

SPRINKLER SYSTEMS

in One- and Two-Family
Dwellings and
Mobile Homes

NFPA
13D
1991 Edition



National Fire Protection Association

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The Board of Directors reaffirms that the National Fire Protection Association recognizes that the toxicity of the products of combustion is an important factor in the loss of life from fire. NFPA has dealt with that subject in its technical committee documents for many years.

There is a concern that the growing use of synthetic materials may produce more or additional toxic products of combustion in a fire environment. The Board has, therefore, asked all NFPA technical committees to review the documents for which they are responsible to be sure that the documents respond to this current concern. To assist the committees in meeting this request, the Board has appointed an advisory committee to provide specific guidance to the technical committees on questions relating to assessing the hazards of the products of combustion.

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NFPA 13D

Standard for the

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

1991 Edition

This edition of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*, was prepared by the Technical Committee on Automatic Sprinklers, released by the Correlating Committee on Water Extinguishing Systems, and acted on by the National Fire Protection Association, Inc. at its Annual Meeting held May 19-23, 1991 in Boston, MA. It was issued by the Standards Council on July 19, 1991, with an effective date of August 16, 1991, and supersedes all previous editions.

The 1991 edition of this document has been approved by the American National Standards Institute.

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.

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 a 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 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 with the 1980 edition, modifications to the standard, including removal of design parameters for dry pipe systems, were made in the 1984 edition.

The 1989 edition established criteria for the use anti-freeze systems and included several style related changes. This edition includes information relating to some of the installation criteria associated with specially listed piping materials. The addition of a new table relating to friction loss through copper fittings has also been included.

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NFPA 13D
Standard for the
Installation of Sprinkler Systems in
One- and Two-Family Dwellings and
Mobile Homes

1991 Edition

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

Information on referenced publications can be found in Chapter 5 and Appendix B.

Preface

It is intended that this standard provide a method for those individuals wishing to install a sprinkler system for additional life safety and property protection. It is not the purpose of this standard to require the installation of an automatic sprinkler system. This standard assumes that one or more smoke detectors will be installed in accordance with NFPA 74, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*.

Chapter 1 General Information

1-1* Scope. This standard deals with the design and installation of automatic sprinkler systems for protection against the fire hazards in one- and two-family dwellings and mobile homes.

1-2* Purpose. The purpose of this standard is to provide a sprinkler system that will aid in the detection and control of residential fires and thus provide improved protection against injury, life loss, and property damage. A sprinkler system installed in accordance with this standard is expected to prevent flashover (total involvement) in the room of fire origin, when sprinklered, and to improve the chance for occupants to escape or be evacuated.

Guidelines are established for the design and installation of sprinkler systems for one- and two-family dwellings and mobile homes. Nothing in this standard is intended to restrict new technologies or alternate arrangements providing the level of safety prescribed by the standard is not lowered.

1-3 Definitions.

Approved. Acceptable to the "authority having jurisdiction."

NOTE: 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 or 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 concerned with product evaluations which is in a position to determine compliance with appropriate standards for the current production of listed items.

Authority Having Jurisdiction. The "authority having jurisdiction" is the organization, office or individual responsible for "approving" equipment, an installation or a procedure.

NOTE: 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, 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 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."

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. Rate of water discharged by an automatic sprinkler expressed in gallons per minute.

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, normally having 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 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 or materials included in a list published by an organization acceptable to the "authority having jurisdiction" and concerned with product evaluation,

that maintains periodic inspection of production of listed equipment or materials and whose listing states either that the equipment or material meets appropriate standards or has been tested and found suitable for use in a specified manner.

NOTE: The means for identifying listed equipment may vary for each organization concerned with product evaluation, some of which 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.

Mobile Home. A factory-assembled structure equipped with service connections and made so as to be readily movable as a unit on its running gear and designed to be used as a dwelling unit with or without a foundation.

Multipurpose Piping Systems. Piping systems within dwellings and mobile homes intended to serve both domestic and fire protection needs.

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

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

Residential Sprinkler. An automatic sprinkler that has been specifically listed for use in residential occupancies.

Shall. Indicates a mandatory requirement.

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

Sprinkler—Automatic. A fire suppression 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 will automatically initiate water discharge over a fire area. When required, the sprinkler system also includes a control valve and a device for actuating an alarm when the system operates.

Standard. A document containing only mandatory provisions using the word "shall" to indicate requirements. Explanatory material may be included only in the form of "fine print" notes, in footnotes, or in an Appendix.

Supply Pressure. Pressure within the supply (i.e., city or private supply water source).

System Pressure. Pressure within the system (i.e., above the control valve).

Waterflow Alarm. A sounding device activated by a waterflow detector or alarm check valve and arranged to sound an alarm that will be 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 water flow in one direction only.

Wet System. A 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 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 may be waived for tanks, pumps, hangers, waterflow detection devices, and waterflow valves.

1-5.3 Preengineered systems shall be installed within the limitations that have been established by the testing laboratories where listed.

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

Exception: When 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.

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

Table 1-6

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

For additional conversions and information see ASTM E380, *Standard for Metric Practice*.

1-6.1 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated shall be regarded as the requirement. A given equivalent value may be approximate.

1-6.2 The conversion procedure for the SI units has been to multiply the quantity by the conversion factor and then round 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. When 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.)

2-2* Water Supply Sources. The following water supply sources are acceptable:

- (a) A connection to a reliable water works system.
- (b) An elevated tank.
- (c) A pressure tank designed to ASME standards for a pressure vessel with a reliable pressure source.
- (d) 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 acceptable when:

- (a)* In common water supply connections serving more than one dwelling unit, 5 gpm (19 L/min) is added to the sprinkler system demand to determine the size of common piping and the size of the total water supply requirements.
- (b) Smoke detectors are provided in accordance with NFPA 74, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*.
- (c) All piping in the system conforms to the piping specifications of this standard.
- (d) Permitted by the local plumbing or health authority.

2-4 Mobile 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*.]

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 and sprinkler systems and a separate shutoff valve for the domestic system only.

Exception No. 1: The sprinkler system piping may 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 will cause the sounding of an audible signal at a constantly attended point, or*
- (c) *Locking the valves open.*

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

3-1.2 Each sprinkler system shall have a 1/2 in. (13 mm) or larger drain and test connection with 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.

