NFPA 13 Installation of Sprinkler Systems 1987 Edition

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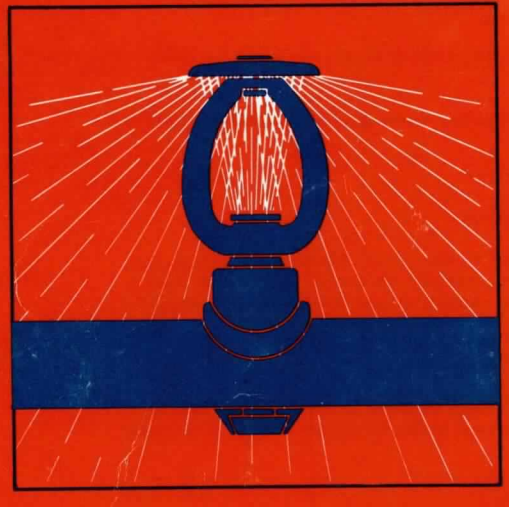

NFPA®

National Fire Protection Association Batterymarch Park, Quincy, MA 02269

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All questions or other communications relating to this document should be sent only to NFPA Headquarters, addressed to the attention of the Committee responsible for the document.

For information on the procedures for requesting Technical Committees to issue Formal Interpretations, proposing Tentative Interim Amendments, proposing amendments for Committee consideration, and appeals on matters relating to the content of the document, write to the Secretary, Standards Council, National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

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Policy Adopted by NFPA Board of Directors on December 3, 1982

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.

Statement on NFPA Procedures

This material has been developed under the published procedures of the National Fire Protection Association, which are designed to assure the appointment of technically competent Committees having balanced representation. While these procedures assure the highest degree of care, neither the National Fire Protection Association, its members, nor those participating in its activities accepts any liability resulting from compliance or noncompliance with the provisions given herein, for any restrictions imposed on materials or processes, or for the completeness of the text.

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Errata

NFPA 13

Installation of Sprinkler Systems

1987 Edition

Reference: Table 4-5.2.1, Figure A-4-4.18, Table 3-6.2 (b)

The Committee on Automatic Sprinklers notes the following errors in NFPA 13-1987.

1. *In Table 4-5.2.1, change the number* 12 *in the second row, third column to* 14.

2. *In Figure A-4-4.18 in the Legend, items K and M, replace existing text with* "In accordance with the listing". *In addition, in the lower part of the figure, delete the dimension* "K" *between* "M" *and* "O".

3. *Table 3-6.2 (b) in the heading to the Table, change* "Less Than" *to* "More Than".

NFPA 13

Standard for the Installation of Sprinkler Systems

1987 Edition

This edition of NFPA 13, *Standard for the Installation of Sprinkler Systems*, 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 Fall Meeting held November 17-20, 1986 in Denver, Colorado. It was issued by the Standards Council on January 23, 1987 with an effective date of February 12, 1987 and supersedes all previous editions.

The 1987 edition of this standard 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 13

This standard was first printed under the direction of the Committee on Automatic Sprinklers in 1896 and since that date has been continuously revised to keep it up to date.

Full information as to the NFPA actions on various changes will be found in the NFPA Proceedings. The dates of successive editions are as follows: 1896, 1899, 1902, 1905, 1907, 1908, 1910, 1912, 1913, 1915, 1916, 1917, 1919, 1920, 1921, 1922, 1923, 1924, 1925, 1926, 1927, 1928, 1929. In 1930 a separate standard was published on "Class B" systems. This was integrated in the 1931 edition. Further revisions were adopted in 1934, 1935 and 1936. A complete revision was presented in the form of a progress report in 1939 and finally adopted in 1940. Further amendments were made in 1947, 1950, 1953, 1956, 1958, 1960, 1961, 1963, 1964, 1965, 1966, 1968, 1969, 1971, 1972, 1973, 1974, 1975, 1976, 1978, 1980, 1982, 1984, and 1986.

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This list represents the membership at the time the Committee was balloted on the text of this edition. Since that time, changes in the membership may have occurred.

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.

Contents

NFPA 13

Standard for the Installation of Sprinkler Systems

1987 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 9 and Appendix D.

Chapter 1 General Information

1-1 Scope. This standard provides the minimum requirements for the design and installation of automatic sprinkler systems and of exposure protection sprinkler systems, including the character and adequacy of water supplies and the selection of sprinklers, piping, valves, and all materials and accessories; but not including the installation of private fire service mains and their appurtenances, the installation of fire pumps, the construction and installation of gravity and pressure tanks and towers.

NOTE: Consult other NFPA standards for additional requirements relating to water supplies.

1-2 Purpose. The purpose of this standard is to provide a reasonable degree of protection for life and property from fire through standardized installation requirements for sprinkler systems based upon sound engineering principles, test data, and field experience. The standard endeavors to continue the excellent record that has been established by standard sprinkler systems and meet the needs of changing technology. 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. Materials or devices not specifically designated by this standard shall be utilized in complete accord with all conditions, requirements, and limitations of their listings.

NOTE 1: A sprinkler system is a specialized fire protection system and requires knowledgeable and experienced design and installation.

NOTE 2: Since its inception, this document has been developed on the basis of standardized materials, devices, and design practices. However, certain paragraphs, such as 3-1.1.5, 4-1.1.3, and this one, allow the use of materials and devices not specifically designated by this standard, provided such use is within parameters established by testing and listing agencies. In using such materials or devices, it is important that all conditions, requirements, and limitations of the listing be fully understood and accepted, and that the installation is in complete accord with such listing requirements.

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."

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.

For purposes of this standard, dwelling unit includes hotel rooms, dormitory rooms, apartments, condominiums, sleeping rooms in nursing homes, and similar living units.

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.

Shall. Indicates a mandatory requirement.

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

Sprinkler System. A sprinkler system, for fire protection purposes, is an integrated system of underground and overhead piping designed in accordance with fire protection engineering standards. The installation includes one or more automatic water supplies. The portion of the sprinkler system aboveground is a network of specially sized or hyraulically designed piping installed in a building, structure or area, generally overhead, and to which sprinklers are attached in a systematic pattern.

The valve controlling each system riser is located in the system riser or its supply piping. Each sprinkler system riser includes a device for actuating an alarm when the system is in operation. The system is usually activated by heat from a fire and discharges water over the fire area.

NOTE: The design and installation of water supply facilities such as gravity tanks, fire pumps, reservoirs or pressure tanks, and underground piping are covered by the following NFPA standards: NFPA 22, *Water Tanks for Private Fire Protection*; NFPA 20, *Installation of Centrifugal Fire Pumps*; and NFPA 24, *Installation of Private Fire Service Mains and Their Appurtenances*.

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.

1-4 Other Publications. A selected list of other publications related to the installation of sprinkler systems is published at the end of this standard.

1-5 Maintenance.

1-5.1* A sprinkler system installed under this standard shall be properly maintained for efficient service. The owner is responsible for the condition of the sprinkler system and shall use due diligence in keeping the system in good operating condition.

1-5.2 The installing contractor shall provide the owner with:

(a) Instruction charts describing operation and proper maintenance of sprinkler devices.

(b) Publication entitled NFPA 13A, *Recommended Practice for the Inspection, Testing, and Maintenance of Sprinkler Systems.*

1-6 Classification of Sprinkler Systems.

1-6.1 This standard covers automatic sprinkler systems of the types listed below, and systems of outside sprinklers for protection against exposure fires covered specifically in Chapter 6. Manually operated deluge systems, used for certain special hazard conditions, are not specifically covered in this standard but certain provisions of this standard will be found applicable.

Wet-Pipe Systems (*See Section 5-1.*)

Dry-Pipe Systems (*See Section 5-2.*)

Preaction Systems (*See Section 5-3.*)

Deluge Systems (*See Section 5-3.*)

Combined Dry-Pipe and Preaction Systems (*See Section 5-4.*)

Sprinkler Systems – Special Types. Special purpose systems employing departures from the requirements of this standard, such as special water supplies and reduced pipe sizing, shall be installed in accordance with their listing.

1-7 Classification of Occupancies.

1-7.1* Occupancy classifications for this standard relate to sprinkler installations and their water supplies only. They are not intended to be a general classification of occupancy hazards.

1-7.2 Light Hazard Occupancies.

1-7.2.1* Light Hazard. Occupancies or portions of other occupancies where the quantity and/or combustibility of contents is low and fires with relatively low rates of heat release are expected.

1-7.3 Ordinary Hazard Occupancies.

1-7.3.1* Ordinary Hazard (Group 1). Occupancies or portions of other occupancies where combustibility is low, quantity of combustibles is moderate, stock piles of combustibles do not exceed 8 ft (2.4 m), and fires with moderate rates of heat release are expected.

1-7.3.2* Ordinary Hazard (Group 2). Occupancies or portions of other occupancies where quantity and combustibility of contents is moderate, stock piles do not exceed 12 ft (3.7 m), and fires with moderate rate of heat release are expected.

1-7.3.3* Ordinary Hazard (Group 3). Occupancies or portions of other occupancies where quantity and/or combustibility of contents is high, and fires of high rate of heat release are expected.

1-7.4* Extra Hazard Occupancies.

1-7.4.1* Extra Hazard Occupancies or portions of other occupancies where quantity and combustibility of contents is very high, and flammable and combustible liquids, dust, lint, or other materials are present introducing the probability of rapidly developing fires with high rates of heat release.

1-7.4.2 Extra Hazard Occupancies involve a wide range of variables that may produce severe fires. The following shall be used to evaluate the severity of Extra Hazard Occupancies:

Extra Hazard (Group 1) includes occupancies described in 1-7.4.1 with little or no flammable or combustible liquids.

Extra Hazard (Group 2) includes occupancies described in 1-7.4.1 with moderate to substantial amounts of flammable or combustible liquids or where shielding of combustibles is extensive.

1-8* Design and Installation.

1-8.1 Devices and Materials.

1-8.1.1 Only new sprinklers shall be employed in the installation of sprinkler systems.

1-8.1.2* When a sprinkler system is installed, only approved materials and devices shall be used.

1-8.1.3 Sprinkler systems shall be designed for a maximum working pressure of 175 psi (12.1 bars).

Exception: Higher design pressures may be used when all system components are rated for pressures higher than 175 psi (12.1 bars).

1-8.1.3.1 Interior system components subject to pressure shall be designed for a working pressure not less than 175 psi (12.1 bars).

1-9* Working Plans.

1-9.1 Working plans shall be submitted for approval to the authority having jurisdiction before any equipment is installed or remodeled. Deviation from approved plans will require permission of the authority having jurisdiction.

1-9.2* Working plans shall be drawn to an indicated scale, on sheets of uniform size, with plan of each floor, made so that they can be easily duplicated, and shall show the following data:

(a) Name of owner and occupant

(b) Location, including street address

(c) Point of compass

(d) Ceiling construction

(e) Full height cross section

(f) Location of fire walls

(g) Location of partitions

(h) Occupancy of each area or room

(i) Location and size of concealed spaces, closets, and bathrooms [*see 4-4.3 to 4-4.17 inclusive, (except 4-4.5 and 4-4.6) and 4-4.20*]

(j) Any questionable small enclosures in which no sprinklers are to be installed

(k) Size of city main in street, pressure and whether dead-end or circulating and, if dead-end, direction and distance to nearest circulating main, city main test results (*see B-2-1*)

(l) Other sources of water supply, with pressure or elevation

(m) Make, type, and nominal orifice size of sprinkler

(n) Temperature rating and location of high-temperature sprinklers

(o) Total area protected by each system on each floor

(p) Number of sprinklers on each riser per floor

(q) Make, type, model, and size of alarm or dry-pipe valve

(r) Make, type, model, and size of preaction or deluge valve

(s) Kind and location of alarm bells

(t) Total number of sprinklers on each dry-pipe system, preaction system, combined dry-pipe/preaction system or deluge system

(u) Approximate capacity in gallons of each dry-pipe system

(v) Pipe type and schedule of wall thickness

(w) Nominal pipe size and cutting lengths of pipe (or center to center dimensions)

NOTE: Where typical branch lines prevail, it will be necessary to size only one line.

(x) Location and size of riser nipples

(y) Type of fittings and joints and location of all welds and bends

(z) Type and locations of hangers, sleeves, braces, and methods of securing sprinklers when applicable

(aa) All control valves, check valves, drain pipes, and test connections

(bb) Size and location of hand hose, hose outlets, and related equipment

(cc) Underground pipe size, length, location, weight, material, point of connection to city main; the type of valves, meters, and valve pits; and the depth that top of the pipe is laid below grade

(dd) Provision for flushing (*see 3-8.2*)

(ee) When the equipment is to be installed as an addition to an existing system enough of the existing system shall be indicated on the plans to make all conditions clear

(ff) For hydraulically designed systems, the material to be included on the hydraulic data nameplate

(gg) Name and address of contractor.

1-10 Approval of Sprinkler Systems.

