkler.

(b) Smoke detectors are provided in accordance with NFPA 72, *National Fire Alarm Code®*.

(c) All piping in the system supplying sprinklers is listed and conforms to the piping specifications of this standard. Piping connected to this system and supplying plumbing fixtures only is required to comply with local plumbing and health authority requirements but is not required to be listed.

(d) Permitted by the local plumbing or health authority.

(e) A sign is affixed adjacent to the main shut-off valve that states in minimum $^1/_4$-inch letters, "Warning, the water system for this home supplies a fire sprinkler system that depends on certain flows and pressures being available to fight a fire. Devices that restrict the flow or decrease the pressure such as water softeners 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."

2-4 Manufactured Home Water Supply. A water supply for a sprinklered dwelling manufactured off-site shall not be less than that specified on the manufacturer's nameplate. *[See 4-4.3(k), Exception No. 2. See Chapter 5 for an alternative design approach for manufactured homes.]*

Chapter 3 System Components

3-1 Valves and Drains.

3-1.1 Each system shall have a single control valve arranged to shut off both the domestic system and the sprinkler system, and there shall be a separate shutoff valve for the domestic system only.

Exception No. 1: The sprinkler system piping shall be permitted to have a separate control valve where supervised by one of the following methods:

(a) Central station, proprietary, or remote station alarm service

(b) Local alarm service that causes the sounding of an audible signal at a constantly attended location.

(c) Valves that are locked open

Exception No. 2: A separate shutoff valve shall not be required for the domestic water supply in multipurpose piping systems.

3-1.2 Each sprinkler system shall have a drain and/or test connection with a valve on the system side of the control valve.

3-1.3 Additional drains shall be installed for each trapped portion of a dry system that is subject to freezing temperatures.

3-1.4* 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. Where sprinklers used in the system have a nominal K-factor smaller than 5.6, the inspector's test shall be of the same size orifice as the smallest sprinkler.

3-2 Pressure Gauges. A pressure gauge shall be installed to indicate air pressure on dry systems and on water supply pressure tanks.

3-3 Piping.

3-3.1* Pipe or tube used in sprinkler systems shall be of the materials specified in Table 3-3.1 or in accordance with 3-3.2 through 3-3.5. The chemical properties, physical properties, and dimensions of the materials in Table 3-3.1 shall be at least equivalent to the standards cited in the table and designed to withstand a working pressure of not less than 175 psi (12.1 bar).

Exception: When multipurpose piping system pressures do not exceed 130 psi (8.9 bar) and when such systems are not equipped with a fire department connection, piping shall be permitted to be designed to withstand a working pressure of not less than 130 psi (8.9 bar). When nonmetallic piping is used for this application, it shall be permitted to be rated at not less than 130 psi (8.9 bar) working pressure at not less than 120°F (49°C).

3-3.2* Other types of pipe or tube shall be permitted to be used, where investigated and listed for sprinkler systems by a testing and inspection agency laboratory. Listed piping materials including, but not limited to, chlorinated polyvinyl chloride (CPVC), polybutylene (PB), and steel differing from those provided in Table 3-3.1 shall be installed in accordance with their listings and the manufacturers' installation instructions. CPVC and PB pipe and tube shall comply with the portions of the American Society for Testing and Materials (ASTM) standards specified in Table 3-3.2 that apply to fire protection service in addition to the provisions of this paragraph.

Table 3-3.1 Pipe or Tube Materials and Dimensions

Materials and Dimensions	Standard
Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A 795
Specification for Welded and Seamless Pipe	ASTM A 53
Wrought Steel Pipe	ANSI B36.10M
Specification for Electric-Resistance-Welded Steel Pipe	ASTM A 135
Specification for Seamless Copper Tube [Copper Tube (Drawn, Seamless)]	ASTM B 75
Specification for Seamless Copper Water Tube	ASTM B 88
Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B 251
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
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

Table 3-3.2 Specially Listed Pipe or Tube Materials and Dimensions

Materials and Dimensions	Standard
Nonmetallic Piping:	
Specification for Chlorinated Polyvinyl Chloride (CPVC) Pipe	ASTM F 442
Specification for Polybutylene (PB) Pipe	ASTM D 3309

Note: In addition to satisfying these minimum standards, specially listed pipe shall be required to comply with the provisions of 3-3.2.

3-3.2.1 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.

3-3.3 Wherever the word *pipe* is used in this standard, it shall be understood also to mean *tube.*

3-3.4 Schedule 10 steel pipe shall be permitted to be joined with mechanical groove couplings approved for service, with grooves rolled on the pipe by an approved groove-rolling machine.

3-3.5 Fittings used in sprinkler systems shall be of the materials listed in Table 3-3.5 or in accordance with 3-3.7. The chemical properties, physical properties, and dimensions of the materials specified in Table 3-3.5 shall be at least equivalent to the standards cited in the table. Fittings used in sprinkler systems shall be designed to withstand a working pressure of not less than 175 psi (12.1 bar).

Exception: When multipurpose piping system pressures do not exceed 130 psi (8.9 bar) and when such systems are not equipped with a fire department connection, fittings shall be permitted to be designed to withstand a working pressure of not less than 130 psi (8.9 bar). When nonmetallic fittings are used for this application, they shall be permitted to be rated at not less than 130 psi (8.9 bar) working pressure at not less than 120°F (49°C).

Table 3-3.5 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	
Buttweld Fittings	ASME B16.9
Buttwelding Ends	ASME B16.25
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 SolderJoint Pressure Fittings	ASME B16.22
Cast Copper Alloy Solder Joint Pressure Fittings	ASME B16.18

3-3.6 Joints for the connection of copper tube shall be brazed.

Exception: Soldered joints shall be permitted to be used for wet pipe copper tube systems.

3-3.7* Other types of fittings shall be permitted to be used, but only where investigated and listed for sprinkler systems by a testing and inspection agency laboratory. Listed fittings including, but not limited to, CPVC, PB, and steel differing from those provided in Table 3-3.5 shall be installed in accordance with their listings and the manufacturers' installation instructions. CPVC and PB pipe and tube fittings shall comply with the portions of the ASTM standards specified in Table 3-3.7 that apply to fire protection service in addition to the provisions of this paragraph.

Table 3-3.7 Specially Listed Fittings and Dimensions

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

Note: In addition to satisfying these minimum standards, specially listed pipe fittings shall be required to comply with the provisions of 3-3.7.

3-4 Piping Support.

3-4.1 Piping shall be supported from structural members using support methods comparable to those required by local plumbing codes.

Exception: Listed piping shall be supported in accordance with any listing limitations.

3-4.2 Piping laid on open joists or rafters shall be secured to prevent lateral movement.

3-4.3* Sprinkler piping shall be adequately secured to restrict the movement of piping upon sprinkler operation.

3-5 Sprinklers.

3-5.1 Listed residential sprinklers shall be used. Listing shall be based on tests to establish the ability of the sprinklers to control residential fires under standardized fire test conditions. The standardized room fires shall be based on a residential array of furnishings and finishes.

Exception No. 1: Residential sprinklers shall not be used in dry pipe systems unless specifically listed for that purpose.

Exception No. 2: Listed dry-type sprinklers shall be permitted to be used in accordance with 4-3.2.