3-2 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 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 listed 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 bars).

Table 3-3.1

Materials and Dimensions	Standard
Specification for Welded and Seamless Steel Pipe	ASTM A53
Wrought-Steel Pipe	ANSI B36.10M
Specifications for Electric-Resistance Welded Steel Pipe	ASTM A135
Copper Tube (Drawn, Seamless) Specification for Seamless Copper Tube	ASTM B75
Specification for Seamless Copper Water Tube	ASTM B88
Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251
Bracing Filler Metal (Classification BCuP-3 or BCuP-4)	AWS A5.8
Specification for Solder Metal, 95-5 (Tin-Antimony-Grade 95TA)	ASTM B32

3-3.2 Other types of pipe or tube shall be permitted to be used, but only those investigated and listed for this service by a testing and inspection agency laboratory. Listed piping materials, including but not limited to chlorinated polyvinyl chloride (CPVC), polybutylene, and steel differing from that provided in Table 3-3.1, shall be installed in accordance with their listing and the manufacturers' installation instructions.

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

3-3.4 Schedule 10 steel pipe may 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 listed 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 the working pressures involved, but not less than 175 psi (12.1 bars) cold water pressure.

Table 3-5.5

Materials and Dimensions	Standard
Cast Iron	
Cast Iron Threaded Fittings, Class 125 and 250	ANSI B16.4
Cast Iron Pipe Flanges and Flanged Fittings	ANSI B16.1
Malleable Iron	
Malleable Iron Threaded Fittings, Class 150 and 300	ANSI B16.3
Steel	
Factory-made Wrought Steel	
Buttweld Fittings	ANSI B16.9
Buttwelding Ends for Pipe, Valves, Flanges and Fittings	ANSI B16.25
Spec. for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures	ASTM A234
Pipe Flanges and Flanged Fittings, Steel Nickel Alloy and Other Special Alloys	ANSI B16.5
Forged Steel Fittings, Socket Welded and Threaded	ANSI B16.11
Copper	
Wrought Copper and Copper Alloy Solder-Joint Pressure Fittings	ANSI B16.22
Cast Copper Alloy Solder-Joint Pressure Fittings	ANSI B16.18

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

Exception: Soldered joints (95-5 solder metal) 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 those investigated and listed for this service by a testing and inspection agency laboratory. Listed fittings, including but not limited to chlorinated polyvinyl chloride (CPVC), polybutylene, and steel differing from that provided in Table 3-3.5, shall be installed in accordance with their listing and the manufacturers' installation instructions.

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. The basis of such a listing shall be 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 systems unless specifically listed for that purpose.

Exception No. 2: Listed dry sprinklers may be used in accordance with 4-3.2.

3-5.2 Ordinary temperature rated residential sprinklers [135 to 170°F (57 to 77°C)] shall be installed where maximum ambient ceiling temperatures do not exceed 100°F (38°C).

3-5.3 Intermediate temperature rated residential sprinklers [175 to 225°F (79 to 107°C)] shall be installed where maximum ambient ceiling temperatures are between 101 and 150°F (39 and 66°C).

3-5.4 The following practices shall be observed when installing residential sprinklers, unless maximum expected ambient temperatures are otherwise determined.

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

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

3-5.5 Operated or damaged sprinklers shall be replaced with sprinklers having the same performance characteristics as original equipment.

3-5.6 Painting and Ornamental Finishes.

3-5.6.1* Sprinkler frames may be factory painted or enameled as ornamental finish in accordance with 3-5.6.2; otherwise sprinklers shall not be painted and any sprinklers that have been painted, except for factory applied coatings, shall be replaced with new listed sprinklers.

3-5.6.2 Ornamental finishes shall not be applied to sprinklers by anyone other than the sprinkler manufacturer, and only sprinklers listed with such finishes shall be used.

3-5.7 When 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 mobile homes having smoke detectors in accordance with NFPA 74, Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment.

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 not less than the listing of the sprinkler.

4-1.2* Number of Design Sprinklers. The number of design sprinklers shall include all sprinklers within a compartment to a maximum of two sprinklers.

4-1.2.1 The definition of compartment for use in 4-1.2 to determine the number of design sprinklers is a space that is completely enclosed by walls and a ceiling. The compartment enclosure may have openings to an adjoining space if 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 of 4-1.1 by the number of design sprinklers of 4-1.2.

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 sq ft (13.4 m²).

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

4-1.5 The minimum operating pressure of any sprinkler shall be in accordance with the listing information of the sprinkler and 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, 4-1.4, and 4-1.5 may be used with special sprinklers that have been listed for such specific residential installation conditions.

4-2 Position of Sprinklers.

4-2.1 Pendent and upright sprinklers shall be positioned so that the deflectors are within 1 to 4 in. (25.4 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 to 6 in. (102 to 152 mm) of 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.

4-3 System Types.

4-3.1 Wet Pipe Systems. A wet pipe system shall be used when 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 anti-freeze system shall be used.

Exception: Listed standard dry-pendent or dry sidewall sprinklers may 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* 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 When sprinkler systems are supplied by public water connections the use of antifreeze solutions other than water solutions of pure glycerine (C.P. or U.S.P. 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 if Public Water Is Connected to Sprinklers

Material	Solution (by Volume)	Specific Gravity at 60°F (15.6°C)		Freezing Point	
				°F	°C
Glycerine C.P. or U.S.P. Grade*	50% Water	1.133		-15	-26.1
	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%.

4-3.3.3.2 If public water is not connected to sprinklers, the commercially available materials indicated in Table 4-3.3.3.2 are suitable for use in antifreeze solutions.

Table 4-3.3.3.2 Antifreeze Solutions to Be Used if Public Water Is Not Connected to Sprinklers

Material	Solution (by Volume)	Specific Gravity at 60°F (15.6°C)	Freezing Point °F °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		
Calcium Chloride 80% "Flake"	lb CaCl ₂ per gal of Water		
Fire Protection Grade*	2.83	1.183	0 -17.8
Add corrosion inhibitor of sodium bichromate 1/4 oz per gal water	3.38	1.212	-10 -23.3
	3.89	1.237	-20 -28.9
	4.37	1.258	-30 -34.4
	4.73	1.274	-40 -40.0
	4.93	1.283	-50 -45.6

*Free from magnesium chloride and other impurities.