1-10.1 The installer shall perform all required acceptance tests (*see Section 1-11*), complete the Contractor's Material and Test Certificate(s) (*see Section 1-12*), and forward the certificate(s) to the authority having jurisdiction prior to asking for approval of the installation.

1-10.2 When the authority having jurisdiction desires to be present during the conduct of acceptance tests, the installer shall give advance notification of the time and date the testing will be performed.

1-11 Acceptance Tests.

1-11.1* Flushing of Underground Connections.

1-11.1.1 Underground mains and lead-in connections to system risers shall be flushed before connection is made to sprinkler piping in order to remove foreign materials that may have entered the underground piping during the course of the installation. For all systems, the flushing operation shall be continued until water is clear.

1-11.1.2* Underground mains and lead-in connections shall be flushed at a flow rate not less than indicated in Table 1-11.1.2 or at the hydraulically calculated water demand rate of the system, whichever is greater.

Exception No. 1: When the water supply will not produce the stipulated flow rate, connections to a hydraulically designed system may be flushed at the demand rate of the system, including hose streams if hose or hydrants or both are supplied from that connection.

Exception No. 2: For pipe schedule systems, when the water supply will not produce the stipulated flow rate, the maximum flow rate available shall be used.

Table 1-11.1.2 Underground Main Flush Rates

Pipe Size	Flow Rate	L/min.
4 in.	400 gpm	1514
5 in.	600 gpm	2271
6 in.	750 gpm	2839
8 in.	1000 gpm	3785
10 in.	1500 gpm	5678
12 in.	2000 gpm	7570

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

1-11.1.3 Provision shall be made for the disposal of water issuing from test outlets to avoid property damage.

1-11.2 Hydrostatic Tests.

1-11.2.1* All new systems including yard piping shall be hydrostatically tested at not less than 200 psi (13.8 bars) pressure for 2 hours, or at 50 psi (3.4 bars) in excess of the maximum pressure, when the maximum pressure to be maintained in the system is in excess of 150 psi (10.3 bars).

The test pressure shall be read from a gage located at the low elevation point of the individual system or portion of the system being tested.

Exception: At seasons of the year that will not permit testing with water an interim test may be conducted with air pressure of at least 40 psi (2.8 bars) allowed to stand for 24 hours. The standard hydrostatic test shall be conducted when weather permits.

1-11.2.2* Permissible Leakage. The inside sprinkler piping shall be installed in such a manner that there will be no visible leakage when the system is subjected to the hydrostatic pressure test. Refer to NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances*, for permissible leakage in underground piping. The amount of leakage shall be measured by pumping from a calibrated container.

1-11.2.3 Fire Department Connection. Piping between the check valve in the fire department inlet pipe and the outside connection shall be tested in the same manner as the balance of the system.

1-11.2.4 Corrosive Chemicals. Brine or other corrosive chemicals shall not be used for testing systems.

1-11.2.5 Test Blanks. Whenever a test blank is used it shall be of the self-indicating type. Test blanks shall have red painted lugs protruding beyond the flange in such a way as to clearly indicate their presence. The installer shall have all test blanks numbered so as to keep track of their use and assure their removal after the work is completed.

1-11.3 Test of Dry-Pipe Systems.

1-11.3.1 Differential Dry-Pipe Valves. The clapper of a differential type dry-pipe valve shall be held off its seat during any test in excess of 50 psi (3.4 bars) to prevent damaging the valve.

1-11.3.2 Air Test. In dry-pipe systems an air pressure of 40 psi (2.8 bars) shall be pumped up, allowed to stand 24 hours, and all leaks that allow a loss of pressure over 1½ psi (0.1 bar) for the 24 hours shall be stopped.

1-11.3.3 Operating Test of Dry-Pipe Valve. A working test of the dry-pipe valve alone and with a quick-opening device, if installed, shall be made before acceptance by opening the system test connection. Trip and water delivery times shall be measured from the time the inspector's test connection is opened and shall be recorded using the Contractor's Material and Test Certificate for Aboveground Piping.

1-11.4 Tests of Drainage Facilities. Tests of drainage facilities shall be made while the control valve is wide open. The main drain valve shall be opened and remain open until the system pressure stabilizes. (*See 2-9.1.*)

1-12 Contractor's Material and Test Certificates.

1-13 Operation of Sprinkler System Control Valves by Contractors. When work on a sprinkler system requires that a contractor operate a valve controlling water supplies to a sprinkler system, the contractor shall inform the owner so that the owner may follow the normal valve supervision procedure.

1-14 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 1-14 with conversion factors.

Table 1-14 Metric Units of Measurement

Name of Unit	Unit Symbol	Conversion Factor
liter	L	1 gal = 3.785 L
liter per minute per square meter	$(L/min)/m^2$	1 gpm/ft^2 = 40.746 $(L/min)/m^2$
millimeter per minute	1 mm/min	1 gpm/ft^2 = 40.746 mm/min
cubic decimeter	dm^3	1 gal = 3.785 dm^3
pascal	Pa	1 psi = 6894.757 Pa
bar	bar	1 psi = 0.0689 bar
bar	bar	1 bar = 10^5 Pa

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

1-14.1 If a value for measurement as given in this standard is followed by an equivalent value in other units, the first stated is to be regarded as the requirement. A given equivalent value may be approximate.

1-14.2 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.

CONTRACTOR'S MATERIAL & TEST CERTIFICATE FOR ABOVEGROUND PIPING

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

PROPERTY NAME | DATE

PROPERTY ADDRESS

PLANS

ACCEPTED BY APPROVING AUTHORITY('S) NAMES

ADDRESS

INSTALLATION CONFORMS TO ACCEPTED PLANS ☐ YES ☐ NO

EQUIPMENT USED IS APPROVED ☐ YES ☐ NO

IF NO, EXPLAIN DEVIATIONS

INSTRUCTIONS

HAS PERSON IN CHARGE OF FIRE EQUIPMENT BEEN INSTRUCTED AS TO LOCATION OF CONTROL VALVES AND CARE AND MAINTENANCE OF THIS NEW EQUIPMENT ☐ YES ☐ NO

IF NO, EXPLAIN

HAVE COPIES OF THE FOLLOWING BEEN LEFT ON THE PREMISES:

1. SYSTEM COMPONENTS INSTRUCTIONS ☐ YES ☐ NO
2. CARE AND MAINTENANCE INSTRUCTIONS ☐ YES ☐ NO
3. NFPA 13A ☐ YES ☐ NO

LOCATION OF SYSTEM

SUPPLIES BLDGS.

SPRINKLERS

MAKE	MODEL	YEAR OF MANUFACTURE	ORIFICE SIZE	QUANTITY	TEMPERATURE RATING

PIPE AND FITTINGS

PIPE CONFORMS TO _____ STANDARD ☐ YES ☐ NO

FITTINGS CONFORM TO _____ STANDARD ☐ YES ☐ NO

IF NO, EXPLAIN

ALARM VALVE OR FLOW INDICATOR

ALARM DEVICE			MAXIMUM TIME TO OPERATE THROUGH TEST CONNECTION	
TYPE	MAKE	MODEL	MIN.	SEC.

DRY PIPE OPERATING TEST

DRY VALVE			Q.O.D.		
MAKE	MODEL	SERIAL NO.	MAKE	MODEL	SERIAL NO.

	TIME TO TRIP THRU TEST CONNECTION*		WATER PRESSURE	AIR PRESSURE	TRIP POINT AIR PRESSURE	TIME WATER REACHED TEST OUTLET*		ALARM OPERATED PROPERLY	
	MIN.	SEC.	PSI	PSI	PSI	MIN.	SEC.	YES	NO
Without Q.O.D.									
With Q.O.D.									

IF NO, EXPLAIN

*MEASURED FROM TIME INSPECTOR'S TEST CONNECTION IS OPENED.

85A (10-80) PRINTED IN USA (OVER)

Contractor's Material and Test Certificate for Aboveground Piping

DELUGE & PREACTION VALVES

OPERATION ☐ PNEUMATIC ☐ ELECTRIC ☐ HYDRAULIC

PIPING SUPERVISED ☐ YES ☐ NO | DETECTING MEDIA SUPERVISED ☐ YES ☐ NO

DOES VALVE OPERATE FROM THE MANUAL TRIP AND/OR REMOTE CONTROL STATIONS ☐ YES ☐ NO

IS THERE AN ACCESSIBLE FACILITY IN EACH CIRCUIT FOR TESTING ☐ YES ☐ NO | IF NO, EXPLAIN

MAKE	MODEL	DOES EACH CIRCUIT OPERATE SUPERVISION LOSS ALARM		DOES EACH CIRCUIT OPERATE VALVE RELEASE		MAXIMUM TIME TO OPERATE RELEASE	
		YES	NO	YES	NO	MIN.	SEC.

TEST DESCRIPTION

HYDROSTATIC: Hydrostatic tests shall be made at not less than 200 psi (13.6 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.2 bars) for two hours. Differential dry-pipe valve clappers shall be left open during test to prevent damage. All aboveground piping leakage shall be stopped.
FLUSHING: Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 400 GPM (1514 L/min) for 4-inch pipe, 600 GPM (2271 L/min) for 5-inch pipe, 750 GPM (2839 L/min) for 6-inch pipe, 1000 GPM (3785 L/min) for 8-inch pipe, 1500 GPM (5678 L/min) for 10-inch pipe and 2000 GPM (7570 L/min) for 12-inch pipe. When supply cannot produce stipulated flow rates, obtain maximum available.
PNEUMATIC: Establish 40 psi (2.7 bars) air pressure and measure drop which shall not exceed 1-½ psi (0.1 bars) in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop which shall not exceed 1-½ psi (0.1 bars) in 24 hours.

TESTS

ALL PIPING HYDROSTATICALLY TESTED AT _____ PSI FOR _____ HRS. | IF NO, STATE REASON

DRY PIPING PNEUMATICALLY TESTED ☐ YES ☐ NO

EQUIPMENT OPERATES PROPERLY ☐ YES ☐ NO

DRAIN TEST READING OF GAGE LOCATED NEAR WATER SUPPLY TEST CONNECTION: _____ PSI | RESIDUAL PRESSURE WITH VALVE IN TEST CONNECTION OPEN WIDE _____ PSI

Underground mains and lead in connections to system risers flushed before connection made to sprinkler piping.

VERIFIED BY COPY OF THE U FORM NO. 85B ☐ YES ☐ NO | OTHER EXPLAIN

FLUSHED BY INSTALLER OF UNDERGROUND SPRINKLER PIPING ☐ YES ☐ NO

BLANK TESTING GASKETS

NUMBER USED	LOCATIONS	NUMBER REMOVED

WELDING

WELDED PIPING ☐ YES ☐ NO

IF YES . . .

DO YOU CERTIFY AS THE SPRINKLER CONTRACTOR THAT WELDING PROCEDURES COMPLY WITH THE REQUIREMENTS OF AT LEAST AWS D10.9, LEVEL AR-3 ☐ YES ☐ NO

DO YOU CERTIFY THAT THE WELDING WAS PERFORMED BY WELDERS QUALIFIED IN COMPLIANCE WITH THE REQUIREMENTS OF AT LEAST AWS D10.9, LEVEL AR-3 ☐ YES ☐ NO

DO YOU CERTIFY THAT WELDING WAS CARRIED OUT IN COMPLIANCE WITH A DOCUMENTED QUALITY CONTROL PROCEDURE TO INSURE THAT ALL DISCS ARE RETRIEVED, THAT OPENINGS IN PIPING ARE SMOOTH, THAT SLAG AND OTHER WELDING RESIDUE ARE REMOVED, AND THAT THE INTERNAL DIAMETERS OF PIPING ARE NOT PENETRATED ☐ YES ☐ NO

CUTOUTS (DISCS)

DO YOU CERTIFY THAT YOU HAVE A CONTROL FEATURE TO ENSURE THAT ALL CUTOUTS (DISCS) ARE RETRIEVED? ☐ YES ☐ NO

HYDRAULIC DATA NAMEPLATE

NAMEPLATE PROVIDED ☐ YES ☐ NO | IF NO, EXPLAIN

REMARKS

DATE LEFT IN SERVICE WITH ALL CONTROL VALVES OPEN:

SIGNATURES

NAME OF SPRINKLER CONTRACTOR

TESTS WITNESSED BY

FOR PROPERTY OWNER (SIGNED)	TITLE	DATE
FOR SPRINKLER CONTRACTOR (SIGNED)	TITLE	DATE

ADDITIONAL EXPLANATION AND NOTES

85A BACK

Contractor's Material and Test Certificate for Aboveground Piping

CONTRACTOR'S MATERIAL & TEST CERTIFICATE FOR UNDERGROUND PIPING

PROCEDURE

Upon completion of work, inspection and tests shall be made by the contractor's representative and witnessed by an owner's representative. All defects shall be corrected and system left in service before contractor's personnel finally leave the job.

A certificate shall be filled out and signed by both representatives. Copies shall be prepared for approving authorities, owners and contractor. It is understood the owner's representative's signature in no way prejudices any claim against contractor for faulty material, poor workmanship, or failure to comply with approving authority's requirements or local ordinances.