3-5.2 Temperature Ratings. The requirements of 3-5.2.1 through 3-5.2.3 shall be used for the selection of sprinkler temperature ratings.

3-5.2.1 Ordinary temperature–rated residential sprinklers [135°F to 170°F (57°C to 77°C)] shall be installed where maximum ambient ceiling temperatures do not exceed 100°F (38°C).

3-5.2.2 Intermediate temperature–rated residential sprinklers [175°F to 225°F (79°C to 107°C)] shall be installed where

Table 3-5.2.3 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				
0W–250W	6	152	3	76
250W–499W	12	305	6	152

maximum ambient ceiling temperatures are between 101°F and 150°F (39°C and 66°C).

3-5.2.3 The following practices shall be observed where installing residential sprinklers.

Exception: Where higher expected ambient temperatures are otherwise determined.

(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 3-5.2.3 shall be of ordinary- or intermediate-temperature rating, as indicated.

Exception: Where sprinklers are listed for positioning closer to a heat source than the minimum distance shown in Table 3-5.2.3, the closer minimum distances shall be permitted to be used.

3-5.3 Operated or damaged sprinklers shall be replaced with sprinklers having the same performance characteristics as the original equipment.

3-5.4 Painting and Ornamental Finishes.

3-5.4.1* Sprinkler frames shall be permitted to be factory painted or enameled as ornamental finish in accordance with 3-5.4.2; otherwise, sprinklers shall not be painted, and any sprinklers that have been painted shall be replaced with new, listed sprinklers.

Exception: Sprinklers painted with factory-applied coatings shall not be required to be replaced.

3-5.4.2 Ornamental finishes shall not be applied to sprinklers by an individual other than the sprinkler manufacturer, and only sprinklers listed with such finishes shall be used.

3-5.5 Escutcheon Plates. Where nonmetallic sprinkler ceiling plates (escutcheons) or recessed escutcheons (metallic or nonmetallic) are used, they shall be listed based on tests of the assembly as a residential sprinkler.

3-6* Alarms. Local waterflow alarms with facilities for flow testing, such as alarm devices, shall be provided on all sprinkler systems.

Exception: Dwellings or manufactured homes having smoke detectors in accordance with NFPA 72, National Fire Alarm Code, shall not be required to be provided with a waterflow alarm.

Chapter 4 System Design

4-1 Design Criteria.

4-1.1 Design Discharge. The system shall provide a discharge of not less than 18 gpm (68 L/min) to any single operating sprinkler and not less than 13 gpm (49 L/min) per sprinkler to the number of design sprinklers, but the discharge shall not be less than the listing of the sprinkler. The minimum operating pressure of any residential sprinkler shall be 7 psi (0.5 bar).

4-1.2* Number of Design Sprinklers.

4-1.2.1 The number of design sprinklers shall include all sprinklers within a compartment up to a maximum of two sprinklers under a flat, smooth, horizontal ceiling. For compartments containing two or more sprinklers, calculations shall be provided to verify the single operating sprinkler criteria and the multiple (two) operating sprinkler criteria.

4-1.2.2 The definition of *compartment* as used in 4-1.2.1 for determining the number of design sprinklers shall be a space that is completely enclosed by walls and a ceiling. The compartment enclosure shall be permitted to have openings to an adjoining space, provided the openings have a minimum lintel depth of 8 in. (203 mm) from the ceiling.

4-1.3 Water Demand. The water demand for the system shall be determined by multiplying the design discharge specified in 4-1.1 by the number of design sprinklers specified in 4-1.2.1.

4-1.4 Sprinkler Coverage.

4-1.4.1 Residential sprinklers shall be spaced so that the maximum area protected by a single sprinkler does not exceed 144 ft^2 (13.4 m^2).

4-1.4.2 The maximum distance between sprinklers shall not exceed 12 ft (3.7 m) on or between pipelines, and the maximum distance to a wall or partition shall not exceed 6 ft (1.8 m).

4-1.4.3 The minimum distance between sprinklers within a compartment shall be 8 ft (2.4 m).

4-1.5 Operating Pressure. The minimum operating pressure of any sprinkler shall be in accordance with the listing information of the sprinkler and shall provide the minimum flow rates specified in 4-1.1.

4-1.6 Application rates, design areas, areas of coverage, and minimum design pressures other than those specified in 4-1.1, 4-1.2.1, 4-1.4, and 4-1.5 shall be permitted to be used with special sprinklers that have been listed for such specific residential installation conditions. The minimum operating pressure of any residential sprinkler shall be 7 psi (0.5 bar).

4-2 Position of Sprinklers.

4-2.1 Pendent and upright sprinklers shall be positioned so that the deflectors are within 1 in. to 4 in. (25.4 mm to 102 mm) from the ceiling.

Exception: Special residential sprinklers shall be installed in accordance with the listing limitations.

4-2.2 Sidewall sprinklers shall be positioned so that the deflectors are within 4 in. to 6 in. (102 mm to 152 mm) from the ceiling.

Exception: Special residential sprinklers shall be installed in accordance with the listing limitations.

4-2.3* Sprinklers shall be positioned so that the response time and discharge are not unduly affected by obstructions such as ceiling slope, beams, or light fixtures.

4-2.4 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.

4-2.5 In closets and storage areas that are required to be protected in accordance with Section 4-6 and are less than 5 ft (1.5 m) in height at the lowest ceiling, a single sprinkler located at the highest ceiling shall be permitted to protect a volume not larger than 300 ft^3 (8.93 m^3).

4-3 System Types.

4-3.1* Wet Pipe Systems. A wet pipe system shall be used where all piping is installed in areas not subject to freezing.

4-3.2 Dry Pipe Systems. Where system piping is located in unheated areas subject to freezing, a dry pipe or antifreeze system shall be used.

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

4-3.3 Antifreeze Systems.

4-3.3.1 Definition. An antifreeze system is one employing automatic sprinklers attached to a piping system containing an antifreeze solution and connected to a water supply. The antifreeze solution, followed by water, discharges immediately from sprinklers opened by a fire.

4-3.3.2* Conformity with Health Regulations. The use of antifreeze solutions shall be in conformity with any state or local health regulations.

4-3.3.3 Antifreeze Solutions.

4-3.3.3.1 Where sprinkler systems are supplied by public water connections, the use of antifreeze solutions other than water solutions of pure glycerine (chemically pure or United States Pharmacopoeia 96.5 percent grade) or propylene glycol shall not be permitted. Suitable glycerine-water and propylene glycol-water mixtures are shown in Table 4-3.3.3.1.

Table 4-3.3.3.1 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
C.P. or U.S.P. Grade*	40% water	1.151	–22	–30.0
	30% water	1.165	–40	–40.0
Hydrometer scale 1.000 to 1.200				
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
Hydrometer scale 1.000 to 1.200 (subdivisions, 0.002)				

*C.P. — Chemically pure; U.S.P. — United States Pharmacopoeia 96.5 percent.

Table 4-3.3.3.2 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	(If glycerine is used, see Table 4-3.3.3.1.)			
Diethylene glycol	50% water	1.078	–13	–25.0
	45% water	1.081	–27	–32.8
	40% water	1.086	–42	–41.1
Hydrometer scale 1.000 to 1.120 (subdivisions, 0.002)				
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
Hydrometer scale 1.000 to 1.120 (subdivisions, 0.002)				
Propylene glycol	(If propylene glycol is used, see Table 4-3.3.3.1.)			