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

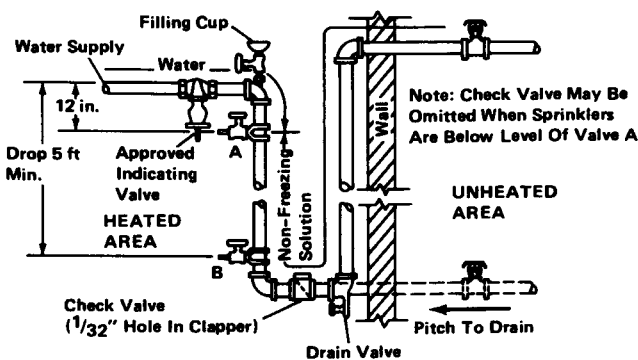
4-3.3.4* Arrangement of Supply Piping and Valves. All permitted antifreeze solutions are heavier than water. At the point of contact (interface) the heavier liquid will be below the lighter liquid in order to prevent diffusion of water into the unheated areas. In most cases, this necessitates the use 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 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.

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 may 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.



NOTE: 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 and thus prevent damage to sprinkler heads.

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Figure 4-3.3.4 Arrangement of supply piping and valves.

Exception No. 1: When 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 is permitted to be calculated based on manufacturer's data when available.

4-4.2 Minimum Pipe Size. Minimum pipe size, including copper piping, shall be 3/4 in. (19 mm).

Exception: Minimum size of steel pipe shall be 1 in. (25.4 mm).

4-4.3* To size piping for systems connected to a city water supply, the following approximate method is acceptable. This procedure cannot be used for gridded or looped type systems. Hydraulic calculation procedures in accordance with Chapter 6 of NFPA 13 for grid-type or looped systems shall be used.

- Establish system flow rate in accordance with Section 4-1.
- Determine water pressure in the street.
- Select pipe sizes.
- Deduct meter pressure losses if any. [See Table 4-4.3(e).]
- Deduct pressure loss for elevation. (Building height above street in ft $\times 0.434$ = psi.) (Building height above street in meters $\times 0.098$ = bars.)
- Deduct pressure losses from the city main to the inside control valve by multiplying the factor from Table 4-4.3(a) or (b) by the total length(s) of pipe in ft (m). [Total length includes equivalent length of fittings as determined by applying Table 4-4.3(c) or (d).]
- Deduct pressure losses for piping within building by multiplying factor from Table 4-4.3(a) or (b) by the total length in ft (m) of each size of pipe between the control valve and the farthest sprinkler.
- Deduct valve and fitting pressure losses. Count the valves and fittings from the control valve to the farthest sprinkler. Determine the equivalent length for each valve and fitting as shown in Table 4-4.3(c) or (d) and add these

Table 4-4.3(a) Pressure Losses (psi/ft) 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 ft = 0.3048 m.

Table 4-4.3(b) Pressure Losses (psi/ft) Copper Tubing — Types K, L, & 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
1 1/4	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 ft = 0.3048 m.

Table 4-4.3(c) Equivalent Length of Pipe in Feet for Steel Fittings and Valves

Fitting/Valve Diameter (in.)	Elbows			Tees		Valves					
	45 Degrees	90 Degrees	Long Radius	Flow Thru Branch	Flow Thru Run	Gate	Angle	Globe	Globe "Y" Pattern	Cock	Check
1	1	3	2	5	2	1	12	28	15	4	4
1 1/4	2	3	2	6	2	2	15	35	18	5	5
1 1/2	2	4	3	8	3	2	18	43	22	6	6
2	3	5	3	10	3	2	24	57	28	7	8

Based on Crane Technical Paper No. 410.

For SI Units: 1 ft = 0.3048 m.

Table 4-4.3(d) Equivalent Length of Pipe in Feet for Copper Fittings and Valves

Fitting/Valve Diameter (in.)	Elbows			Tees		Valves					
	45 Degrees	90 Degrees	Long Radius	Flow Thru Branch	Flow Thru Run	Gate	Angle	Globe	Globe "Y" Pattern	Cock	Check
3/4	1.5	3	1.5	4.5	1.5	1.5	15	32	17	4.5	4.5
1	1.5	3	3	7.5	3	1.5	18	42	23	6.0	7.5
1 1/4	1.5	4.5	3	9	3	1.5	23	53	27	7.5	11
1 1/2	3	6	3	12	4.5	1.5	27	65	33	9	14
2	3	7	4.5	15	4.5	1.5	36	86	42	11	17

Table 4-4.3(e) Pressure Losses in Water Meters

Meter (in.)	Pressure Loss (psi) 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

NOTE: Higher pressure losses specified by the manufacturer should be used in place of those specified in the table. Lower pressure losses may be used when supporting data is provided by the meter manufacturer.

* Above maximum rated flow of commonly available meters.

**Less than 1 psi.

For SI Units: 1 gpm = 3.785 L/min; 1 in. = 25.4 mm.

values to obtain the total equivalent length for each pipe size. Multiply the equivalent length for each size by the factor from Table 4-4.3(a) or (b) and total these values.

(i) In multilevel buildings, steps (a) through (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, a redesign is necessary. If this pressure is higher than required, smaller piping may be used when justified by calculations.

(k) The remaining piping shall be sized the same as the piping to the farthest sprinkler unless smaller sizes are justified by calculations.

Exception: 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.)

4-4.4 To size piping for systems with an elevated tank, pump, or pump-tank combination, determine the pressure at the water supply outlet and proceed through steps (c), (e), (g), (h), (i), (j), and (k) of 4-4.3.

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

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

Exception No. 1: Sprinklers are not required in bathrooms 55 sq ft (5.1 m²) and less.

Exception No. 2: Sprinklers are not required in clothes closets, linen closets, and pantries where the area of the space does not exceed 24 sq ft (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 may be omitted from garages, open attached porches, carports, and similar structures.

Exception No. 4: Sprinklers may be omitted from attics, crawl spaces, and other concealed spaces that are not used or intended for living purposes or storage.

Exception No. 5: Sprinklers may be omitted from entrance foyers that are not the only means of egress.