PROPERTY NAME | DATE

PROPERTY ADDRESS

PLANS

ACCEPTED BY APPROVING AUTHORITY('S) NAMES

ADDRESS

INSTALLATION CONFORMS TO ACCEPTED PLANS ☐YES ☐NO

EQUIPMENT USED IS APPROVED ☐YES ☐NO

IF NO, STATE DEVIATIONS

INSTRUCTIONS

HAS PERSON IN CHARGE OF FIRE EQUIPMENT BEEN INSTRUCTED AS TO LOCATION OF CONTROL VALVES AND CARE AND MAINTENANCE OF THIS NEW EQUIPMENT ☐YES ☐NO

IF NO, EXPLAIN

HAVE COPIES OF APPROPRIATE INSTRUCTIONS AND CARE AND MAINTENANCE CHARTS BEEN LEFT ON PREMISES ☐YES ☐NO

IF NO, EXPLAIN

LOCATION

SUPPLIES BLDGS.

UNDERGROUND PIPES AND JOINTS

PIPE TYPES AND CLASS | TYPE JOINT

PIPE CONFORMS TO _____ STANDARD ☐YES ☐NO

FITTINGS CONFORM TO _____ STANDARD ☐YES ☐NO

IF NO, EXPLAIN

JOINTS NEEDING ANCHORAGE CLAMPED, STRAPPED, OR BLOCKED IN ACCORDANCE WITH _____ STANDARD ☐YES ☐NO

IF NO, EXPLAIN

TEST DESCRIPTION

FLUSHING. Flow the required rate until water is clear as indicated by no collection of foreign material in burlap bags at outlets such as hydrants and blow-offs. Flush at flows not less than 400 GPM (1514 L/min) for 4-inch pipe, 600 GPM (2271 L/min) for 5-inch pipe, 750 GPM (2839 L/min) for 6-inch pipe, 1000 GPM (3785 L/min) for 8-inch pipe, 1500 GPM (5678 L/min) for 10-inch pipe and 2000 GPM (7570 L/min) for 12-inch pipe. When supply cannot produce stipulated flow rates, obtain maximum available.

HYDROSTATIC. Hydrostatic tests shall be made at not less than 200 psi (13.8 bars) for two hours or 50 psi (3.4 bars) above static pressure in excess of 150 psi (10.3 bars) for two hours.

LEAKAGE. New pipe laid with rubber gasketed joints shall, if the workmanship is satisfactory, have little or no leakage at the joints. The amount of leakage at the joints shall not exceed 2 qts. per hr. (1.89 L/h) per 100 joints irrespective of pipe diameter. The leakage shall be distributed over all joints. If such leakage occurs at a few joints the installation shall be considered unsatisfactory and necessary repairs made. The amount of allowable leakage specified above may be increased by 1 fl oz per in. valve diameter per hour (30 mL/25 mm/h) for each metal seated valve isolating the test section. If dry barrel hydrants are tested with the main valve open, so the hydrants are under pressure, an additional 5 oz per minute (150 mL/min) leakage is permitted for each hydrant.

FLUSHING TESTS

NEW UNDERGROUND PIPING FLUSHED ACCORDING TO _____ STANDARD ☐YES ☐NO

BY (COMPANY)

IF NO, EXPLAIN

HOW FLUSHING FLOW WAS OBTAINED | THROUGH WHAT TYPE OPENING

☐PUBLIC WATER ☐TANK OR RESERVOIR ☐FIRE PUMP | ☐HYDRANT BUTT. ☐OPEN PIPE

LEAD-INS FLUSHED ACCORDING TO _____ STANDARD ☐YES ☐NO

BY (COMPANY)

IF NO, EXPLAIN

HOW FLUSHING FLOW WAS OBTAINED | THROUGH WHAT TYPE OPENING

☐PUBLIC WATER ☐TANK OR RESERVOIR ☐FIRE PUMP | ☐Y CONN. TO FLANGE & SPIGOT ☐OPEN PIPE

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HYDROSTATIC TEST	ALL NEW UNDERGROUND PIPING HYDROSTATICALLY TESTED AT _____ PSI FOR _____ HOURS	JOINTS COVERED ☐ YES ☐ NO
LEAKAGE TEST	TOTAL AMOUNT OF LEAKAGE MEASURED _____ GALS. _____ HOURS	
	ALLOWABLE LEAKAGE _____ GALS. _____ HOURS	
HYDRANTS	NUMBER INSTALLED / TYPE AND MAKE	ALL OPERATE SATISFACTORILY ☐ YES ☐ NO
CONTROL VALVES	WATER CONTROL VALVES LEFT WIDE OPEN IF NO, STATE REASON	☐ YES ☐ NO
	HOSE THREADS OF FIRE DEPARTMENT CONNECTIONS AND HYDRANTS INTERCHANGEABLE WITH THOSE OF FIRE DEPARTMENT ANSWERING ALARM	☐ YES ☐ NO
REMARKS	DATE LEFT IN SERVICE	
SIGNATURES	NAME OF INSTALLING CONTRACTOR	
	TESTS WITNESSED BY	
	FOR PROPERTY OWNER (SIGNED) / TITLE / DATE	
	FOR INSTALLING CONTRACTOR (SIGNED) / TITLE / DATE	
	ADDITIONAL EXPLANATION AND NOTES	

Contractor's Material and Test Certificate for Underground Piping

Chapter 2 Water Supplies

2-1* General Provisions. Every automatic sprinkler system shall have at least one automatic water supply.

2-2* Water Supply Requirements for Sprinkler Systems.

2-2.1 Water Supply Requirement Tables.

2-2.1.1* Water supply requirement tables shall be used in determining the minimum water supply requirements for Light, Ordinary, and Extra Hazard Occupancies. Occupancy classification shall be determined from Section 1-7.

(a) Table 2-2.1(a) is used to determine the minimum volume of water and pressure normally required for a pipe schedule sprinkler system. *THE TABLE IS TO BE USED ONLY WITH EXPERIENCED JUDGMENT.*

(b) Table 2-2.1(b) is used to determine the minimum volume of water and pressure normally required for a hydraulically designed sprinkler system.

2-2.1.2 The following shall be used in applying Table 2-2.1(b).

2-2.1.2.1 The densities and areas provided in Figure 2-2.1(b) are based on the use of standard response, standard orifice (½ in.), and large orifice ($^{17}/_{32}$ in.) sprinklers. For use of other types of sprinklers see 4-1.1.3.

2-2.1.2.2 The water supply requirement for sprinklers only shall be calculated from the density curves in Figure 2-2.1(b). System piping shall be calculated to satisfy a single point on the appropriate design curve. It is not necessary to meet all points on the selected curve.

2-2.1.2.3 When inside hose stations are planned or are required by other standards, a water allowance of 50 gpm (189 L/min) for a one hose station installation [100 gpm (378 L/min) for a two or more hose station installation] shall be added to the sprinkler requirement at the point of connection to the system at the residual pressure required by the sprinkler system design.

2-2.1.2.4 Water demand of sprinklers installed in racks shall be added to the ceiling sprinkler water demand at the point of connection. Demands shall be balanced to the higher pressure.

2-2.1.2.5 Water allowance for outside hose shall be added to the sprinkler and inside hose requirement at the connection to the city water main, or at a yard hydrant, whichever is closer to the system riser.

2-2.1.2.6 The lower duration figure is ordinarily acceptable where remote station water flow alarm service or equivalent is provided.

2-2.1.2.7 When pumps, gravity tanks, or pressure tanks supply sprinklers only, requirements for inside and outside hose need not be considered in determining the size of such pumps or tanks.

2-2.1.2.8* The water supply requirement for sprinklers only shall be based upon the area of the sprinkler opera-

tion selected from Table 2-2.1(b) or upon the area of the largest room, at the discretion of the designer. Such a room shall be enclosed with construction having a fire resistance rating equal to the water supply duration indicated in Table 2-2.1(b) with minimum protection of openings as follows:

(a) Light Hazard — automatic or self-closing doors.

Exception No. 1: When openings are not protected, calculations shall include the sprinklers in the room plus two sprinklers in the communicating space nearest each such unprotected opening unless the communicating space has only one sprinkler, in which case calculations shall be extended to the operation of that sprinkler. The selection of the room and communicating space sprinklers to be calculated shall be that which produces the greatest hydraulic demand.

Exception No. 2: The water supply for dwelling units protected by residential sprinklers shall be in accordance with 7-4.4 in wet systems only.

(b) Ordinary and Extra Hazard — automatic or self-closing doors with appropriate fire resistance ratings for the enclosure.

2-2.1.2.9 For areas of sprinkler operation less than 1500 sq ft (139 m²) used for Light and Ordinary Hazard Occupancies, the density for 1500 sq ft (139 m²) shall be used. For areas of sprinkler operation less than 2500 sq ft (232 m²) for Extra Hazard Occupancies, the density for 2500 sq ft (232 m²) shall be used.

2-2.1.2.10 For dry-pipe systems, increase the area of sprinkler operation by 30 percent without revising density.

2-2.1.2.11* For construction having unsprinklered combustible concealed spaces (as described in 4-4.4) the minimum area of sprinkler operation shall be 3000 sq ft (279 m²).

Exception No. 1: Combustible concealed spaces filled entirely with noncombustible insulation.

Exception No. 2: Light or Ordinary Hazard Occupancies where noncombustible ceilings are directly attached to the bottom of solid wood joists so as to create enclosed joist spaces, each less than 160 ft³ (4.8 m³) in volume.

2-2.1.2.12 For hazard classifications other than those indicated see appropriate NFPA standards for design criteria.

2-2.1.2.13 When high-temperature sprinklers are used for Extra Hazard Occupancies, the area of sprinkler operation may be reduced by 25 percent without revising the density, but not to less than 2000 sq ft (186 m²).

2-2.1.3 When other NFPA standards have developed sprinkler system design criteria, they shall take precedence.

2-3 Connections to Water Works Systems.

2-3.1 Acceptability.

2-3.1.1* General. A connection to a reliable water works system shall be an acceptable water supply source. The volume and pressure of a public water supply shall be determined from waterflow test data.

2-3.1.2 Meters. Meters are not recommended for use on sprinkler systems; however, where required by other authorities, they shall be of an approved type.

Table 2-2.1(a) Guide to Water Supply Requirements for Pipe Schedule Sprinkler Systems

Occupancy Classification	Residual Pressure Required (see Note 1)	Acceptable Flow at Base of Riser (see Note 2)	Duration in Minutes (see Note 4)
Light Hazard	15 psi	500-750 gpm (see Note 3)	30-60
Ordinary Hazard (Group 1)	15 psi or higher	700-1000 gpm	60-90
Ordinary Hazard (Group 2)	15 psi or higher	850-1500 gpm	60-90
Ordinary Hazard (Group 3)	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction.		60-120
High-Piled Storage (*see 4-1.3.9*)	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction. (*See Chapter 7 and NFPA 231 and NFPA 231C.*)		
High-Rise Buildings	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction. (*See Chapter 8.*)		
Extra Hazard	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction.		

For SI Units 1 psi = 0.0689 bar, 1 gpm = 3.785 L/min

Notes:

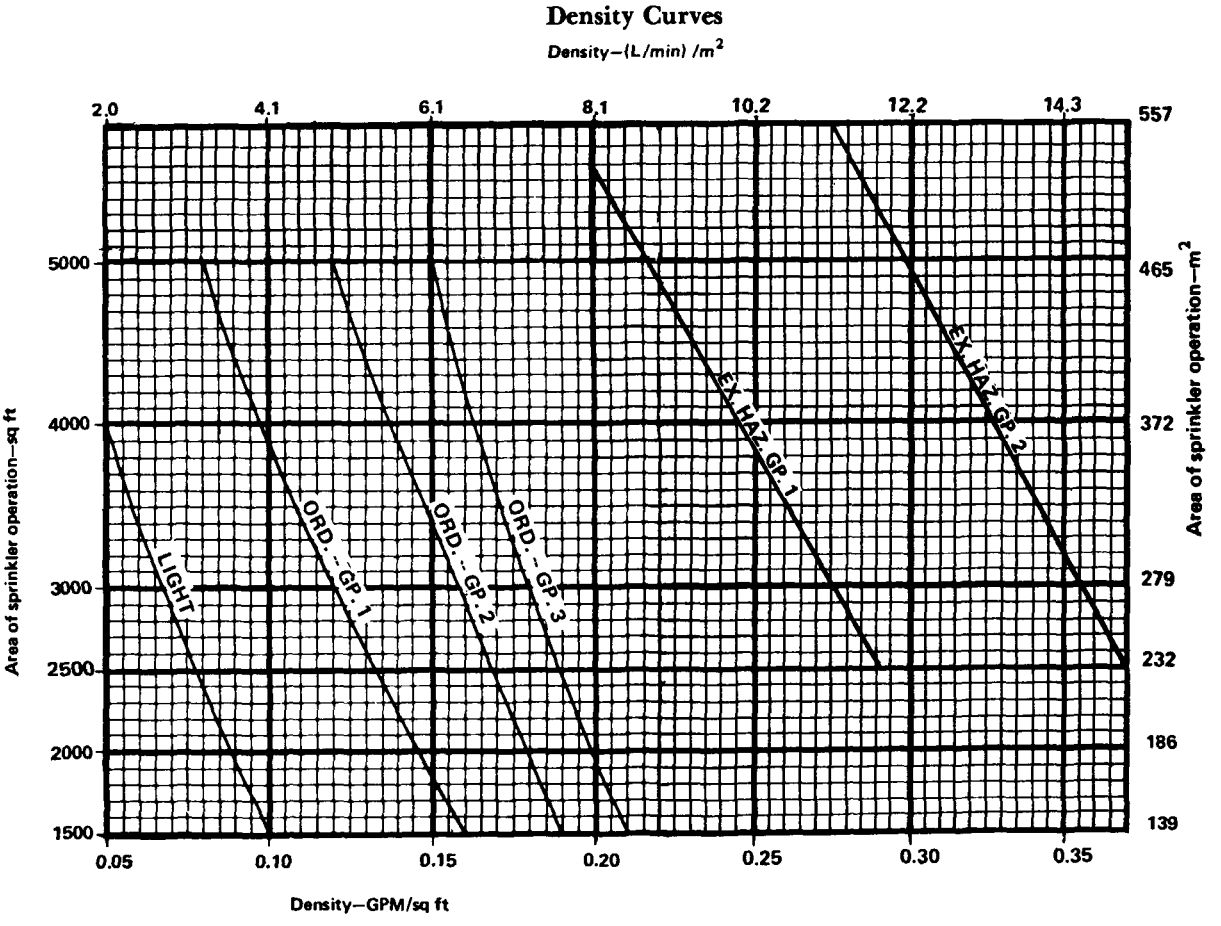
1. The pressure required at the base of the sprinkler riser(s) is defined as the residual pressure required at the elevation of the highest sprinkler plus the pressure required to reach this elevation.
2. The lower figure is the minimum flow including hose streams ordinarily acceptable for pipe schedule sprinkler systems. The higher flow should normally suffice for all cases under each group.
3. The requirement may be reduced to 250 gpm if building area is limited by size or compartmentation or if building (including roof) is noncombustible construction.
4. The lower duration figure is ordinarily acceptable where remote station water flow alarm service or equivalent is provided. The higher duration figure should normally suffice for all cases under each group.

Table 2-2.1(b) Table and Design Curves for Determining Density, Area of Sprinkler Operation, and Water Supply Requirements for Hydraulically Designed Sprinkler Systems

Minimum Water Supply Requirements

Hazard Classification	Sprinklers Only — gpm	Inside Hose — gpm	Total Combined Inside and Outside Hose — gpm	Duration in Minutes
Light	See 2-2.1.2.1	0, 50 or 100	100	30
Ord. — Gp. 1	See 2-2.1.2.1	0, 50 or 100	250	60-90
Ord. — Gp. 2	See 2-2.1.2.1	0, 50 or 100	250	60-90
Ord. — Gp. 3	See 2-2.1.2.1	0, 50 or 100	500	60-120
Ex. Haz. — Gp. 1	See 2-2.1.2.1	0, 50 or 100	500	90-120
Ex. Haz. — Gp. 2	See 2-2.1.2.1	0, 50 or 100	1000	120

For SI Units: 1 gpm = 3.785 L/min



For SI Units: 1 sq ft = 0.0920 m²; 1 gpm/sq ft = 40.746 (L/min)/m².

Figure 2-2.1(b)

2-3.2* Capacity. The connection and arrangement of underground supply piping shall be capable of supplying the volume as required in Table 2-2.1(a) or 2-2.1(b). Pipe size shall be at least as large as the system riser. (*See NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*)

Exception: Unlined cast or ductile iron pipe shall not be less than 4 in. (10 cm) in size.

2-4 Gravity Tanks.

2-4.1 Acceptability. An elevated tank sized in accordance with Table 2-2.1(a) or 2-2.1(b) shall be an acceptable water supply source. (*See NFPA 22, Standard for Water Tanks for Private Fire Protection.*)

2-4.2 Capacity and Elevation. The capacity and elevation of the tank and the arrangement of the under-

ground supply piping shall provide the volume and pressure required by Table 2-2.1(a) or 2-2.1(b) designs.

2-5 Pumps.

2-5.1* Acceptability. A single automatically controlled fire pump sized in accordance with Table 2-2.1(a) or 2-2.1(b) supplied under positive head shall be an acceptable water supply source. (*See NFPA 20, Standard for the Installation of Centrifugal Fire Pumps.*)

2-5.2* Supervision. When a single fire pump constitutes the sole sprinkler supply, it shall be provided with supervisory service from an approved central station, proprietary, remote station system or equivalent.

2-6 Pressure Tanks.

2-6.1 Acceptability.

2-6.1.1 A pressure tank sized in accordance with Table 2-2.1(a) or 2-2.1(b) is an acceptable water supply source. (*See NFPA 22, Standard for Water Tanks for Private Fire Protection.*)

2-6.1.2 Pressure tanks shall be provided with an approved means for automatically maintaining the required air pressure. When a pressure tank is the sole water supply there shall also be provided an approved trouble alarm to indicate low air pressure and low water level with the alarm supplied from an electrical branch circuit independent of the air compressor.

2-6.1.3 Pressure tanks shall not be used to supply other than sprinklers and hand hose attached to sprinkler piping.

2-6.2 Capacity. The required water capacity of a pressure tank shall be in accordance with 2-2.1 and shall include the extra capacity needed to fill dry-pipe or preaction systems when installed. The total volume shall be based on the water capacity, plus the air capacity required by 2-6.3.

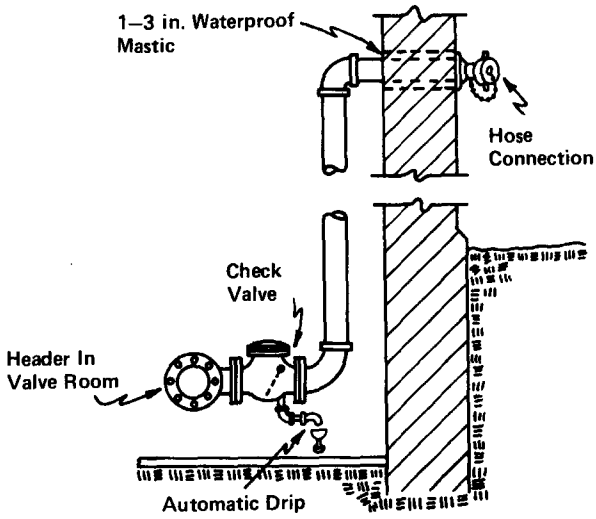
2-6.3* Water Level and Air Pressure. Unless otherwise approved by the authority having jurisdiction, the pressure tank shall be kept two-thirds full of water, and an air pressure of at least 75 psi (5.2 bars) by the gage shall be maintained. When the bottom of the tank is located below the highest sprinklers served, the air pressure by the gage shall be at least 75 psi (5.2 bars) plus three times the pressure caused by the column of water in the sprinkler system above the tank bottom.

2-7 Fire Department Connections.

2-7.1* A fire department connection shall be provided as described in this section.

Exception: When permission of the authority having jurisdiction has been obtained for its omission.

2-7.2* Size. Pipe size shall be not less than 4 in. (10 cm) for fire engine connections and not less than 6 in. (15 cm) for fire boat connections, except that 3-in. (7.5-cm) pipe may be used to connect a single hose connection to a 3-in. (7.5-cm) or smaller riser.



For SI Units: 1 in. = 25.4 mm.

Figure 2-7.1 Fire Department Connection.

2-7.3* Arrangement. (*See 3-14.2.5 and 3-14.2.6.*)

2-7.3.1 The fire department connection shall be made on the system side of a check valve in the water supply piping.

2-7.3.2 On wet-pipe systems with a single riser the connection shall be made on the system side of approved indicating, check, and alarm valves to the riser, unless the system is supplied by a fire department pumper connection in the yard. (*See 3-14.2.6.*)

2-7.3.3 On dry-pipe systems with a single riser the connection shall be made between the approved indicating valve and the dry-pipe valve, unless the system is supplied by a fire department pumper connection in the yard.

2-7.3.4 On systems with two or more risers, the connection shall be made on the system side of all shutoff valves controlling other water supplies, but on the supply side of the riser shutoff valves so that, with any one riser off, the connection will feed the remaining sprinklers, unless the sprinklers are supplied by a fire department pumper connection in the yard.

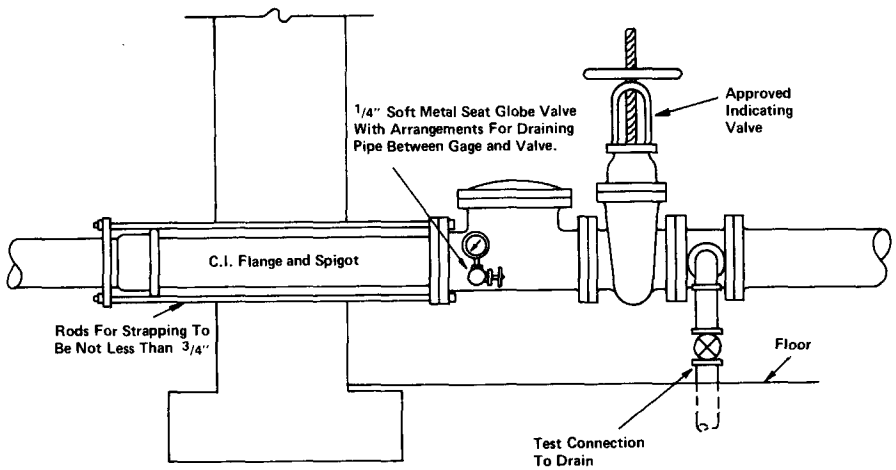
2-7.3.5 Fire department connections shall not be connected on the suction side of booster pumps.

2-7.3.6 Fire department connections to sprinkler systems shall be designated by a sign having raised letters at least 1 in. (25 mm) in size cast on plate or fitting reading for service designated: e.g. – "AUTOSPKR.," "OPEN SPKR." or "AUTOSPKR. and STANDPIPE."

2-7.4 Valves.

2-7.4.1 An approved check valve shall be installed in each fire department connection, located as near as practicable to the point where it joins the system.

2-7.4.2 There shall be no shutoff valve in the fire department connection.



For SI Units: 1 in. = 25.4 mm.

Figure 2-9.1 Water Supply Connection with Test Connection.

2-7.5 Drainage. The piping between the check valve and the outside hose coupling shall be equipped with an approved automatic drip.

2-7.6 Hose Connections.

2-7.6.1 The fire department connection(s) shall be internal threaded swivel fitting(s) having the NH standard thread, at least one of which shall be 2.5 — 7.5 NH standard thread, as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections.*

Exception: When local fire department connections do not conform to NFPA 1963, the authority having jurisdiction shall designate the connection to be used.

2-7.6.2 Hose connections shall be equipped with listed plugs or caps.

2-8 Arrangement of Water Supply Connections.

2-8.1 Connection Between Underground and Aboveground Piping. The connection between the system piping and underground piping shall be made with a suitable transition piece and shall be properly strapped or fastened by approved devices. The transition piece shall be protected against possible damage from corrosive agents, solvent attack, or mechanical damage.

2-8.2* Connection Passing Through or Under Foundation Walls. When system piping pierces a foundation wall below grade or is located under the foundation wall, clearance shall be provided to prevent breakage of the piping due to building settlement.

2-9 Water Supply Test Connections and Gages.

2-9.1* Test Connections. Test connections, which may also be used as drain pipes, shall be provided at locations that will permit flow tests to be made to determine whether water supplies and connections are in order. Such test connections shall be not less than the sizes specified in 3-11.2 and equipped with a shutoff valve. They shall be so installed that the valve may be opened wide for a sufficient time to assure a proper test without causing water damage. (*See 3-11.2 and 3-11.4.*)

2-9.2 Gages.

2-9.2.1 A pressure gage with a connection not smaller than ¼ in. shall be installed on the riser or feed main at or near each test connection. This gage connection shall be equipped with a shutoff valve and with provision for draining.

2-9.2.2 The required pressure gages shall be of an approved type and shall have a maximum limit not less than twice the normal working pressure at the point where installed. They shall be installed to permit removal, and shall be located where they will not be subject to freezing.

Chapter 3 System Components

3-1 Piping.

3-1.1 Piping Specifications.

3-1.1.1 Pipe or tube used in sprinkler systems shall be of the materials in Table 3-1.1.1 or in accordance with 3-1.1.2 through 3-1.1.6. The chemical properties, physical properties, and dimensions of the materials listed in Table 3-1.1.1 shall be at least equivalent to the standard cited in the table. Pipe and tube used in sprinkler systems shall be designed to withstand a working pressure of not less than 175 psi (12.1 bars).