*Free from magnesium chloride and other impurities.

4-3.3.3.2 Where public water is not connected to sprinklers, the commercially available materials in Table 4-3.3.3.2 shall be permitted to be used in antifreeze solutions.

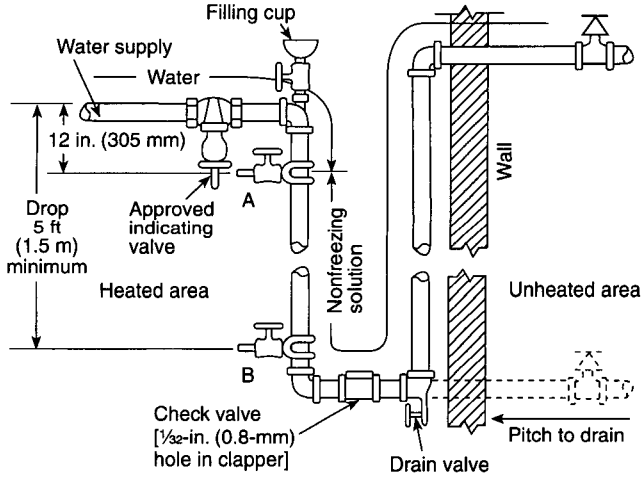
4-3.3.3.3* An antifreeze solution with a freezing point below the expected minimum temperature for the locality shall be prepared. The specific gravity of the prepared solution shall be checked by a hydrometer with a suitable scale.

4-3.3.4* Arrangement of Supply Piping and Valves. All permitted antifreeze solutions are heavier than water. At the point of contact (interface), the heavier liquid is below the lighter liquid, which prevents diffusion of water into the unheated areas. In most cases, this necessitates the use of a 5-ft (1.5-m) drop pipe or U-loop as illustrated in Figure 4-3.3.4. The preferred arrangement is to have the sprinklers located below the interface between the water and the antifreeze solution.

If sprinklers are above the interface, a check valve with a $^1/_{32}$-in. (0.8-mm) hole in the clapper shall be provided in the U-loop. A water control valve and two small solution test valves shall be provided as illustrated in Figure 4-3.3.4. An acceptable arrangement of a filling cup is also shown.

Exception: Where the connection between the antifreeze system and the wet pipe system incorporates a backflow prevention device, an expansion chamber shall be provided to compensate for the expansion of the antifreeze solution.

Figure 4-3.3.4 Arrangement of supply piping and valves.



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.

4-3.3.5* Testing. Before freezing weather each year, the solution in the entire system shall be emptied into convenient containers and brought to the proper specific gravity by adding concentrated liquid as needed. The resulting solution shall be permitted to be used to refill the system.

4-4 Pipe Sizing.

4-4.1 Piping shall be sized in accordance with 4-4.3 and 4-4.4. If more than one design discharge is required *(see 4-1.1)*, the pipe sizing procedure shall be repeated for each design discharge.

Exception No. 1: Where piping is sized hydraulically, calculations shall be made in accordance with the methods described in NFPA 13, Standard for the Installation of Sprinkler Systems.

Exception No. 2: For specially listed piping products, friction loss for pipe and fittings shall be permitted to be calculated based on the manufacturer's data, where available.

4-4.2 Minimum Pipe Size. Minimum pipe size, including that for copper, listed CPVC, and PB piping, shall be $^3/_4$ in. (19 mm).

Exception No. 1: The minimum size of steel pipe shall be 1 in. (25.4 mm).

Exception No. 2: $^1/_2$-in. (12.7-mm) nonmetallic pipe and $^1/_2$-in. (12.7-mm) copper pipe along with listed special fittings shall be permitted to be used only in network systems under the following conditions.

(a) Each sprinkler shall be supplied through a minimum of three separate paths from the supply shutoff valve assembly within the dwelling unit.

(b) Sprinkler supply lines shall not terminate in a dead end.

(c) Hydraulic calculations shall be prepared for each sprinkler flowing individually within the system and for each pair of sprinklers within the same compartment. 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.

(d) The system shall be hydraulically calculated in accordance with the provisions of NFPA 13, Standard for the Installation of Sprinkler Systems. The friction loss straight through the fitting shall be included.

(e) The system shall be supplied from a potable water source, or it shall be equipped with a strainer at the connection to the supply line.

(f) The method of joining the pipe to fittings or to other pipe shall be covered by the listing.

(g) Insert fittings shall not be installed between sprinkler fitting inlet ports.

(h) The piping to the plumbing fixtures shall be of copper or listed pipe.

4-4.3* To size piping for systems connected to a city water supply, the following general method shall be considered to be acceptable.

(a) The system flow rate shall be established in accordance with Section 4-1, 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.

(b) The water pressure in the street shall be determined.

(c) Pipe sizes shall be selected.

(d) Meter pressure losses, if any, shall be deducted. *[See Table 4-4.3(g).]* Higher pressure losses specified by the manufacturer shall be used in place of those specified in Table 4-4.3(e). Lower pressure losses shall be permitted to be used where supporting data is provided by the meter manufacturer.

(e) Pressure loss for elevation shall be deducted. (Building height above street in feet × 0.434 = psi. Building height above street in meters × 0.098 = bar.)

(f) Pressure losses from the city main to the inside control valve shall be deducted by multiplying the factor from Tables 4-4.3(a) or 4-4.3(b) by the total length(s) of pipe in feet (meters). [The total length includes equivalent length of fittings as determined by applying Tables 4-4.3(c), 4-4.3(d), 4-4.3(e), or 4-4.3(f).]

(g) Pressure losses for piping within the building shall be deducted by multiplying the factor from Tables 4-4.3(a) or 4-4.3(b) by the total length in feet (meters) of each size of pipe between the control valve and the farthest sprinkler.

(h) 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 Tables 4-4.3(c), 4-4.3(d), 4-4.3(e), or 4-4.3(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 Tables 4-4.3(a) or 4-4.3(b) and the values totaled.

(i) In multilevel buildings, steps 4-4.3(a) through 4-4.3(h) shall be repeated to size piping for each floor.

(j) 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.

(k) The remaining piping shall be sized the same as the piping up to and including the farthest sprinkler.

Exception No. 1: Where smaller pipe sizes are justified by calculations.

Exception No. 2: For sprinklered dwellings 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. (See Section 2-3.)