Chapter 5 Referenced Publications

5-1 The following documents or portions thereof are referenced within this standard and shall be considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

5-1.1 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*, 1991 edition

NFPA 22, *Standard for Water Tanks for Private Fire Protection*, 1987 edition

NFPA 74, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*, 1989 edition

NFPA 220, *Standard on Types of Building Construction*, 1985 edition.

5-1.2 Other Publications.

5-1.2.1 ANSI Publications. American National Standards Institute, Inc., 1450 Broadway, New York, NY 10018.

ANSI B16.1-1989, *Cast Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800*

ANSI B16.3-1985, *Malleable Iron Threaded Fittings, Class 150 and 300*

ANSI B16.4-1985, *Cast Iron Threaded Fittings, Classes 125 and 250*

ANSI B16.5-1988, *Pipe Flanges and Flanged Fittings*

ANSI B16.9-1986, *Factory-Made Wrought Steel Butt Welding Fittings*

ANSI B16.11-1980, *Forged Steel Fittings, Socket-Welding and Threaded*

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

ANSI B16.22-1989, *Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*

ANSI B16.25-1986, *Butt Welding Ends*

ANSI B36.10M-1985, *Welded and Seamless Wrought Steel Pipe*

5-1.2.2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19105.

ASTM A53-1990, *Standard Specification for Pipe, Steel, Black, and Hot-Dipped, Zinc-Coated Welded and Seamless Steel Pipe*

ASTM A135-1989, *Standard Specification for Electric-Resistance-Welded Steel Pipe*

ASTM A234-1990, *Standard Specification for Piping Fittings of Wrought Carbon Steel and Alloy Steel for Moderate and Elevated Temperatures*

ASTM A795-1990, *Specification for Black and Hot-Dipped Zinc-Coated Welded and Seamless Steel Pipe for Fire Protection Use*

ASTM B32-1989, *Standard Specification for Solder Metal, 95-5 (Tin-Antimony-Grade 95TA)*

ASTM B75-1986, *Standard Specification for Seamless Copper Tube*

ASTM B88-1989, *Standard Specification for Seamless Copper Water Tube*

ASTM B251-1988, *Standard Specification for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*

ASTM E380-1989, *Standard for Metric Practice*

5-1.2.3 AWS Publication. American Welding Society, 550 NW LeJeune Road, Miami, FL 33135.

AWS A5.8-1989, *Specification for Brazing Filler Metal*

Appendix A

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

A-1-1 NFPA 13D is appropriate for the protection against fire hazards only in one- and two-family dwellings and mobile homes. Residential portions of any other building may be protected with residential sprinklers in accordance with 4-3.6 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), (b), and (c) on the following page. 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 if sprinklers are installed in the compartment. A sprinkler system designed and installed according to this standard cannot, however, be completely expected to control a fire involving unusually higher average fuel loads than typical for dwelling units [10 lb/sq ft (49 kg/m²)] and

where the interior finish has an unusually high flame spread rating (greater than 225).

For protection of multifamily dwellings, refer to 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*.

A-1-2 Levels of Protection. Various levels of firesafety 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 are the ones shown by NFPA statistics [see Table A-1-2(a)] to be the ones where the incidence of life loss from fires in dwellings is low. Such an approach produces a reasonable degree of firesafety. Greater protection to both life and property will be achieved by sprinklering all areas.

Guidance for installation of smoke detectors and fire detection systems may be found in NFPA 74, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*.

A-1-3 Control Valve. System control valves should be of the indicating type, such as plug valves, ball valves, butterfly valves, or O. S. & Y. gate valves.

A-1-4 The responsibility for properly maintaining a sprinkler system is the obligation of the owner or manager who should understand the sprinkler system operation. A minimum monthly maintenance program should include the following:

- (a) Visually inspect all sprinklers to ensure against obstruction of spray.
- (b) Inspect all valves to assure that they are open.
- (c) Test all waterflow devices.
- (d) The alarm system, if installed, should be tested.

NOTE: When it appears likely that the test will result in a response of the fire department, notification to the fire department should be made prior to the test.

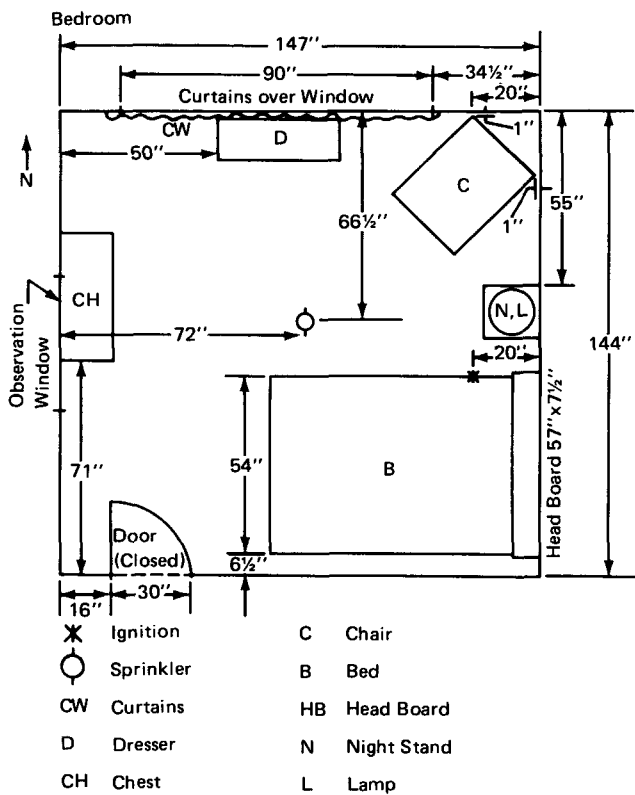
(e) Pumps, where employed, should be operated. (See NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*.)

(f) The pressure of air used with dry systems should be checked.

(g) Water level in tanks should be checked.