3-1.1.2* When welded and seamless steel pipe listed in Table 3-1.1.1 is used and joined by welding as referenced in 3-12.2 or by roll grooved pipe and couplings as referenced in 3-12.3, the minimum nominal wall thickness for pressures up to 300 psi (20.7 bars) shall be in accordance with Schedule 10 for sizes up to 5 in. (11.2 cm); 0.134 in. (3.40 mm) for 6 in. (15.2 cm); and 0.188 in. (4.78 mm) for 8- and 10-in. (20- and 25-cm) pipe; or as modified in 3-1.1.5, or as defined in 3-1.1.6.

Table 3-1.1.1 Pipe or Tube Materials and Dimensions

Materials and Dimensions	Standard
Ferrous Piping (Welded and Seamless)	
Welded and Seamless Steel Pipe for Ordinary Uses, Spec. for Black and Hot-Dipped Zinc Coated (Galvanized)	ANSI/ASTM A120
†Spec. for Black and Hot-Dipped Zinc Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use	ASTM A795
†Spec. for Welded and Seamless Steel Pipe	ANSI/ASTM A53
Wrought Steel Pipe	ANSI B36.10
Spec. for Elec.-Resistance Welded Steel Pipe	ASTM A135
Copper Tube (Drawn, Seamless)	
†Spec. for Seamless Copper Tube	ASTM B75
†Spec. for Seamless Copper Water Tube	ASTM B88
Spec. for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube	ASTM B251
Brazing Filler Metal (Classification BCuP-3 or BCuP-4)	AWS A 5.8
Solder Metal, 95-5 (Tin-Antimony-Grade 95TA)	ASTM B32

†Denotes pipe or tubing suitable for bending (*see 3-1.1.7*) according to ASTM standards.

3-1.1.3 When steel pipe listed in Table 3-1.1.1 is used and joined by threaded fittings referenced in 3-12.1 or by couplings used with pipe having cut grooves, the minimum wall thickness shall be in accordance with Schedule 30 [in sizes 8 in. (20 cm) and larger] or Schedule 40 [in sizes less than 8 in. (20 cm)] pipe for pressures up to 300 psi (20.7 bars).

3-1.1.4* Copper tube as specified in the standards listed in Table 3-1.1.1, used in sprinkler systems, shall have a wall thickness of Type K, L, or M.

3-1.1.5* Other types of pipe or tube may be used if investigated and listed for this service.

3-1.1.6 Whenever the word pipe is used in this standard it shall be understood to also mean tube.

3-1.1.7 Pipe Bending. Bending of steel pipe (Schedule 40) and copper tube (Types K & L) may be accomplished when bends are made in conformance with good installation practices and show no kinks, ripples, distortions, reduction in diameter, or any noticeable deviations from round. The minimum radius of a bend shall be 6 pipe diameters for pipe sizes 2 in. (5 cm) and smaller, and 5 pipe diameters for pipe sizes 2½ in. (6 cm) and larger.

3-2* Definitions. *(See Figure A-3-2.)*

Risers. The vertical pipes in a sprinkler system.

System Riser. The aboveground supply pipe directly connected to the water supply.

Feed Mains. Mains supplying risers or cross mains.

Cross Mains. Pipes directly supplying the lines in which the sprinklers are placed.

Branch Lines. Lines of pipe, from the point of attachment to the cross main (or similar connection) to the end sprinkler, in which the sprinklers are directly placed.

3-3 Area Limitation.

3-3.1 The maximum floor area on any one floor to be protected by sprinklers supplied by any one sprinkler system riser or combined system riser shall be as follows:

Light Hazard — 52,000 sq ft (4831 m²)

Ordinary Hazard — 52,000 sq ft (4831 m²)

Extra Hazard — 25,000 sq ft (2323 m²)

Storage — High-piled storage (as defined in 4-1.3.9) and storage covered by other NFPA standards — 40,000 sq ft (3716 m²).

Exception: When single systems protect both high-piled storage or storage covered by other NFPA standards and ordinary hazard areas, the storage area coverage shall not exceed 40,000 sq ft (3716 m²) and the total area coverage shall not exceed 52,000 sq ft (4831 m²).

3-4* Pipe Schedules.

3-4.1 The pipe schedule sizing provisions shall not apply to hydraulically designed systems. Sprinkler systems having sprinklers with orifices other than ½ in. (12.7 mm) nominal, or piping material other than that covered in Table 3-1.1.1, shall be hydraulically designed or evaluated, except for exposure protection systems installed in conformance with Chapter 6.

3-4.2 The number of automatic sprinklers on a given pipe size on one floor shall not exceed the number given in Sections 3-5, 3-6, or 3-7 for a given occupancy.

3-4.3 Size of Risers. Each system riser shall be sized to supply all sprinklers on the riser on any one floor as determined by the standard schedules of pipe sizes in Sections 3-5, 3-6, or 3-7.

3-4.4 Slatted Floors, Large Floor Openings, Mezzanines, and Large Platforms. Buildings having slatted floors, or large unprotected floor openings without approved stops, shall be treated as one area with reference to the pipe sizes, and the feed mains or risers shall be of the size required for the total number of sprinklers.

3-5 Schedule for Light Hazard Occupancies.

3-5.1 Branch lines shall not exceed 8 sprinklers on either side of a cross main.

Exception: When more than 8 sprinklers on a branch line are necessary, lines may be increased to 9 sprinklers by making the two end lengths 1 in. and 1¼ in. respectively, and the sizes thereafter standard. Ten sprinklers may be placed on a branch line making the two end lengths 1 in. and 1¼ in., respectively, and feeding the tenth sprinkler by a 2½ in. (64 mm) pipe.

3-5.2 Pipe sizes shall be in accordance with Table 3-5.2.

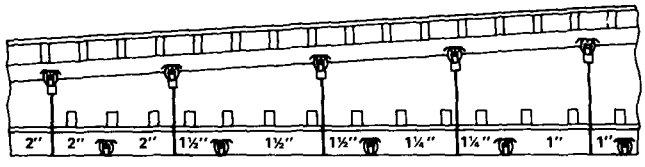
Exception: Each area requiring more sprinklers than the number specified for 3½ in. (9 cm) pipe in Table 3-5.2 and without subdividing partitions (not necessarily

fire walls) shall be supplied by mains or risers sized for ordinary hazard occupancies.

Table 3-5.2 Light Hazard Pipe Schedules

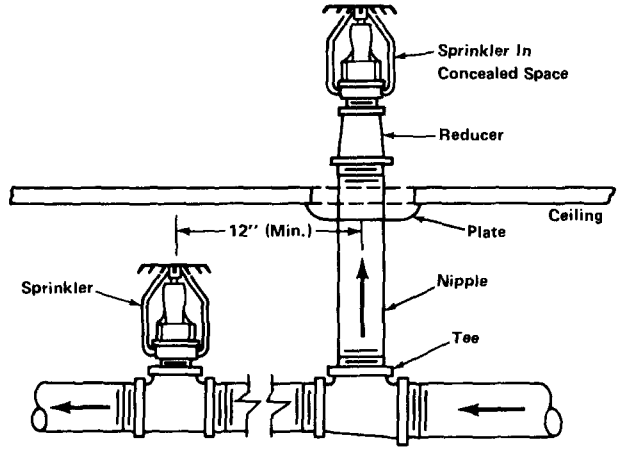
Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	3 sprinklers	1¼ in.	3 sprinklers
1½ in.	5 sprinklers	1½ in.	5 sprinklers
2 in.	10 sprinklers	2 in.	12 sprinklers
2½ in.	30 sprinklers	2½ in.	40 sprinklers
3 in.	60 sprinklers	3 in.	65 sprinklers
3½ in.	100 sprinklers	3½ in.	115 sprinklers
4 in.	See 3-3.1	4 in.	See 3-3.1

3-5.3 When sprinklers are installed above and below ceilings [see Figure 3-5.3(a), Figure 3-5.3(b) and Figure 3-5.3(c)] and such sprinklers are supplied from a common set of branch lines, such branch lines shall not exceed 8 sprinklers above and 8 sprinklers below any ceiling on either side of the cross main. Pipe sizing, up to and including 2½-in. (64-mm), shall be as shown in Table 3-5.3.



For SI Units: 1 in. = 25.4 mm.

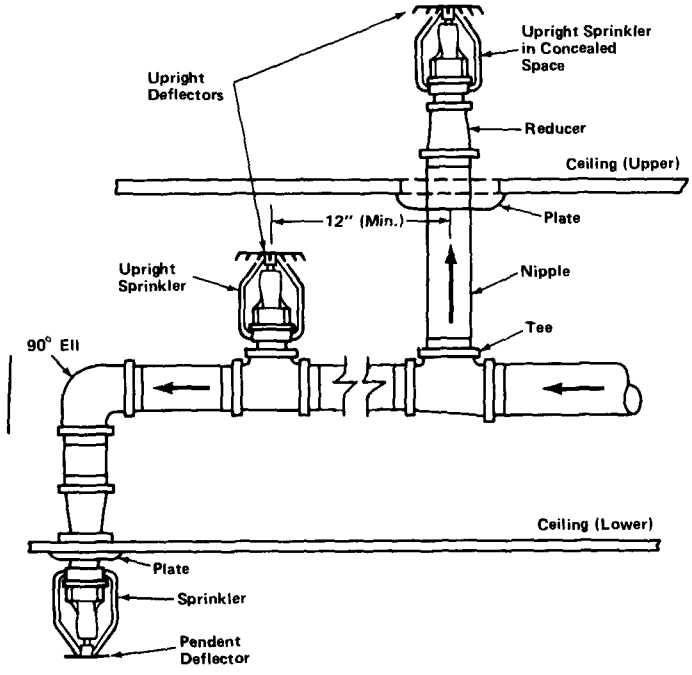
Figure 3-5.3(a) Arrangement of Branch Lines Supplying Sprinklers Above and Below a Ceiling.



For SI Units: 1 in. = 25.4 mm.

Figure 3-5.3(b) Sprinkler on Riser Nipple from Branch Line in Lower Fire Area.

3-5.3.1* When the total number of sprinklers above and below a ceiling exceeds the number specified in Table 3-5.3 for 2½ in. pipe, the pipe supplying such sprinklers shall be increased to 3 in. (7.6 cm) and sized thereafter according to the schedule shown in Table 3-5.2 for the number of sprinklers above or below a ceiling, whichever is larger.



For SI Units: 1 in. = 25.4 mm.

Figure 3-5.3(c) Arrangement of Branch Lines Supplying Sprinklers Above and Below Ceilings.

Table 3-5.3 Number of Sprinklers Above and Below a Ceiling

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	4 sprinklers	1¼ in.	4 sprinklers
1½ in.	7 sprinklers	1½ in.	7 sprinklers
2 in.	15 sprinklers	2 in.	18 sprinklers
2½ in.	50 sprinklers	2½ in.	65 sprinklers

3-6 Schedule for Ordinary Hazard Occupancies.

3-6.1 Branch lines shall not exceed 8 sprinklers on either side of a cross main.

Exception: When more than 8 sprinklers on a branch line are necessary, lines may be increased to 9 sprinklers by making the two end lengths 1 in. and 1¼ in., respectively, and the sizes thereafter standard. Ten sprinklers may be placed on a branch line making the two end lengths 1 in. and 1¼ in. respectively, and feeding the tenth sprinkler by a 2½ in. pipe.

3-6.2 Pipe sizes shall be in accordance with Table 3-6.2(a).

Table 3-6.2(a) Ordinary Hazard Pipe Schedule

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	3 sprinklers	1¼ in.	3 sprinklers
1½ in.	5 sprinklers	1½ in.	5 sprinklers
2 in.	10 sprinklers	2 in.	12 sprinklers
2½ in.	20 sprinklers	2½ in.	25 sprinklers
3 in.	40 sprinklers	3 in.	45 sprinklers
3½ in.	65 sprinklers	3½ in.	75 sprinklers
4 in.	100 sprinklers	4 in.	115 sprinklers
5 in.	160 sprinklers	5 in.	180 sprinklers
6 in.	275 sprinklers	6 in.	300 sprinklers
8 in.	See 3-3.1 and 3-3.1 Exception	8 in.	See 3-3.1 and 3-3.1 Exception

Exception: When the distance between sprinklers on the branch line exceeds 12 ft (3.7 m), or the distance between the branch lines exceeds 12 ft (3.7 m), the number of sprinklers for a given pipe size shall be in accordance with Table 3-6.2(b).

Table 3-6.2(b) Number of Sprinklers—Less than 12 ft Separations

Steel		Copper	
2½ in.	15 sprinklers	2½ in.	20 sprinklers
3 in.	30 sprinklers	3 in.	35 sprinklers
3½ in.	60 sprinklers	3½ in.	65 sprinklers

For other pipe and tube sizes, see Table 3-6.2(a).

3-6.3 When sprinklers are installed above and below ceilings and such sprinklers are supplied from a common set of branch lines, such branch lines shall not exceed 8 sprinklers above and 8 sprinklers below any ceiling on either side of the cross main. Pipe sizing up to and including 3 in. (7.6 cm) shall be as shown in Table 3-6.3 [see Figures 3-5.3(b) and 3-5.3(c)].