Table 4-4.3(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
$1^1/_4$	0.01	0.01	0.02	0.02	0.03	0.03	0.05	0.07	0.10	0.12	0.15	0.19
$1^1/_2$	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 4-4.3(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
$^3/_4$	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
11/4	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
$1^1/_2$	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 4-4.3(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
$1^1/_4$	1	3	2	6	2	0	15	35	18	5	7
$1^1/_2$	2	4	2	8	3	0	18	43	22	6	9
2	2	5	3	10	3	1	24	57	28	7	11

Table 4-4.3(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
$^3/_4$	0	1	0	3	1	0	7	14	7	2	0
1	1	2	2	6	2	0	14	33	18	5	6
$1^1/_4$	1	3	2	5	2	0	14	32	16	5	6
$1^1/_2$	2	4	2	8	3	0	18	43	22	6	9
2	2	6	3	12	4	1	28	66	33	8	13

Table 4-4.3(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
$^3/_4$	0	2	0	4	1	0	8	18	10	3	0
1	1	3	3	7	2	0	16	38	20	5	7
$1^1/_4$	1	3	2	6	2	0	15	35	18	5	7
$1^1/_2$	2	4	2	9	3	0	20	47	24	7	10
2	2	6	4	12	4	1	30	71	35	9	14

Table 4-4.3(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
3/4	0	2	0	4	1	0	10	21	11	3	0
1	2	3	3	8	3	0	19	43	23	6	8
1 1/4	1	3	2	7	2	0	16	38	20	5	8
1 1/2	2	5	2	9	3	0	21	50	26	7	11
2	3	7	4	13	5	1	32	75	37	9	14

Table 4-4.3(g) Pressure Losses in psi in Water Meters

Meter (in.)	Flow (gpm)					
	18	23	26	31	39	52
5/8	9	14	18	26	†	†
3/4	4	8	9	13	†	†
1	2	3	3	4	6	10
1 1/2	††	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).

4-4.4 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 steps (c), (e), (g), (h), (i), (j), and (k) of 4-4.3 shall be followed.

4-4.5 Hydraulic calculation procedures in accordance with NFPA 13, *Standard for the Installation of Sprinkler Systems*, shall be used for grid-type systems, looped-type systems, and systems connected to city water mains of less than 4 in. (100 mm) in diameter.

4-5 Piping Configurations. Piping configurations shall be permitted to be looped, gridded, or straight run, or to be combinations thereof.

4-6 Location of Sprinklers. Sprinklers shall be installed in all areas.

Exception No. 1: Sprinklers shall not be required in bathrooms of 55 ft² (5.1 m²) and less.

Exception No. 2: Sprinklers shall not be required in clothes closets, linen closets, and pantries where the area of the space does not exceed 24 ft² (2.2 m²) and the least dimension does not exceed 3 ft (0.9 m) and the walls and ceilings are surfaced with noncombustible or limited-combustible materials as defined in NFPA 220, Standard on Types of Building Construction.

Exception No. 3: Sprinklers shall not be required in garages, open attached porches, carports, and similar structures.

Exception No. 4: Sprinklers shall not be required in attics, crawl spaces, and other concealed spaces that are not used or intended for living purposes.

Exception No. 5: Sprinklers shall not be required in entrance foyers that are not the only means of egress.

Chapter 5 Limited Area Dwellings

5-1* General. This chapter shall apply only as an alternative for one- and two-family dwellings, including manufactured homes, that do not exceed 2000 ft² (186 m²) in area and that are one story in height with smooth ceilings with a slope not exceeding 10 degrees and a height not exceeding 8 ft (2.4 m) for horizontal ceilings and 9 ft (2.7 m) for sloped ceilings. All other requirements of this standard shall apply.

Exception: Where modified by this chapter.

5-2 Water Supply.

5-2.1 The water supply for sprinkler systems in limited area dwellings shall be capable of supporting the system demand for 10 minutes for one sprinkler operating as determined by 5-4.1 and 7 minutes for two sprinklers operating as determined by 5-4.2.

5-2.2 A listed strainer shall be provided in risers or feed mains that supply sprinklers with orifices less than $^3/_8$ in. (9.5 mm) nominal diameter.

5-3 Components.

5-3.1* Sprinklers. Sprinklers for use in this type of system shall be specifically listed for use in the conditions described in Section 5-1. All sprinklers installed in a compartment shall have the same thermal response characteristics.

5-3.2* Alarms. Local waterflow alarms and facilities for flow testing them shall be provided on such sprinkler systems.

5-4 System Design.

5-4.1 The water demand for the system shall be not less than 10 gpm (37.8 L/min) at a flowing pressure of 25 psi (1.72 bar) at the sprinkler where only one sprinkler is installed in a compartment.

5-4.2 The water demand for the system shall be not less than 6.5 gpm (24.6 L/min) to each of two sprinklers at a flowing pressure of 11 psi (0.76 bar) at the sprinkler where two or more sprinklers are installed in a compartment. The single sprinkler demand point, as described in 5-4.1, also shall be verified.

5-4.3* The area of coverage for sprinklers used in this system shall not exceed 64 ft^2 (5.9 m^2) per sprinkler.

Exception: For compartments not exceeding 100 ft^2 (9.3 m^2) and having no dimension exceeding 10 ft (3.1 m), a single sprinkler shall be permitted to cover this area.

5-4.4 The maximum perpendicular distance to a wall or partition shall not exceed 5 ft (1.5 m), and the minimum distance between sprinklers shall not be less than 6 ft (1.8 m).

5-4.5 The definition of *compartment*, as used in 5-4.1, 5-4.2, and 5-4.3 shall be a space that is enclosed by walls and a ceiling.

The compartment enclosure shall be permitted to have openings to an adjoining space, provided the openings have a minimum lintel depth of 2 in. (51 mm) from the ceiling and do not exceed 20 ft^2 (1.86 m^2) from each compartment.

5-5* Location of Sprinklers. Sprinklers shall be installed in all areas.

Exception No. 1: Sprinklers are not required in clothes closets, linen closets, and pantries where the area of space does not exceed 24 ft^2 (2.2 m^2) and the least dimension does not exceed 3 ft (0.9 m) and the walls and ceilings are surfaced with noncombustible or limited-combustible materials as defined by NFPA 220, Standard on Types of Building Construction.

Exception No. 2: Sprinklers are not required in garages, open attached porches, carports, and similar structures.

Exception No. 3: Sprinklers are not required in attics, crawl spaces, and other concealed spaces that are not used or intended for living purposes or storage.

Chapter 6 Referenced Publications

6-1 The following documents or portions thereof are referenced within this standard as mandatory requirements and shall be considered part of the requirements of this standard. The edition indicated for each referenced mandatory document is the current edition as of the date of the NFPA issuance of this standard. Some of these mandatory documents might also be referenced in this standard for specific informational purposes and, therefore, are also listed in Appendix B.

6-1.1 NFPA Publications. National Fire Protection Association, 1 Batterymarch Park, P.O. Box 9101, Quincy, MA 02269-9101.

NFPA 13, *Standard for the Installation of Sprinkler Systems*, 1999 edition.

NFPA 72, *National Fire Alarm Code®*, 1999 edition.

NFPA 220, *Standard on Types of Building Construction*, 1999 edition.

6-1.2 Other Publications.

6-1.2.1 ANSI Publication. American National Standards Institute, Inc., 11 West 42nd Street, 13th floor, New York, NY 10036.

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

6-1.2.2 ASME Publications. American Society of Mechanical Engineers, 345 East 47th Street, New York, NY 10017

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.

6-1.2.3 ASTM Publications. American Society for Testing and Materials, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959.

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

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

*Standard Specification for Seamless Copper Tube*ASTM B 75, 1995.

ASTM B 88, *Standard Specification for Seamless Copper Water Tube*, 1996.

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*, 1993.

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.

6-1.2.4 AWS Publication. American Welding Society, 550 N.W. LeJeune Road, Miami, FL 33126.

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

Appendix A Explanatory Material

Appendix A is not a part of the requirements of this NFPA document but is included for informational purposes only. This appendix 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 should be protected with residential sprinklers in accordance with 4-4.5 of NFPA 13, *Standard for the Installation of Sprinkler Systems.* Other portions of such buildings should be protected in accordance with NFPA 13.