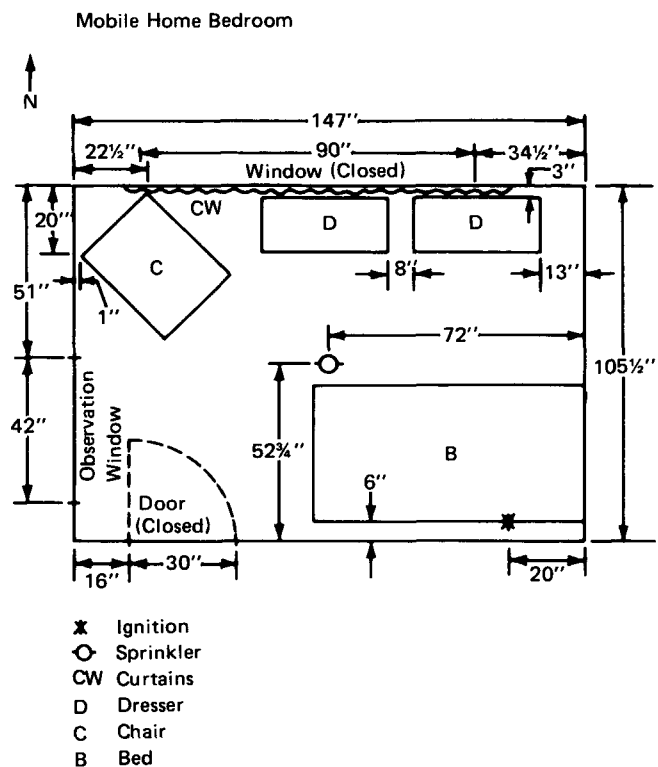
(h) Care should be taken to see that sprinklers are not painted either at the time of installation or during subsequent redecoration. When painting sprinkler piping or painting in areas next to sprinklers, the sprinklers may be protected by covering with a bag, which should be removed immediately after painting has been finished.

(i) For further information see NFPA 13A, *Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems*.



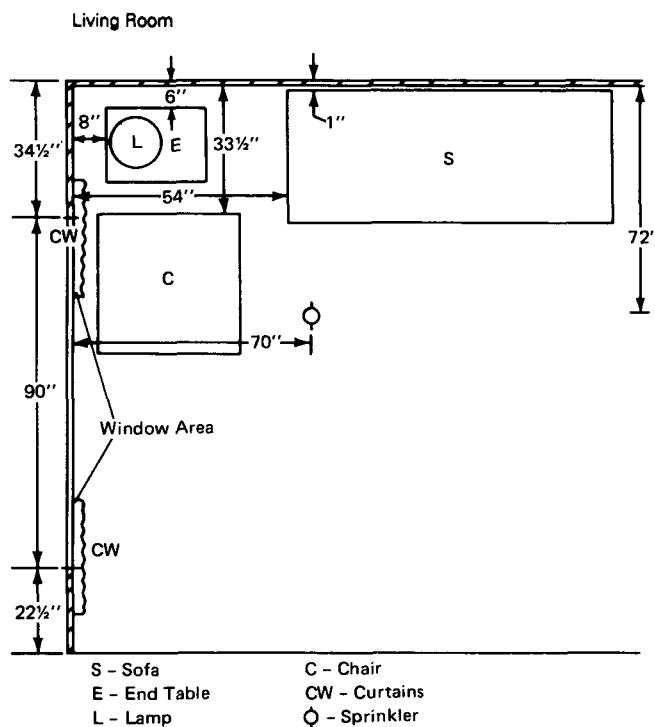
For SI Units: 1 in. = 25.4 mm.

Figure A-1-1(a) Bedroom.



For SI Units: 1 in. = 25.4 mm.

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



For SI Units: 1 in. = 25.4 mm.

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

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

Area of Origin		Form of Heat of Ignition	
Living Room	41%	Smoking Materials	36%
Bedroom	27%	Heat from Fuel — Fire or	25%
Kitchen	15%	Powered Object	
Storage Area	4%	Heat from Miscellaneous	15%
Heating Equipment Room	3%	Open Flame (Including	
Structural Area	2%	Match)	
Other Areas	8%	Heat from Electrical	14%
		Equipment Arcing or	
		Overload	
Form of Materials Ignited		Hot Objects Including	
Furniture	27%	Properly Operating	7%
Bedding	18%	Electrical Equipment	
Combustible Liquid or Gas	13%	Other	3%
Interior Finish	9%		
Structural Member	9%		
Waste, Rubbish	4%		
Clothing, on a Person	3%		
Cooking Materials	3%		
Electrical Insulation	2%		
Curtains, Drapery	2%		
Other	10%		

Based on 6066 incidents where area of origin was reported

Based on 5016 incidents where form of heat of ignition was reported

Based on 5080 incidents where form of material ignited was reported

Total number of incidents reported 10,194

Source: FIDO Data Base 1973 to 1982, NFPA Fire Analysis Department.

Table A-1-2(b) 1980-84 One- and Two-Family Dwellings and Mobile Homes Annual Averages

Fires—544,000		Civilian Deaths—3,900		Civilian Injuries—14,000	
		Percentages by Area of Origin			
Area of Origin (901 Code)	Civilian Deaths (Used for Ranking)	Fires	Civilian Injuries		
Living room, den, lounge (14)	40.2	11.6	21.9		
Bedroom (21-22)	24.1	11.6	20.9		
Kitchen (24)	14.0	20.6	27.5		
Structural Area (70-79)	5.8	15.5	7.4		
[Crawl space (71)]	(1.5)	(3.2)	(2.9)		
[Unspecified (79)]	(1.0)	(1.0)	(0.7)		
[Balcony, porch (72)]	(0.9)	(1.1)	(0.9)		
[Ceiling/Floor assembly (73)]	(0.7)	(0.8)	(0.5)		
[Ceiling/Roof assembly (74)]	(0.6)	(2.3)	(0.7)		
[Wall assembly (75)]	(0.6)	(2.0)	(0.8)		
Dining room (23)	2.3	1.1	1.6		
Heating equipment room (62)	1.9	3.7	3.6		
Bathroom (25)	1.2	1.7	1.9		
Hallway, corridor (01)	1.2	0.9	1.1		
Garage* (47)	1.1	3.4	3.7		
Interior stairway (03)	1.0	0.4	0.4		
Closet (42)	0.9	1.2	1.3		
Other known single area	4.2	26.6	7.5		
[Chimney (51)]	(0.4)	(18.9)	(0.7)		
Multiple areas (97)	0.8	0.7	0.6		
Unclassified, not applicable (98-99)	1.3	1.0	0.6		
Total:	100.0	100.0	100.0		

* Does not include dwelling garages coded as property type, which is a large number.