Table 3-6.3 Number of Sprinklers Above and Below a Ceiling

Steel		Copper	
1 in.	2 sprinklers	1 in.	2 sprinklers
1¼ in.	4 sprinklers	1¼ in.	4 sprinklers
1½ in.	7 sprinklers	1½ in.	7 sprinklers
2 in.	15 sprinklers	2 in.	18 sprinklers
2½ in.	30 sprinklers	2½ in.	40 sprinklers
3 in.	60 sprinklers	3 in.	65 sprinklers

3-6.3.1* When the total number of sprinklers above and below a ceiling exceeds the number specified in Table 3-6.3 for 3-in. pipe, the pipe supplying such sprinklers shall be increased to 3½ in. and sized thereafter according to the schedule shown in Table 3-5.2 or Table 3-6.2(a) for the number of sprinklers above or below a ceiling, whichever is larger.

Exception: When the distance between the sprinklers protecting the occupied area exceeds 12 ft (3.7 m) or the distance between the branch lines exceeds 12 ft (3.7 m), the branch lines shall be sized in accordance with either Table 3-6.2(b), taking into consideration the sprinklers protecting the occupied area only or Section 3-6.3, whichever requires the greater size of pipe.

3-7 Schedule for Extra Hazard Occupancies.

3-7.1 Branch lines shall not exceed 6 sprinklers on either side of a cross main. The number of sprinklers for a given pipe size shall be in accordance with Table 3-7.1.

Table 3-7.1 Extra Hazard Pipe Schedule

Steel		Copper	
1 in.	1 sprinkler	1 in.	1 sprinkler
1¼ in.	2 sprinklers	1¼ in.	2 sprinklers
1½ in.	5 sprinklers	1½ in.	5 sprinklers
2 in.	8 sprinklers	2 in.	8 sprinklers
2½ in.	15 sprinklers	2½ in.	20 sprinklers
3 in.	27 sprinklers	3 in.	30 sprinklers
3½ in.	40 sprinklers	3½ in.	45 sprinklers
4 in.	55 sprinklers	4 in.	65 sprinklers
5 in.	90 sprinklers	5 in.	100 sprinklers
6 in.	150 sprinklers	6 in.	170 sprinklers
8 in.	See 3-3.1	8 in.	See 3-3.1

3-7.2 Open sprinkler and deluge systems shall be hydraulically calculated according to applicable standards.

Exception: Open sprinklers for exposure protection. See Chapter 6.

3-8 Special Provisions Applicable to Piping.

3-8.1 Rack Storage. For sprinklers in storage racks see NFPA 231C, *Standard for Rack Storage of Materials.*

3-8.2* Provision for Flushing Systems. All sprinkler systems shall be arranged for flushing. Readily removable fittings shall be provided at the end of all cross mains. All cross mains shall terminate in 1¼-in. or larger pipe. All branch lines on gridded systems shall be arranged to facilitate flushing. (*See NFPA 13A, Recommended Practice for the Inspection, Testing and Maintenance of Sprinkler Systems.*)

3-8.3 Stair Towers. Stairs, towers, or other construction with incomplete floors, if piped on independent risers, shall be treated as one area with reference to pipe sizes.

3-8.4 Return Bends. Return bends shall be used when pendent sprinklers are supplied from a raw water source, mill pond, or from open-top reservoirs. Return bends shall be connected to the top of branch lines in order to avoid accumulation of sediment in the drop nipples.

Exception No. 1: Return bends are not required for deluge systems.

Exception No. 2: Return bends are not required when dry-pendent sprinklers are used.

3-8.4.1 In revamping existing systems, when it is not necessary to retain sprinklers in the concealed space, a nipple not exceeding 4 in. (10 cm) in length and of the same pipe thread size as the sprinkler being removed, may be used with 1-in. (2.54-cm) pipe and fittings for the other portions of the return bend to a single sprinkler.

3-8.4.2 In revamping existing systems when it is necessary to retain sprinklers in the concealed space, the return bend shall be not less than 1 in. (2.54 cm) throughout to a single sprinkler in each area.

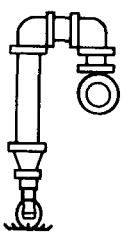


Figure 3-8.4 Return Bend Arrangment.

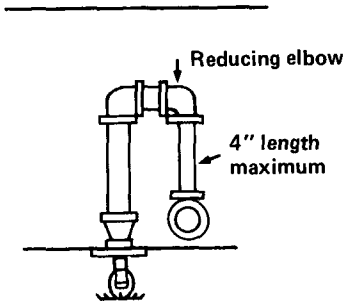


Figure 3-8.4.1 Nipple and Reducing Elbow in Return Bend.

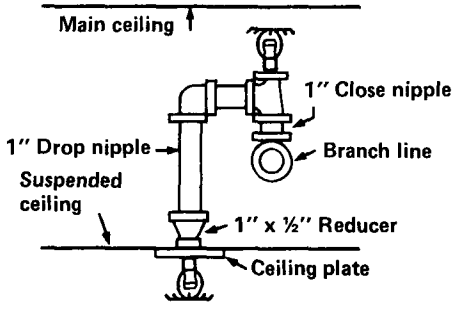


Figure 3-8.4.2 Sprinklers in Concealed Space and Below Ceiling.

3-8.5 Dry-Pipe Underground. When necessary to place pipe that will be under air pressure underground, the pipe shall be protected against corrosion (*see 3-10.2*), or unprotected cast or ductile iron pipe may be used when joined with a gasketed joint listed for air service underground.

3-8.6* One and One-Half-Inch Hose Connections. One and one-half-inch [1½-in. (3.8-cm)] hose used for fire purposes only may be connected to wet sprinkler systems only, subject to the following restrictions:

(a) Hose stations supply pipes shall not be connected to any pipe smaller than 2½ in.

Exception: For hydraulically designed loops and grids the minimum size pipe between the hose stations supply pipe and the source may be 2 in.

(b) Pipe shall be minimum 1 in. for horizontal runs up to 20 ft (6.1 m), minimum 1¼ in. for the entire run for runs between 20 and 80 ft (6.1 and 24.4 m), and minimum 1½ in. for the entire run for runs greater than 80 ft (24.4 m).

(c) Piping shall be at least 1 in. for vertical runs.

(d) When the pressure at any hose station outlet exceeds 100 psi (6.9 bars), an approved device shall be installed at the outlet to reduce the pressure at the outlet to 100 psi (6.9 bars).

3-8.7* Hose Connections for Fire Department Use. In buildings of Light or Ordinary Hazard occupancy, 2½-in. (6.4-cm) hose valves for fire department use may be attached to wet-pipe sprinkler system risers subject to the following restrictions:

(a) Sprinklers shall be under separate floor control valves.

(b) The minimum size of the riser shall be 4 in. (10 cm) unless hydraulic calculations indicate a smaller size riser will satisfy sprinkler and hose stream demands.

(c) For completely sprinklered buildings, the water supply for sprinklers need not be added to standpipe demand as determined from NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.*

Exception: When the sprinkler system demand, including hose stream allowance, indicated in Table 2-2.1(b) exceeds the requirements of NFPA 14, Standard for the Installation of Standpipe and Hose Systems, the values in Table 2-2.1(b) shall be used.

(d) For partially sprinklered buildings, the sprinkler demand, not including hose stream allowance, as indicated in Table 2-2.1(b) shall be added to the requirements given in NFPA 14, *Standard for the Installation of Standpipe and Hose Systems.*

(e) Each combined sprinkler and standpipe riser shall be equipped with a riser control valve to permit isolating a riser without interrupting the supply to other risers from the same source of supply.

(f) For fire department connections serving standpipe and sprinkler systems, refer to Section 2-7.

3-9 System Test Connections.

3-9.1 Wet Systems.

3-9.1.1* A test connection not less than 1 in. (2.54 cm) in diameter, terminating in a smooth bore corrosion-resistant orifice, giving a flow equivalent to one sprinkler of a type having the smallest orifice installed on the particular system, shall be provided to test each water flow alarm device for each system. The test connection valve shall be readily accessible. The discharge shall be to the outside, to a drain connection capable of accepting full flow under system pressure or to another location where water damage will not result.

3-9.2* Dry-Pipe Systems. A test connection not less than 1 in. (2.54 cm) in diameter, terminating in a smooth bore corrosion-resistant orifice to provide a flow equivalent to one sprinkler of a type installed on the particular system, shall be installed on the end of the most distant sprinkler pipe in the upper story and be equipped with a readily accessible 1-in. (2.54-cm) shutoff valve and plug, at least one of which shall be brass. In lieu of a plug, a nipple and cap may be used.

3-9.3 Preaction Systems. A test connection shall be used on a preaction system using supervisory air.

3-9.4 Deluge Systems. A test connection is not required on a deluge system.

3-10* Protection of Piping.

3-10.1 Protection of Piping Against Freezing.

3-10.1.1 When portions of systems are subject to freezing and temperatures cannot be reliably maintained at or above 40°F (4°C) sprinklers shall be installed as a dry-pipe or preaction system.

Exception: Small unheated areas may be protected by antifreeze systems. (See Section 5-5.)

3-10.1.2* When water-filled supply pipes, risers, system risers, or feed mains pass through open areas, cold rooms, passageways, or other areas exposed to freezing, the pipe shall be protected against freezing by insulating coverings, frostproof casings, or other reliable means capable of maintaining a minimum temperature of 40°F (4°C).

3-10.2 Protection of Piping Against Corrosion.

3-10.2.1* When corrosive conditions are known to exist due to moisture or fumes from corrosive chemicals, or both, types of piping, fittings, and hangers that resist corrosion shall be used or a protective coating shall be applied to all unprotected exposed surfaces of the sprinkler system to resist corrosion (*see 3-16.4*).

3-10.2.2 When water supplies are known to have unusual corrosive properties and threaded or cut grooved steel pipe is to be used, wall thickness shall be in accordance with Schedule 30 [in sizes 8 in. (20.3 mm) or larger] or Schedule 40 [in sizes less than 8 in. (20.3 mm)].

3-10.2.3* Steel pipe, when exposed to weather, shall be externally galvanized or otherwise protected against corrosion.

3-10.2.4 When steel pipe is used underground as a connection from a system to sprinklers in a detached building, the pipe shall be protected against corrosion before being buried.

3-10.3* Protection of Piping Against Damage Where Subject to Earthquakes.

3-10.3.1* General. Sprinkler systems shall be protected to minimize or prevent pipe breakage where subject to earthquakes in accordance with the requirements of 3-10.3.

Exception: Alternative methods of providing earthquake protection of sprinkler systems based on a dynamic seismic analysis certified by a registered professional engineer such that system performance will be at least equal to that of the building structure under expected seismic forces.

3-10.3.2* Couplings. Listed flexible pipe couplings joining grooved end pipe shall be provided as flexure joints to allow individual sections of piping 3½ in. or larger to move differentially with the individual sections of the building to which it is attached. Couplings shall be arranged to coincide with structural separations within a building. They shall be installed:

(a) Within 24 in. (610 mm) of the top and bottom of all risers.

Exception No. 1: In risers less than 3 ft (0.9 m) in length flexible couplings may be omitted.

Exception No. 2: In risers 3 to 7 ft (0.9 to 2.1 m) in length, one flexible coupling is adequate.

(b) At the ceiling of each story in multistory buildings.

(c) At each side of concrete or masonry walls 2 to 3 ft (0.6 to 0.9 m) from the wall surface.

(d)* At or near building expansion joints.

(e) At the top of drops to hose lines regardless of piping size.

3-10.3.3* Swing Joints. Swing joints assembled with flexible fittings shall be installed:

(a) Where sprinkler piping crosses building seismic joints.

(b) At the top of drops to sprinklers in racks.

3-10.3.4* Clearance. Clearance shall be provided around all piping extending through walls, floors, platforms, and foundations, including drains, fire department connections, and other auxiliary piping.

(a) Minimum clearance on all sides shall be not less than 1 in. (25 mm) for pipes 1 in. through 3½ in. and 2 in. (51 mm) for pipe sizes 4 in. and larger.

Exception No. 1: When clearance is provided by a pipe sleeve, a nominal diameter 2 in. (50 mm) larger than the nominal diameter of the pipe is acceptable for pipe sizes 1 in. through 3½ in. and the clearance provided by a pipe sleeve of nominal diameter 4 in. larger than the nominal diameter of the pipe is acceptable for pipe sizes 4 in. and larger.

Exception No. 2: No clearance is necessary for piping passing through gypsum board or equally frangible construction which is not required to have a fire-resistance rating.

Exception No. 3: No clearance is necessary if the pipe is attached firmly to the wall with flexible couplings or swing joints within one foot of both sides.

(b) When required the clearance shall be filled with a flexible material such as mastic.

3-10.3.5* Sway Bracing.