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 Figures A-1-1(a), A-1-1(b), and 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 rating (greater than 225).

(For protection of multifamily dwellings, see NFPA 13, Standard for the Installation of Sprinkler Systems, or NFPA 13R, Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height.)

Figure A-1-1(a) Bedroom.

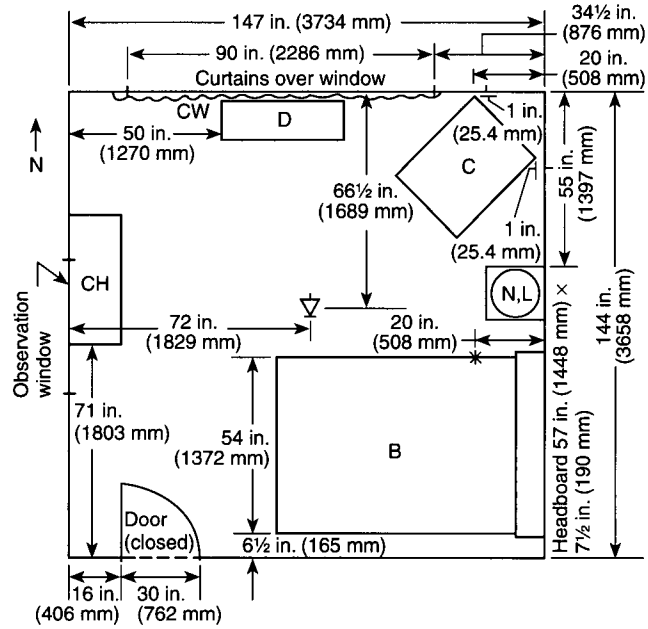


Figure A-1-1(b) Manufactured home bedroom.

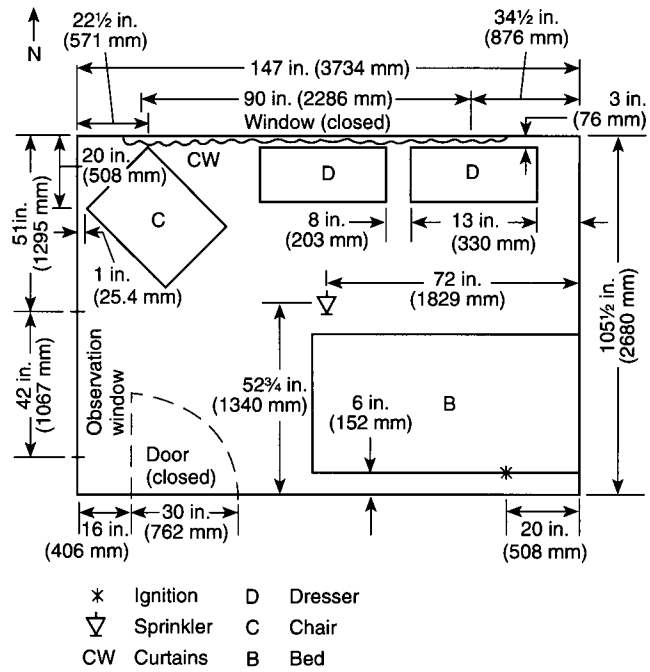
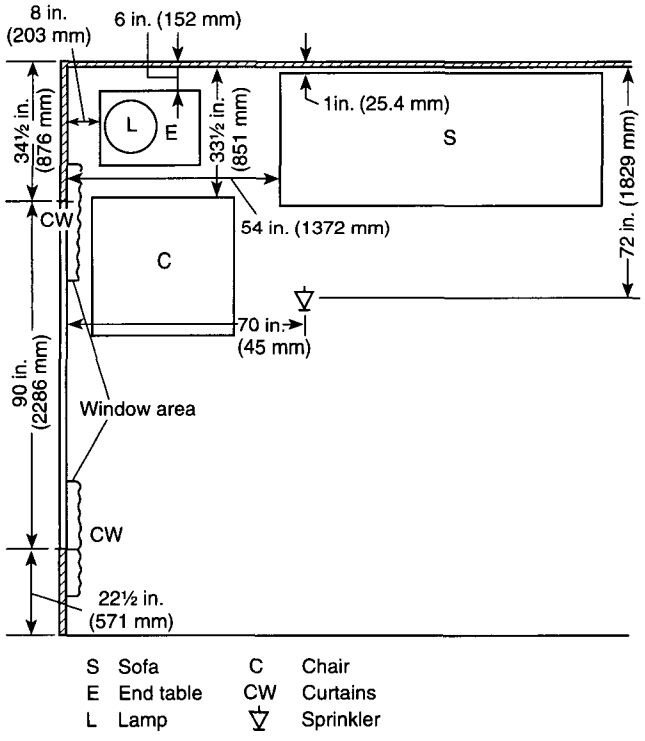


Figure A-1-1(c) Living room.



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 Tables A-1-2(a) and 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.*

Table A-1-2(a) Causal Factors in One- and Two-Family Dwelling Fires that Caused One or More Deaths

Area of Origin (Based on 6066 incidents where area of origin was reported)	
Living room	41%
Bedroom	27%
Kitchen	15%
Storage area	4%
Heating equipment room	3%
Structural area	2%
Other areas	8%
Form of Materials Ignited (Based on 5080 incidents where form of material ignited was reported)	
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 (Based on 5016 incidents where form of heat of ignition was reported)	
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.
Source: FIDO Database 1973 to 1982, NFPA Fire Analysis Department.

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.

A-1-3 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-1-3 Authority Having Jurisdiction. The phrase "authority having jurisdiction" is used in NFPA documents in a broad manner, since jurisdictions and approval agencies vary, as do their responsibilities. Where public safety is primary, the authority having jurisdiction may be a federal, state, local, or other regional department or individual such as a fire chief; fire marshal; chief of a fire prevention bureau, labor department, or health department; building official; electrical inspector; or others having statutory authority. For insurance purposes, an insurance inspection department, rating bureau, or other insurance company representative may be the authority having jurisdiction. In many circumstances, the property owner or his or her designated agent assumes the role of the authority having jurisdiction; at government installations, the commanding officer or departmental official may be the authority having jurisdiction.

A-1-3 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-1-3 Listed. The means for identifying listed equipment may vary for each organization concerned with product evaluation; some organizations do not recognize equipment as listed unless it is also labeled. The authority having jurisdiction should utilize the system employed by the listing organization to identify a listed product.

A-1-3 Manufactured Home. Manufactured homes were formerly referred to as "mobile homes" or "trailer coaches."

A-1-4 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: 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-1-5.1 At least one spare sprinkler of each type, temperature rating, and orifice size used in the system should be kept on the premises. 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-1-5.4 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.