A-1-5.1 At least three spare sprinklers of each type, temperature rating, and orifice size used in the system should be kept on the premises. When fused sprinklers are replaced by the owner, fire department, or others, care should be taken to assure 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 may 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 required.

Dry systems should also 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. Check for leaks using soapy water

brushed on each joint or coupling. Leaks will be shown by the presence of bubbles. This test should be made prior to concealing of piping.

A-2-2 Connection for fire protection to city mains is often subject to local regulation concerning metering and back-flow prevention requirements. Preferred and acceptable water supply arrangements are shown in Figures A-2-2(a), (b), and (c). When a meter must be used between the city water main and the sprinkler system supply, an acceptable arrangement is shown in Figure A-2-2(c). Under these circumstances, the flow characteristics of the meter must be included in the hydraulic calculation of the system. [See Table 4-4.3(e).] When a tank is used for both domestic and fire protection purposes, a low water alarm actuated 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.

A-2-3 See Figures A-2-3(a), (b), and (c).

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

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-3-5.6.1 Decorative painting of a residential sprinkler is not to be confused with the temperature identification colors as referenced 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 with all intervening doors closed. The tests of audibility level should be conducted with all household equipment that may be in operation at night in full operation. Examples of such equipment are window air conditioners and room humidifiers. When off-premises alarms are provided, at least water flow and control valve position should be monitored.

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

A-4-1.2 It is intended that the design area is to include the two adjacent sprinklers producing the greatest water demand within the compartment. It is also intended that the number of design sprinklers is limited to a maximum of two sprinklers even if there are more than two sprinklers in the compartment, except as noted in A-4-2.3.

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 will be necessary to achieve proper response and distribution. In addition, for sloped ceilings, higher flow rates may be needed. Guidance may be obtained from the manufacturer.

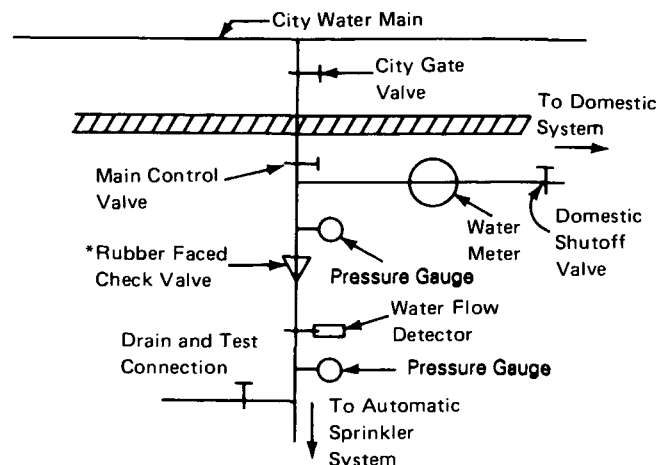


Figure A-2-2(a) Preferred arrangement.

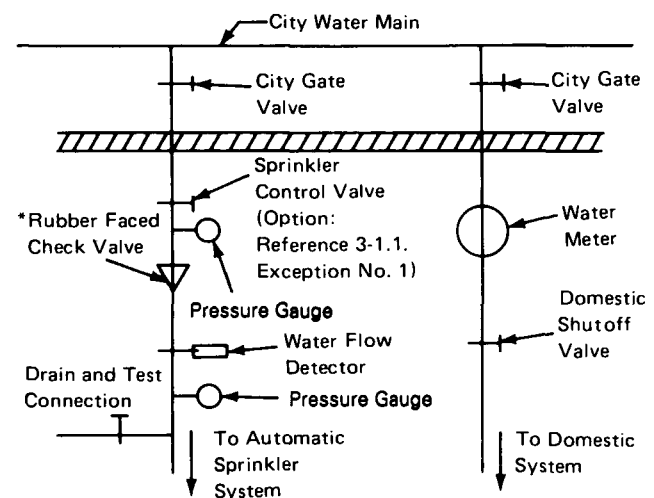
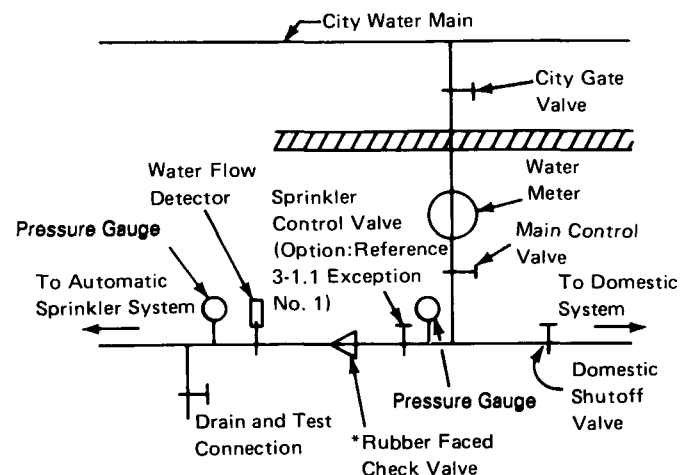


Figure A-2-2(b) Acceptable arrangement.



*Rubber Faced Check Valves Optional.

Figure A-2-2(c) Acceptable arrangement.

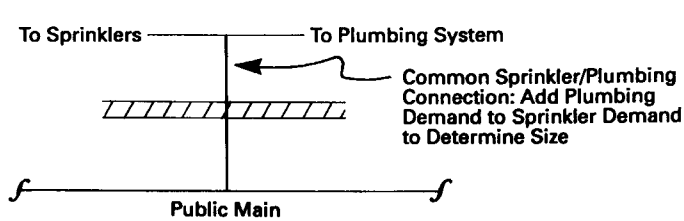


Figure A-2-3(a).

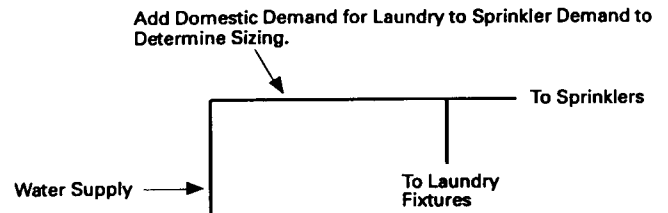


Figure A-2-3(b).