3-10.3.5.1* Sway bracing shall be designed to withstand a force in tension or compression equivalent to not less than half the weight of water-filled piping. For individual sway braces the slenderness ratio l/r shall not exceed 200.

3-10.3.5.2 Longitudinal sway bracing spaced at a maximum of 80 ft (24 m) on center shall be provided for feed and cross mains.

3-10.3.5.3* Tops of risers shall be secured against drifting in any direction, utilizing a four-way sway brace.

3-10.3.5.4 Lateral sway bracing spaced at a maximum of 40 ft (12 m) on center shall be provided for feed and cross mains.

Exception No. 1: Lateral sway bracing may be omitted when hanger rods less than 6 in. (15.2 cm) long are used.

Exception No. 2: U-type hangers used to support the mains may be used to satisfy the requirements for lateral

sway bracing provided the legs are bent out at least 10 degrees from the vertical.

3-10.3.5.5 Bracing shall be attached directly to feed and cross mains.

3-10.3.5.6 A length of pipe shall not be braced to sections of the building that will move differentially.

3-10.3.5.7 The last length of pipe at the end of a feed or cross main shall be provided with a lateral brace. Lateral braces may also act as longitudinal braces if they are within 24 in. (610 mm) of the center line of the piping braced longitudinally.

3-10.3.5.8 When additional flexible couplings are used in horizontal piping for purposes other than the requirements for earthquake protection (usually for ease of installation), a sway brace shall be provided within 24 in. (610 mm) of each such coupling.

3-10.3.5.9 Sway bracing is not required for branch lines.

Exception: The end sprinkler on a line shall be restrained against excessive movement by use of wrap-around U-hook (see Figure A-3-15.1) or by other approved means.

3-10.3.5.10 C-type clamps used to attach hangers to the building structure in areas subject to earthquakes shall be equipped with a retaining strap or other approved means to prevent movement. (*See Figure A-3-15.1.*)

3-10.3.5.11 C-type clamps, with or without retaining straps, shall not be used to attach braces to the building structure.

3-11 Drainage.

3-11.1 Pitching of Piping for Drainage.

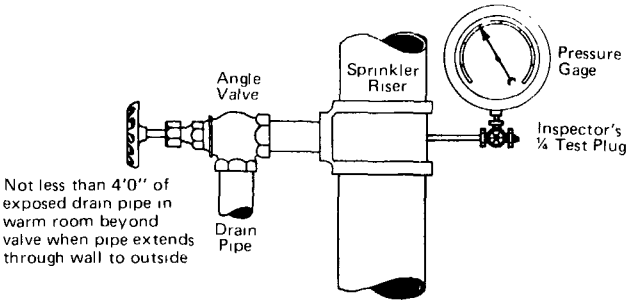
3-11.1.1* All sprinkler pipe and fittings shall be so installed that the system may be drained.

3-11.1.2 On wet-pipe systems, sprinkler pipes may be installed level. Trapped piping shall be drained in accordance with 3-11.3.

3-11.1.3 On those portions of preaction systems subject to freezing and on dry-pipe systems, sprinkler pipe on branch lines shall be pitched at least ½-in. in 10 ft (4 mm/m) and the pipe of cross and feed mains shall be given a pitch of not less than ¼-in. in 10 ft (2 mm/m). A pitch of ¾ to 1-in. (19 to 25 mm) shall be provided for short branch lines and ½-in. in 10 ft (4 mm/m) for cross and feed mains in refrigerated areas and in buildings of light construction that may settle under heavy loads.

3-11.2 System, Main Drain, or Sectional Drain Connections. [*See Figures 3-11.2 and A-3-9.1.1(b).*]

3-11.2.1 Provisions shall be made to properly drain all parts of the system.



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

Figure 3-11.2 Drain Connection for System Riser.

3-11.2.2 Drain connections for systems supply risers and mains shall be sized as shown in Table 3-11.2.2.

Table 3-11.2.2

Riser or Main Size	Size of Drain Connection
Up to 2 in.	¾ in. or larger
2½ in., 3 in., 3½ in.	1¼ in. or larger
4 in. and larger	2 in. only

3-11.2.3 Each interior sectional control valve shall be provided with a drain connection sized as shown in Table 3-11.2.2 so as to drain that portion of the system controlled by the sectional valve. These drains shall discharge either outside or to a drain connection.

3-11.2.4 The test valves required by 2-9.1 may be used as main drain valves.

3-11.3 Auxiliary Drains.

3-11.3.1 Auxiliary drains shall be provided when a change in piping direction prevents drainage of sections of branch lines or mains through the main drain valve.

3-11.3.2 Auxiliary Drains for Wet-Pipe Systems.

3-11.3.2.1 When the capacity of trapped sections of pipes is 5 gal (18.9 L) or less, the auxiliary drain shall consist of a nipple and cap or brass plug not less than ¾ in. in size.

Exception: Auxiliary drains are not required for piping that can be drained by removing a single pendent sprinkler.

3-11.3.2.2 When the capacity of isolated trapped sections of pipe is more than 5 gal (18.9 L) and less than 50 gal (189 L), the auxiliary drain shall consist of a valve not smaller than ¾ in. (19.1 mm) size and a plug, at least one of which shall be brass. In lieu of a plug, a nipple and cap may be used.

3-11.3.2.3* When the capacity of isolated trapped sections of pipe is 50 gal (189 L) or more, the auxiliary drain shall consist of a valve not smaller than 1 in. (2.54 cm), piped to an accessible location.

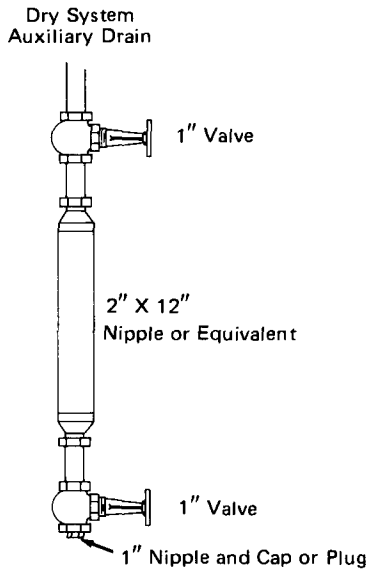
3-11.3.2.4 Tie-in drains are not required on wet-pipe systems.

3-11.3.3 Auxiliary Drains for Dry-Pipe Systems.

3-11.3.3.1 When capacity of trapped sections of pipe is 5 gal (18.9 L) or less, the auxiliary drain shall consist of a valve not smaller than ¾ in. and a plug, at least one of which shall be brass. In lieu of a plug, a nipple and cap may be used.

Exception: Auxiliary drains are not required for a drop nipple when installed in accordance with 5-2.2.

3-11.3.3.2 When capacity of isolated trapped sections of pipe is more than 5 gal (18.9 L), the auxiliary drain shall consist of two 1-in. valves, and one 2-in. by 12-in. (305-mm) condensate nipple or equivalent, accessibly located. (*See Figure 3-11.3.3.*)



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

Figure 3-11.3.3 Dry System Auxiliary Drain

3-11.3.3.3* Tie-in drains shall be provided for multiple adjacent trapped branch lines and shall be a minimum of 1-in. (2.54-cm). Tie-in drain lines shall be pitched a minimum of ½ in. in 10 ft (4 mm/m).

3-11.3.4 Auxiliary Drains for Preaction Systems.

3-11.3.4.1 When trapped sections of pipe are in areas subject to freezing, auxiliary drains shall conform to 3-11.3.3.

3-11.3.4.2 When trapped sections of pipe are in areas not subject to freezing, auxiliary drains shall consist of a valve not smaller than ¾ in. and a plug, at least one of which shall be brass. In lieu of a plug, a nipple and cap may be used.

Exception: Auxiliary drains are not required for piping that can be drained by removing a single pendent sprinkler when capacity of the trapped sections of pipe is 5 gal (18.9 L) or less.

3-11.4 Discharge of Drain Valves.

3-11.4.1* Direct interconnections shall not be made between sewers and sprinkler drains of systems supplied by public water. The drain discharge shall be in conformity with any health or water department regulations.

3-11.4.2 When drain pipes are buried underground, approved corrosion-resistant pipe shall be used.

3-11.4.3 Drain pipes shall not terminate in blind spaces under the building.

3-11.4.4 When exposed, drain pipes shall be fitted with a turned down elbow.

3-11.4.5* Drain pipes shall be arranged so as not to expose any part of the sprinkler system to freezing conditions.

3-12 Joining of Pipe and Fittings.

3-12.1 Threaded Pipe and Fittings.

3-12.1.1 All threaded fittings and pipe shall have threads cut to ANSI/ASME Standard B1.20.1. Care shall be taken that the pipe does not extend into the fitting sufficiently to reduce the waterway.

3-12.1.2* Steel pipe with wall thicknesses less than Schedule 30 (in sizes 8 in. and larger) or Schedule 40 (in sizes less than 8 in.) shall not be joined by threaded fittings, unless a threaded assembly has been investigated for suitability in automatic sprinkler installations and listed for this service.

3-12.1.3 Joint compound or tape shall be applied to the threads of the pipe and not in the fitting.

3-12.2* Welded Piping.

3-12.2.1 Welding methods that comply with all of the requirements of AWS D10.9, *Standard for Building Service Piping*, Level AR-3, are acceptable means of joining fire protection piping.

3-12.2.2* Welding sections of sprinkler piping in place inside the building shall not be permitted. Sections of branch lines, cross mains or risers may be shop welded.

Exception: Welding sections of sprinkler piping in place inside new buildings under construction may be permitted only when the construction is noncombustible and no combustible contents are present and when the welding process is performed in accordance with NFPA 51B, Standard for Fire Prevention in Use of Cutting and Welding Processes.

3-12.2.3 Welding procedures, welders, and welding machine operators shall be qualified as required by 3-12.2.11.

3-12.2.4 Fittings used to join pipe shall be listed fabricated fittings, or manufactured in accordance with Table 3-13.1.1. Such fittings joined in conformance with a qualified welding procedure as set forth in this section are an acceptable product under this standard, provided that materials and wall thickness are compatible with other sections of this standard.

Exception: Fittings are not required when pipe ends are buttwelded.

3-12.2.5 No welding shall be performed if there is impingement of rain, snow, sleet, or high wind on the weld area of the pipe product.

3-12.2.6 When welding is performed:

(a)* Holes in piping for outlets shall be cut to the full inside diameter of fittings prior to welding in place of the fittings.

(b) Discs shall be retrieved.

(c) Openings cut into piping shall be smooth bore and all internal slag and welding residue shall be removed.

(d) Fittings shall not penetrate the internal diameter of the piping.

(e) Steel plates shall not be welded to the ends of piping or fittings.

(f) Fittings shall not be modified.

(g) Nuts, clips, eye rods, angle brackets, or other fasteners shall not be welded to pipe or fittings.

3-12.2.7 When reducing a pipe size in the run of a main, cross main, or branch, a reducing fitting designed for that purpose shall be used.

3-12.2.8 Torch cutting and welding shall not be permitted as a means of modifying or repairing sprinkler systems.

3-12.2.9 When welding is planned, a contractor shall specify the section to be shop welded on drawings and the type of fittings or formations to be used.

3-12.2.10 Sections of shop welded piping shall be joined by means of flanged or flexible gasketed joints or other approved fittings.

Exception: See 3-12.2.2.

3-12.2.11 Qualifications.

3-12.2.11.1 A welding procedure shall be prepared and qualified before any welding is done. Qualification of the welding procedure to be used and the performance of welders and welding operators is required and shall comply with the requirements of American Welding Society Standard AWS D10.9, Level AR-3.

3-12.2.11.2 Each contractor or fabricator shall be responsible for all welding s/he installs. Each contractor or fabricator shall have an established written quality assurance procedure related to control of the requirements of 3-12.2.6, available to the authority having jurisdiction.

3-12.2.11.3 Each contractor or fabricator shall be responsible for qualifying any welding procedure that s/he intends to have used by personnel of his/her organization.

3-12.2.11.4 Each contractor or fabricator shall be responsible for qualifying all of the welders and welding machine operators employed by him/her in compliance with the requirements of AWS D10.9, Level AR-3.

3-12.2.12 Records.

3-12.2.12.1 Each welder or welding machine operator shall, upon completion of each weld, stamp an imprint of his/her identification into the side of the pipe adjacent to the weld.

3-12.2.12.2 The contractor or fabricator shall maintain certified records, which are available to the authority having jurisdiction, of the procedures used and the welders or welding machine operators employed by him/her along with their welding identification imprints. Records shall show the date and the results of procedure and performance qualifications.

3-12.3 Groove Joining Methods.

3-12.3.1 Pipe joined with mechanical grooved fittings shall be joined by a listed combination of fittings, gaskets, and grooves. When grooves are cut or rolled on the pipe they shall be dimensionally compatible with the fitting.

Exception: Steel pipe with wall thicknesses less than Schedule 30 (in sizes 8 in. and larger) or Schedule 40 (in sizes less than 8 in.) shall not be joined by fittings used with pipe having cut grooves.