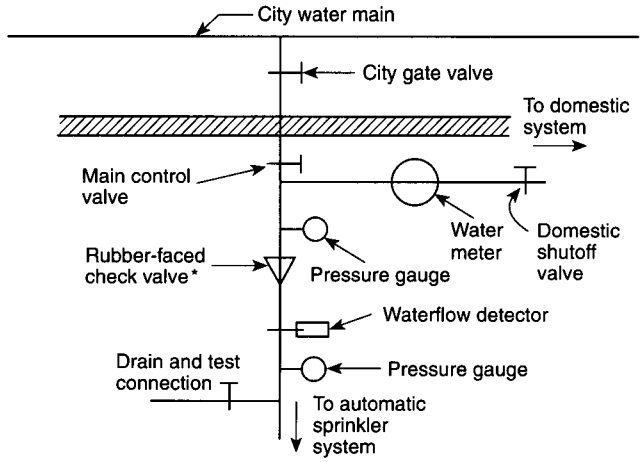
Dry systems also should be tested by placing the system under air pressure. Any leak that results in a drop in system pressure greater than 2 psi (0.14 bar) in 24 hours should be corrected. Leaks should be identified using soapy water brushed on each joint or coupling. The presence of bubbles indicates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

A-1-6 For additional conversions and information, see ASTM SI 10, *Standard for Use of the International System of Units (SI): the Modernized Metric System.*

A-2-2 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 Figures A-2-2(a), A-2-2(b), and A-2-2(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-2-2(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 4-4.3(e)]*. 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 Section 2-1 should be provided.

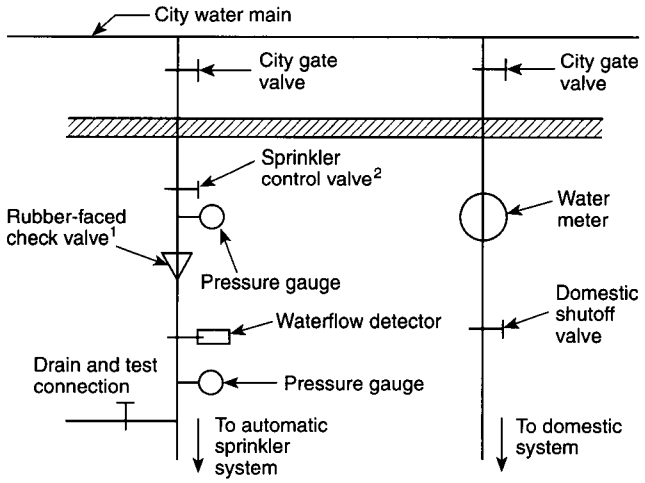
The effect of pressure-reducing valves on the system should be considered in the hydraulic calculation procedures.

Figure A-2-2(a) Preferable arrangement.



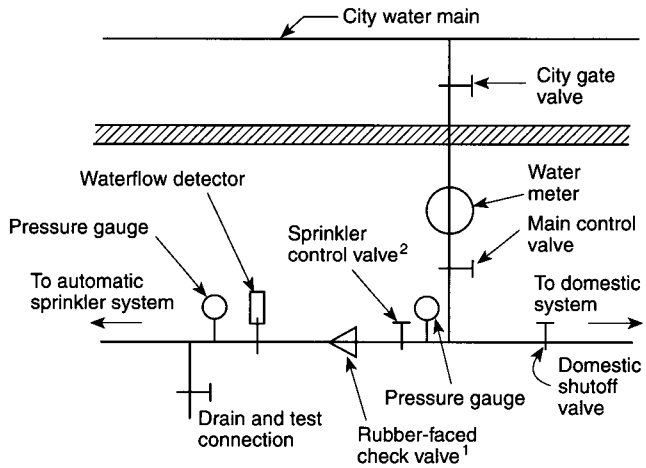
* Rubber-faced check valves are optional.

Figure A-2-2(b) Acceptable arrangement with valve supervision — Option 1.



[1] Rubber-faced check valves are optional.
[2] Option: See 3-1.1, Exception No. 1.

Figure A-2-2(c) Acceptable arrangement with valve supervision — Option 2.



[1] Rubber-faced check valves are optional.
[2] Option: See 3-1.1, Exception No. 1.

Figure A-2-3(a) Multipurpose pipe system with separate supply.

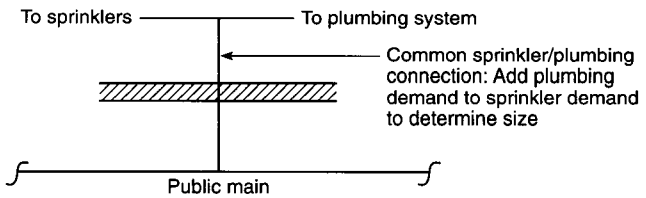
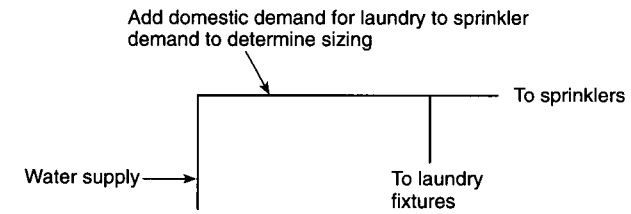
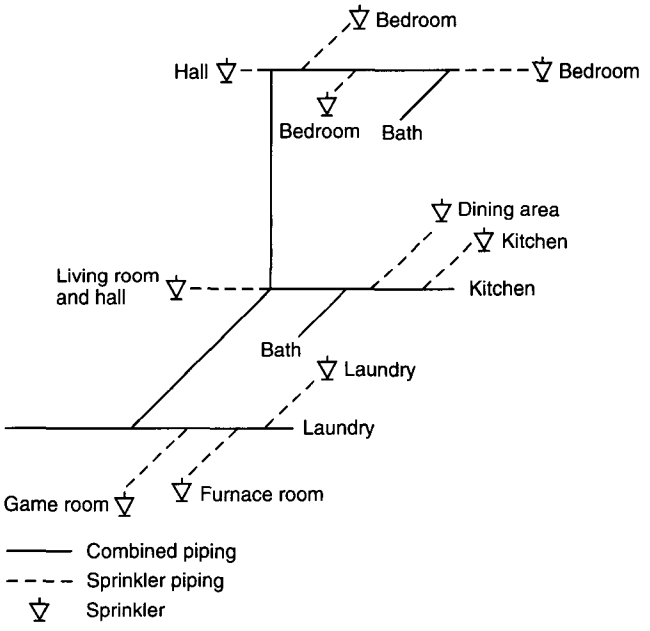


Figure A-2-3(b) Multipurpose pipe system calculation procedure.



A-2-3 Figures A-2-3(a), A-2-3(b), and A-2-3(c) illustrate acceptable water supply arrangements. When contemplating the use of multipurpose piping system, consideration should be given to possible future modifications for domestic purposes, such as the installation of a water softener or a water filtration system, which effect the performance of the sprinkler system.

Figure A-2-3(c) Multipurpose pipe system arrangement.



A-2-3(a) In dwellings where long-term use of lawn sprinklers is common, provision should be made for such usage.

A-3-1.4 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-3-3.1 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-3-3.2 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 3-3.1 and 3-3.2 is listed for fire sprinkler service. Listed pipe is identified by the logo of the listing agency.

A-3-3.7 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 3-3.5 and 3-3.7 are listed for fire sprinkler service. Listed fittings are identified by the logo of the listing agency.

A-3-4.3 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-3-5.4.1 Decorative painting of a residential sprinkler is not to be confused with the temperature identification colors as specified in 2-2.3 of NFPA 13, *Standard for the Installation of Sprinkler Systems.*

A-3-6 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.