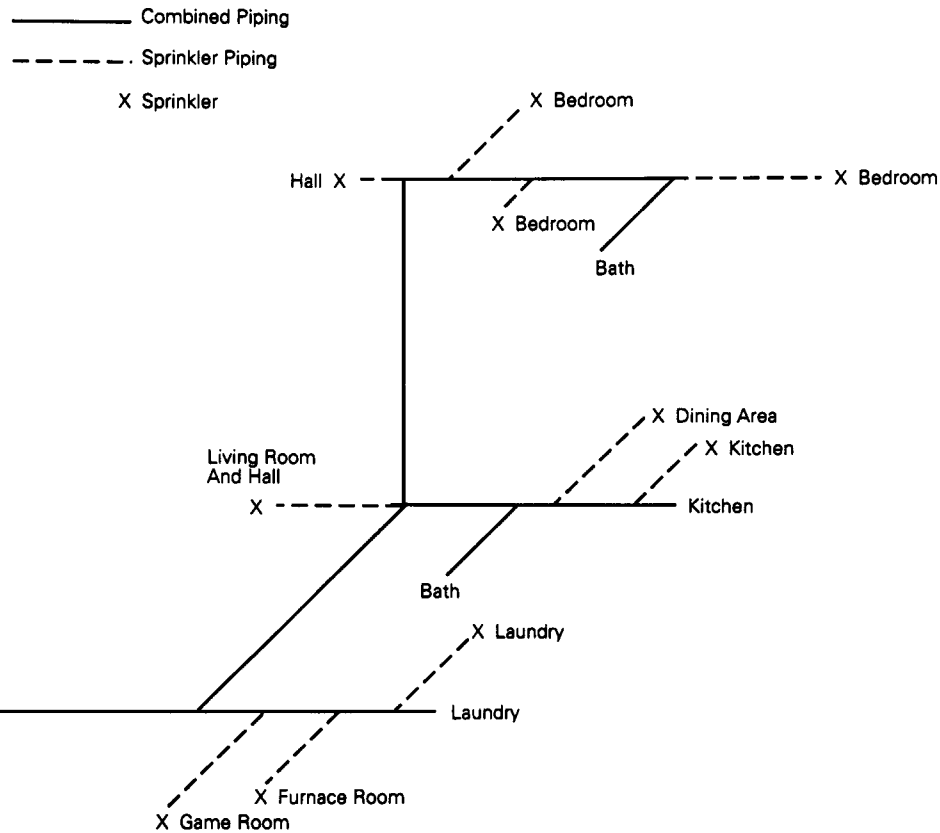


Figure A-2-3(c).

A series of 33 full-scale tests were conducted in a test room of 12 ft × 24 ft (3.6 m × 7.2 m) floor area to determine the effect of cathedral (sloped) and/or beamed ceiling construction on fast response residential sprinkler performance. The testing was limited to one pendent-type residential sprinkler model, two ceiling slopes (0 and 14 degrees), and two beam configurations on the 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 NFPA 13D. The results of the baseline tests were compared with tests in which the ceiling was beamed and/or sloped and two pendent sprinklers were installed with the same water supply. Under the limited conditions tested, the comparison indicates that sloped and/or beamed ceilings 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 may be obtained if 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 when 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.¹

A-4-3.3.2 Antifreeze solutions may be used for maintaining automatic sprinkler protection in small unheated areas. Antifreeze solutions are recommended only for systems not exceeding 40 gal (151 L).

¹ Effects of Cathedral and Beamed Ceiling Construction on Residential Sprinkler Performance, FMRC J.I. M3N5.RA(3), by Bill Jr., R.G.; Kung, N-C; Brown, W.R.; and Hill, E., prepared for U.S. Fire Administration (Feb. 1988).

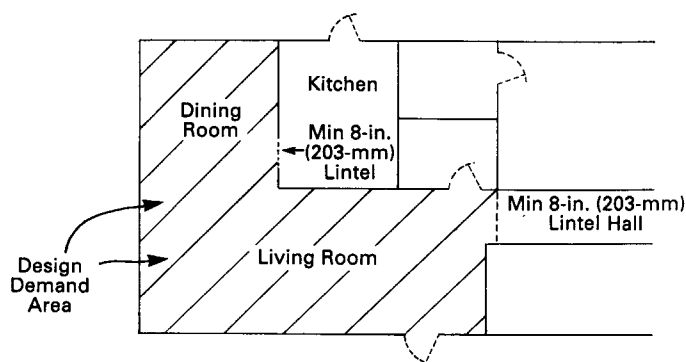


Figure A-4-1.2(a) Sprinkler design areas for typical residential occupancy.

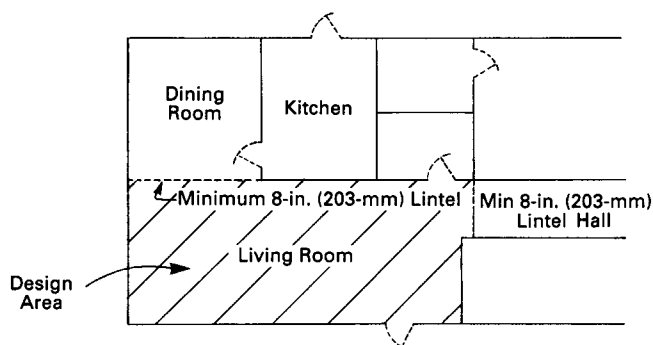


Figure A-4-1.2(b) Sprinkler design areas for typical residential occupancy.

Table A-4-2.3 Maximum Distance from Sprinkler Deflector to Bottom of Ceiling Obstruction

Distance from Sprinkler to Side of Ceiling Obstruction	Maximum Distance from Sprinkler Deflector to Bottom of Ceiling Obstruction
Less than 6 in.	Not permitted
6 in. to less than 1 ft	0 in.
1 ft to less than 2 ft	1 in.
2 ft to less than 2 ft 6 in.	2 in.
2 ft 6 in. to less than 3 ft	3 in.
3 ft to less than 3 ft 6 in.	4 in.
3 ft 6 in. to less than 4 ft	6 in.
4 ft to less than 4 ft 6 in.	7 in.
4 ft 6 in. to less than 5 ft	9 in.
5 ft to less than 5 ft 6 in.	11 in.
5 ft 6 in. to less than 6 ft	14 in.