A waterflow test is normally conducted using the system drain. Figures A-2-2(a), A-2-2(b), and A-2-2(c) show examples of this arrangement.

A-4-1.2 Residential sprinklers are currently listed for use under flat, smooth, horizontal ceilings only. Sloped, beamed, and pitched ceilings could require special design features such as larger flow, a design for three or more sprinklers to operate in the compartment, or both. Figures A-4-1.2(a) and A-4-1.2(b) show examples of a design configuration.

Figure A-4-1.2(a) Sprinkler design areas for typical residential occupancy — without lintel.

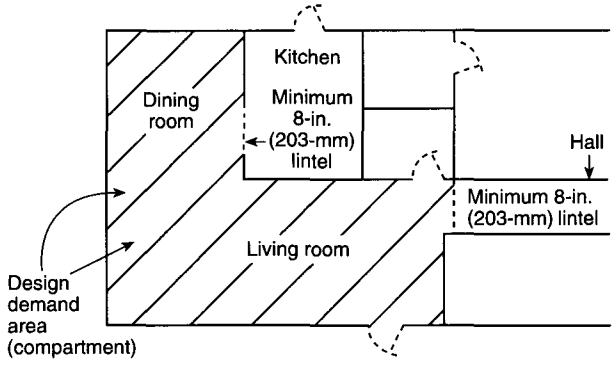
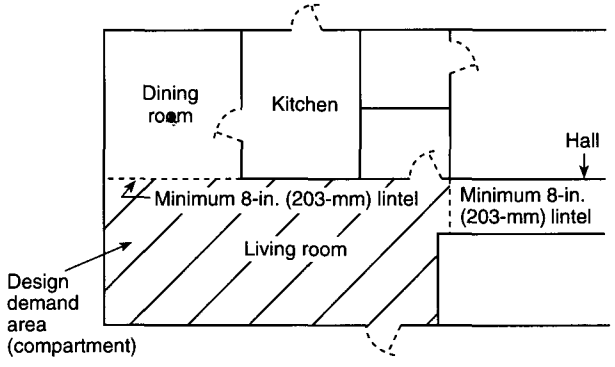


Figure A-4-1.2(b) Sprinkler design areas for typical residential occupancy — with lintel.



A-4-2.3 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.

Table A-4-2.3 and Figure A-4-2.3 provide guidance for the location of sprinklers near ceiling obstructions.

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

(a) Where no additional floor area is created by the architectural feature, no additional sprinkler protection is required.

(b) Where additional floor area is created by an architectural feature, no additional sprinkler protection is required, provided all of the following conditions are met.

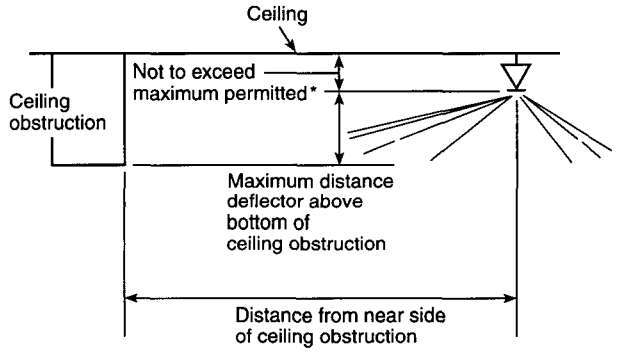
(1) The floor area does not exceed 18 ft^2 (1.7 m^2).
(2) The floor area is not greater than 2 ft (0.65 m) in depth at the deepest point of the architectural feature to the plane of the primary wall where measured along the finished floor.
(3) The floor area is not greater than 9 ft (2.9 m) in length 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.

Table A-4-2.3 Positioning of Sprinklers Near Ceiling Obstructions

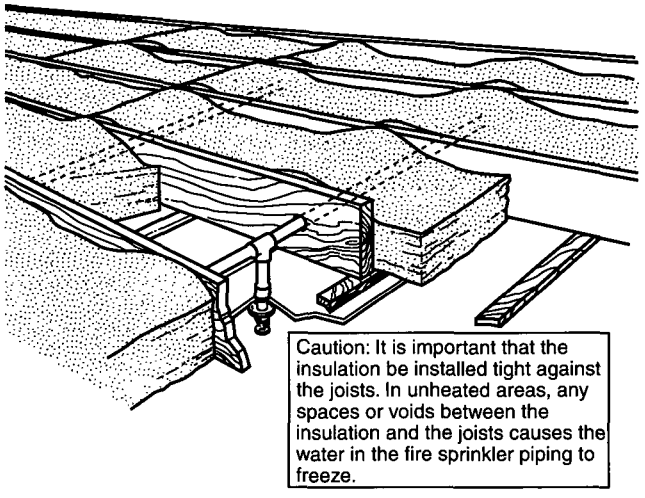
Distance from Sprinkler to Side of Ceiling Obstruction		Maximum Distance from Sprinkler Deflector to Bottom of CeilingObstruction	
		in.	mm
<6 in.	<152 mm	Not permitted	
6 in. to <1 ft	152 mm to <305 mm	0	0
1 ft to <2 ft	0.32 m to <0.64 m	1	25.4
2 ft to <2 ft 6 in.	0.64 m to <0.80 m	2	51
2 ft 6 in. to <3 ft	0.80 m to < .97 m	3	76
3 ft to <3 ft 6 in.	0.97 m to <1.13 m	4	102
3 ft 6 in. to <4 ft	1.13 m to <1.29 m	6	152
4 ft to <4 ft 6 in.	1.29 m to <1.45 m	7	178
4 ft 6 in. to <5 ft	1.45 m to <1.61 m	9	229
5 ft to <5 ft 6 in.	1.61 m to <1.77 m	11	279
5 ft 6 in. to <6 ft	1.77 m to <1.93 m	14	356

Figure A-4-2.3 Position of deflector, upright or pendent, where located above bottom of ceiling obstruction.



* See 4-2.1 and 4-2.2.

Figure A-4-3.1(a) Insulation recommendations — Arrangement 1.



A-4-3.1 In areas subject to freezing, care should be taken to cover sprinkler piping completely in unheated attic spaces with insulation. Installation should follow the guidelines of the insulation manufacturer. Figures A-4-3.1(a) through A-4-3.1(e) show several methods that can be considered.

Figure A-4-3.1(b) Insulation recommendations — Arrangement 2.

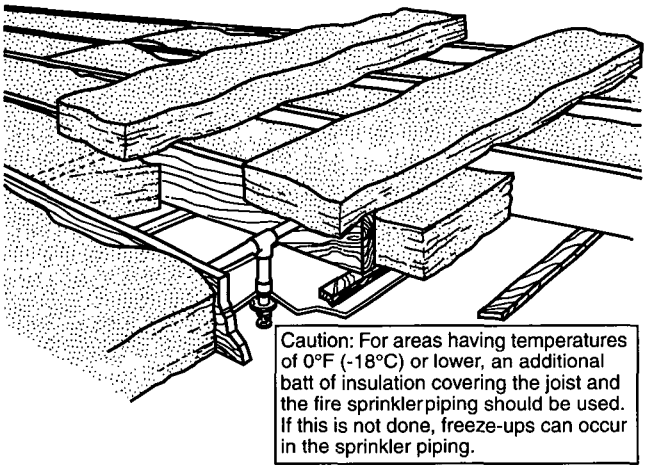


Figure A-4-3.1(c) Insulation recommendations — Arrangement 3.

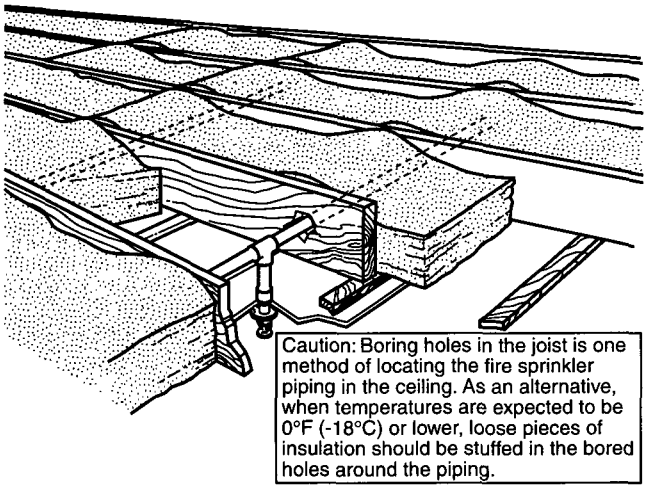


Figure A-4-3.1(d) Insulation recommendations — Arrangement 4.

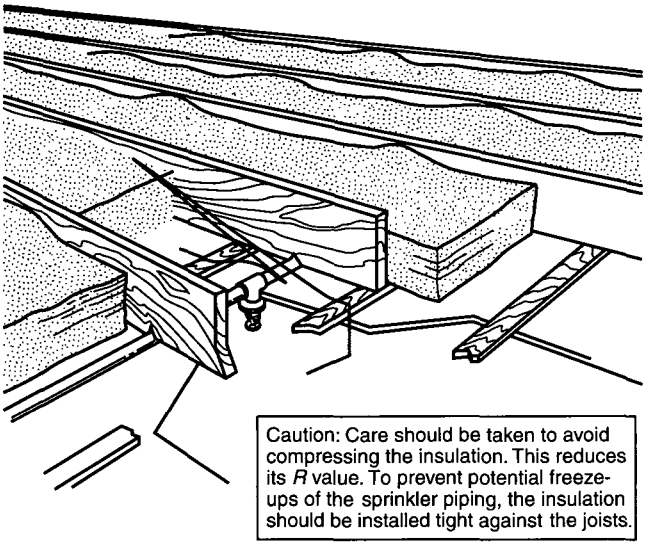
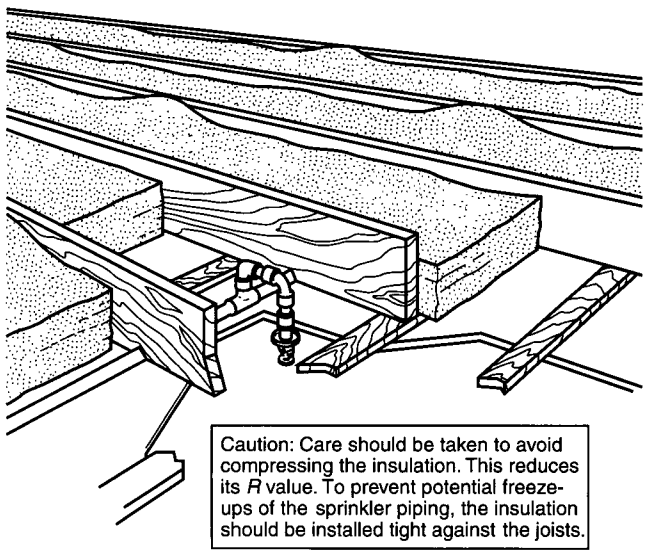


Figure A-4-3.1(e) Insulation recommendations — Arrangement 5.



A-4-3.3.2 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).

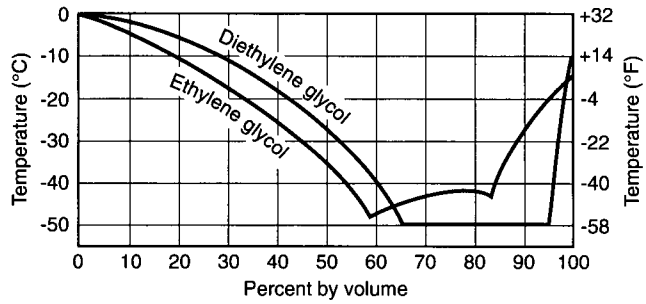
Because of the cost of refilling the system or replenishing small leaks, small, dry valves should be used where more than 40 gal (151 L) are to be supplied.

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.

A-4-3.3.3.3 Beyond certain limits, an increased proportion of antifreeze does not lower the freezing point of the solution *(see Figure A-4-3.3.3.3)*. 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).

Listed CPVC sprinkler pipe and fittings should be protected from freezing with glycerine only. The use of diethylene glycol, ethylene glycol, or propylene glycol are 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.

Figure A-4-3.3.3.3 Freezing points of water solutions of ethylene glycol and diethylene glycol.



A-4-3.3.4 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-4-3.3.5 Tests should be made by drawing a sample of the solution from valve B, as shown in Figure 4-3.3.4, 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-4-4.3 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 Figures A-4-4.3(a) and A-4-4.3(b).]*

Figure A-4-4.3(a) Calculation sheet.

	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 furthest 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 4-4.3(a), (b), (c), (d), and (e).

Figure A-4-4.3(b) Calculation sheet — elevated tank, booster pump, pump tank supply.

	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 4-4.3(a), (b), (c), (d), (e), (f), and (g).

A-5-1 The concept of this sprinkler system is the result of testing conducted by the U. S. Fire Administration. One of the goals of these tests was to determine if a smaller quantity of water could be used to protect smaller dwellings. The purpose of the system is to enhance life safety and make installation economically feasible for smaller dwellings.

Design items in this chapter assume that egress times from smaller dwellings are minimal, since the units are single-story at grade level and occupants would be made aware of a fire in the unit almost immediately. This approach is considered in permitting the reduction of the water supply, in some instances, to 7 minutes.

A-5-3.1 The criteria used to list a sprinkler for this use should include, but should not be limited to, the following:

(1) Temperature rating — 155°F to 165°F (68°C to 74°C)
(2) RTI — nominal 60 $(ft\text{-}s)^{1/2}$
(3) Droplet size
(4) Distribution patterns
(5) Areas of coverage
(6) Flow rates
(7) Operating pressures
(8) K-factor = nominal 2.0
(9) Ceiling slope

All sprinklers within a compartment, as defined in 5-4.5, should be within 10°F (5.5°C) of one another in temperature rating.

A-5-3.2 These alarms should be located within the dwelling and should be of sufficient intensity to be clearly audible in all bedrooms over background noise levels with all intervening doors closed.

A-5-4.3 Sample areas of coverage for a sprinkler where listed for this design approach are provided in Table A-5-4.3.

Table A-5-4.3 Sample Areas of Coverage

Compartment Size		
ft	m	Number of Sprinklers
10 × 10	3 × 3	1
10 × 12	3 × 3.6	2
12 × 12	3.6 × 3.6	4
16 × 16	4.8 × 4.8	4
16 × 20	4.8 × 6	6