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m.

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

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

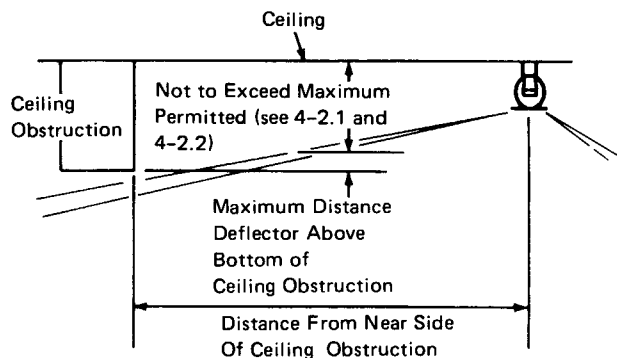


Figure A-4-2.3 Position of deflector, upright or pendent, when located above bottom of ceiling obstruction.

A-4-3.3.3.3 Beyond certain limits, increased proportion of antifreeze does not lower the freezing point of solution. (See Figure A-4-3.3.3.3.) Glycerine, diethylene glycol, ethylene glycol, and propylene glycol should never be used without mixing with water in 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 polybutylene sprinkler pipe and fittings can be protected with glycerine, diethylene glycol, ethylene glycol, or propylene glycol.

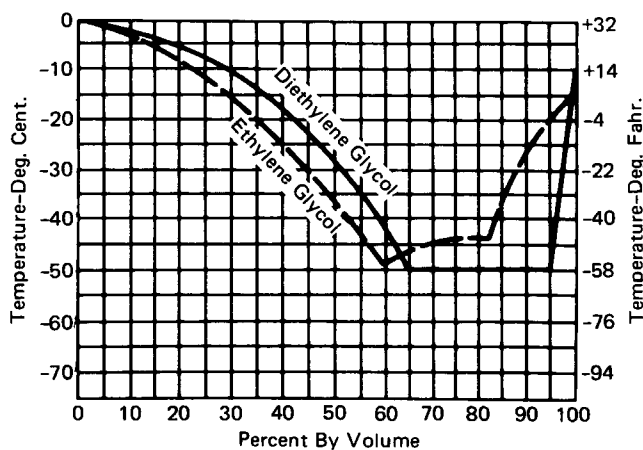


Figure A-4-3.3.3.3 Freezing points of water solutions of ethylene glycol and diethylene glycol.

A-4-3.3.4 To avoid leakage, the materials and workmanship should be excellent, the threads clean and sharp, and the joints tight. Use only metal-faced valves.

A-4-3.3.5 Tests should be made by drawing a sample of the solution from valve B two or three times during the freezing season, especially if it has been necessary to drain the building sprinkler system for repairs, changes, etc. A

small hydrometer should be used so that a small sample will be sufficient. When water appears at valve B or when the test sample indicates that the solution has become weakened, empty the entire system and recharge as previously described.

A-4-4.3 Determination of public water supply pressure should take into account probable minimum pressure conditions prevailing during such periods as at night, or during summer months when heavy usage may occur; also, the possibility of interruption by floods, or ice conditions in winter.

		Individual Loss	Net Total
a.	Water Pressure in Street _____	_____	_____
b.	Arbitrarily Select Pipe Size _____	_____	_____
c.	Deduct Meter Loss (____ Size) _____	_____	_____
d.	Deduct Head Loss for Elevation System Control Valve* (____ ft × 0.434) _____	_____	_____
e.	Deduct Pressure Loss from City Main to Sprinkler _____	_____	_____
	____ Pipe – _____ ft		
	____ Valves – _____ ft		
	____ Elbows – _____ ft		
	____ Tee – _____ ft		
	____ Total – _____ ft × _____	_____	_____
f.	Deduct Pressure Loss for Piping— Control Valve to Farthest Sprinkler*	_____	_____

Size	Quan.	Description	Total Equiv. Feet
_____	_____	90° Elbow	_____
_____	_____	45° Elbow	_____
_____	_____	Tee	_____
_____	_____	Check Valve	_____
_____	_____	Valve (____)	_____
_____	_____	Total	_____

Ft × ____ = ____

Size	Quan.	Description	Total Equiv. Feet
_____	_____	90° Elbow	_____
_____	_____	45° Elbow	_____
_____	_____	Tee	_____
_____	_____	Check Valve	_____
_____	_____	Valve (____)	_____
_____	_____	Total	_____

Ft × ____ = ____

Remaining Pressure for Sprinkler Operation _____

*Factors from Tables 4-4.3(a), (b), (c), (d), and (e).
For SI Units: 1 ft = 0.3048 m; 1 psi = 0.0689 bar.

Figure A-4-4.3(1) Calculation sheet.

	Individual Loss	Net Total
Water Pressure at Supply Outlet		
a. Deduct Head Loss for Elevation (____ ft × 0.434)	_____	_____
b. Deduct Pressure Loss from Piping within Building*	_____	_____
Remaining Pressure for Sprinkler Operation	_____	_____

*Factors from Tables 4-4.3(a), (b), (c), (d), and (e).
For SI Units: 1 ft = 0.3048 m; 1 psi = 0.0689 bar.

**Figure A-4-4.3(2) Calculation sheet — elevated tank,
booster pump, pump tank supply.**

Appendix B Referenced Publications

This Appendix is not a part of the requirements of this NFPA document, but is included for information purposes only.

B-1 The following documents or portions thereof are referenced within this standard for informational purposes only and thus are not considered part of the requirements of this document. The edition indicated for each reference is the current edition as of the date of the NFPA issuance of this document.

B-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*, 1991 edition

NFPA 13A, *Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems*, 1987 edition

NFPA 13R, *Standard for the Installation of Sprinkler Systems in Residential Occupancies up to and Including Four Stories in Height*, 1991 edition

NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*, 1990 edition

NFPA 74, *Standard for the Installation, Maintenance, and Use of Household Fire Warning Equipment*, 1989 edition

Index

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