3-12.3.2 Mechanical grooved couplings including gaskets used on dry-pipe systems shall be listed for dry-pipe service.

3-12.4* Brazed and Soldered Joints. Joints for the connection of copper tube shall be brazed.

Exception No. 1: Solder joints may be permitted for wet-pipe systems in Light Hazard Occupancies where the temperature classification of the installed sprinklers is Ordinary or Intermediate.

Exception No. 2: Solder joints may be permitted for wet-pipe systems in Ordinary Hazard (Group 1) Occupancies where the piping is concealed.

3-12.5 Other Types. Other types of joints shall be made or installed in accordance with the requirements of the listing for this service.

3-12.6 End Treatment. After cutting, pipe ends shall have burrs and fins removed.

3-12.6.1 When using listed fittings, the pipe and its end treatment shall be in accordance with the manufacturer's installation instructions and the listing.

3-13 Fittings.

3-13.1 Types of Fittings.

3-13.1.1 Fittings used in sprinkler systems shall be of the materials listed in Table 3-13.1.1 or in accordance with 3-13.1.2. The chemical properties, physical properties, and dimensions of the materials listed in Table 3-13.1.1 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 [125 psi (8.6 bars) saturated steam] pressure.

Table 3-13.1.1 Fittings Materials and Dimensions

Material 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
Steel Pipe Flanges and Flanged Fittings	ANSI B16.5
Forged Steel Fittings, Socket Welded and Threaded	ANSI B16.11
Copper	
Wrought Copper and Bronze Solder-Joint Pressure Fittings	ANSI B16.22
Cast Bronze Solder-Joint Pressure Fittings	ANSI B16.18

3-13.1.2* Other types of fittings may be used, but only those investigated and listed for this service.

3-13.1.2.1* When unique characteristics of a fitting, such as a tendency to rotate, require support in addition to that required in Section 3-15, restraint shall be provided in accordance with its listing.

3-13.1.3 Fittings used in sprinkler systems shall be extra-heavy pattern where pressures exceed 175 psi (12.1 bars).

Exception No. 1: Standard weight pattern cast-iron fittings 2 in. in size and smaller may be used where pressures do not exceed 300 psi (20.7 bars).

Exception No. 2: Standard weight pattern malleable iron fittings 6 in. (15.2 cm) size and smaller may be used where pressures do not exceed 300 psi (20.7 bars).

Exception No. 3: Fittings may be used for system pressures up to the limits specified in listings by a testing laboratory.

3-13.1.4 When water pressures are 175 psi to 300 psi (12.1 to 20.7 bars), extra heavy valves shall be used in accordance with their pressure ratings.

3-13.1.5* When individual floor/zone control valves are not provided, a flanged joint or mechanical coupling shall be used at the riser at each floor for connections to piping serving floor areas in excess of 5000 sq ft.

3-13.2* Couplings and Unions. Screwed unions shall not be used on pipe larger than 2 in. Couplings and unions of other than screwed-type shall be of types approved specifically for use in sprinkler systems. Unions, screwed or mechanical couplings, or flanges may be used to facilitate installation.

3-13.3 Reducers and Bushings. A one-piece reducing fitting shall be used wherever a change is made in the size of the pipe.

Exception: Hexagonal or face bushings may be used in reducing the size of openings of fittings when standard fittings of the required size are not available.

3-14 Valves.

3-14.1 Types of Valves to Be Used.

3-14.1.1 All valves on connections to water supplies and in supply pipes to sprinklers shall be listed indicating valves, unless a nonindicating valve, such as an underground gate valve with approved roadway box complete with T-wrench, is accepted by the authority having jurisdiction.

Such valves shall not close in less than 5 seconds when operated at maximum possible speed from the fully open position. This is to avoid damage to piping by water hammer.

The following may not incorporate indicating devices as part of the valve, but the valve assembly described shall qualify as an indicating valve:

(a) A listed underground gate valve equipped with a listed indicator post,

(b) A listed water control valve assembly with a reliable position indication connected to a remote supervisory station.

3-14.1.2 Drain valves and test valves shall be of approved type of 175 psi (12.1 bars) cold water [125 psi (8.6 bars) saturated steam] pressure rating.

3-14.1.3 Check valves shall be listed and installed in a vertical or horizontal position in accordance with their listing.

3-14.2* Valves Controlling Sprinkler Systems.

3-14.2.1* Each system shall be provided with a listed indicating valve so located as to control all sources of water supply except fire department connections.

3-14.2.2 At least one listed indicating valve shall be installed in each source of water supply except fire department connections.

3-14.2.3 Valves on connections to water supplies, sectional control valves, and other valves in supply pipes to sprinklers shall be supervised open by one of the following methods:

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

(b) Local signaling service that will cause the sounding of an audible signal at a constantly attended point,

(c) Locking valves open,

(d) Sealing of valves and approved weekly recorded inspection when valves are located within fenced enclosures under the control of the owner.

Exception: Underground gate valves with roadway boxes need not be supervised.

3-14.2.4 When there is more than one source of water supply, a check valve shall be installed in each connection.

Exception: When cushion tanks are used with automatic fire pumps, no check valve is required in the cushion tank connection.

3-14.2.5* A check valve shall be installed in each water supply connection if there is a fire department connection on the system.

3-14.2.6* When a single wet-pipe sprinkler system is equipped with a fire department connection the alarm valve is considered a check valve and an additional check valve shall not be required.

3-14.2.7 In a city connection serving as one source of supply the city valve in the connection may serve as one of the required valves. A listed indicating valve or an indicator post valve shall be installed on the system side of the check valve. (*See Figure A-3-14.2.5.*)

Exception: When a wet-pipe sprinkler system is equipped with an (alarm) check valve, a gate valve is not required on the system side of the (alarm) check valve.

3-14.3* Identification of Valves. When there is more than one control valve, permanently marked identification signs indicating the portion of the system controlled by each valve shall be provided.

Embossed plastic tape, pencil, ink, crayon, etc., shall not be considered permanent markings. The sign shall be secured with noncorrosive wire, chain, or other means.

3-15 Hangers.

3-15.1* General. Type of hangers and installation methods shall be in accordance with the requirements of Section 3-15.

Exception: Hangers and installation methods certified by a registered professional engineer for the following:

(a) Designed to support five times the weight of the water-filled pipe plus 250 lb (114 kg) at each point of piping support.

(b) These points of support are enough to support the sprinkler system.

(c) Ferrous materials are used for hanger components.

Detailed calculations shall be submitted, when required by the reviewing authority, showing stresses developed both in hangers and piping, and safety factors allowed.

3-15.1.1 Hangers and their components shall be ferrous.

Exception: Nonferrous components that have been proven by fire tests to be adequate for the hazard application, are listed for this purpose, and are in compliance with the other requirements of this section.

3-15.1.2 The components of hanger assemblies that directly attach to the pipe or to the building structure shall be listed.

Exception: Mild steel hangers formed from rods need not be listed.

3-15.1.3* Sprinkler piping or hangers shall not be used to support nonsystem components.

3-15.1.4 Sprinkler piping shall be substantially supported from the building structure, which must support the added load of the water-filled pipe plus a minimum of 250 lb (114 kg) applied at the point of hanging.

3-15.1.5 Sprinkler piping shall be supported independently of the ceiling sheathing.

Exception: Toggle hangers shall be used only for the support of pipe 1½ in. or smaller in size under ceilings of hollow tile or metal lath and plaster.

3-15.1.6 When sprinkler piping is installed below ductwork, piping shall be substantially supported from the building structure or from the steel angles supporting the ductwork provided the angles conform to Tables 3-15.1.7 (a) and (b).

3-15.1.7* For trapeze hangers, the minimum size of steel angle or pipe span between purlins or joists shall be such that the available section modulus of the trapeze member from Table 3-15.1.7 (a) equals or exceeds the section modulus required in Table 3-15.1.7 (b).

Table 3-15.1.7(a) Available Section Moduli of Common Trapeze Hangers

Pipe	Modulus	Angles					Modulus
Schedule 10							
1 in.	.12	1½	X	1½	X	3/16	.10
1¼ in.	.19	2	X	2	X	⅛	.13
1½ in.	.26	2	X	1½	X	3/16	.18
2 in.	.42	2	X	2	X	3/16	.19
2½ in.	.69	2	X	2	X	¼	.25
3 in.	1.04	2½	X	1½	X	3/16	.28
3½ in.	1.38	2½	X	2	X	3/16	.29
4 in.	1.76	2	X	2	X	5/16	.30
5 in.	3.03	2½	X	2½	X	3/16	.30
6 in.	4.35	2	X	2	X	⅜	.35
		2½	X	2½	X	¼	.39
Schedule 40		3	X	2	X	3/16	.41
		3	X	2½	X	3/16	.43
1 in.	.13	3	X	3	X	3/16	.44
1¼ in.	.23	2½	X	2½	X	5/16	.48
1½ in.	.33	3	X	2	X	¼	.54
2 in.	.56	2½	X	2	X	⅜	.55
2½ in.	1.06	2½	X	2½	X	⅜	.57
3 in.	1.72	3	X	3	X	¼	.58
3½ in.	2.39	3	X	3	X	5/16	.71
4 in.	3.21	2½	X	2½	X	½	.72
5 in.	5.45	3½	X	2½	X	¼	.75
6 in.	8.50	3	X	2½	X	⅜	.81
		3	X	3	X	⅜	.83
		3½	X	2½	X	5/16	.93
		3	X	3	X	7/16	.95
		4	X	4	X	¼	1.05
		3	X	3	X	½	1.07
		4	X	3	X	5/16	1.23
		4	X	4	X	5/16	1.29
		4	X	3	X	⅜	1.46
		4	X	4	X	⅜	1.52
		5	X	3½	X	5/16	1.94
		4	X	4	X	½	1.97
		4	X	4	X	⅝	2.40
		4	X	4	X	¾	2.81
		6	X	4	X	⅜	3.32
		6	X	4	X	½	4.33
		6	X	4	X	¾	6.25
		6	X	6	X	1	8.57

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

Any other sizes or shapes giving equal or greater section modulus will be acceptable. All angles are to be used with the longer leg vertical. The trapeze member shall be secured to prevent slippage. When a pipe is suspended from a pipe trapeze, ring, strap, or clevis, hangers of the size corresponding to the suspended pipe shall be used on both ends.

Table 3-15.1.7(b) Section Modulus Required for Trapeze Members (in.^{3})

Pipe Size	2½ in. or less	3 in.	3½ in.	4 in.	5 in.	6 in.	8 in.	10 in.
1 ft 6 in.	.102	.111	.119	.128	.153	.179	.241	.325
	.110	.124	.135	.148	.180	.217	.301	.411
2 ft 0 in.	.135	.148	.159	.171	.204	.238	.322	.434
	.147	.165	.180	.198	.240	.289	.401	.547
2 ft 6 in.	.169	.185	.198	.213	.255	.298	.402	.542
	.184	.206	.225	.247	.300	.361	.502	.684
3 ft 0 in.	.203	.221	.238	.256	.306	.357	.483	.650
	.221	.247	.271	.297	.360	.433	.602	.821
4 ft 0 in.	.271	.295	.317	.341	.408	.476	.644	.867
	.294	.329	.361	.396	.479	.578	.803	1.09
5 ft 0 in.	.338	.369	.397	.427	.510	.595	.805	1.08
	.368	.412	.451	.495	.599	.722	1.00	1.37
6 ft 0 in.	.406	.443	.476	.512	.611	.715	.966	1.30
	.442	.494	.541	.593	.719	.867	1.20	1.64
7 ft 0 in.	.474	.517	.555	.597	.713	.834	1.13	1.52
	.515	.576	.631	.692	.839	1.01	1.41	1.92
8 ft 0 in.	.541	.591	.635	.683	.815	.953	1.29	1.73
	.589	.659	.721	.791	.959	1.16	1.61	2.19
9 ft 0 in.	.609	.664	.714	.768	.917	1.07	1.45	1.95
	.662	.741	.812	.890	1.08	1.30	1.81	2.46
10 ft 0 in.	.677	.738	.793	.853	1.02	1.19	1.61	2.17
	.736	.823	.902	.989	1.20	1.44	2.01	2.74

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

Top Values are for Schedule 10 pipe, bottom values are for Schedule 40 Pipe.

Note: The table is based on a maximum allowable bending stress of 15 KSI and a midspan concentrated load from 15 ft of water-filled pipe, plus 250 lb.

3-15.1.8 The size of hanger rods and fasteners required to support the steel angle iron or pipe indicated in Table 3-15.1.7(a) shall comply with 3-15.4.

3-15.1.9 Eye rods and ring hangers shall be secured with necessary lock washers to prevent lateral motion at the point of support.

3-15.1.10 Holes through concrete beams may also be considered as a substitute for hangers for the support of pipes.

3-15.1.11* Maximum Distance Between Hangers.

3-15.1.11.1* For steel pipe sizes 1½ in. and larger the maximum distance between hangers shall be 15 ft (4.5 m). For steel pipe sizes less than 1½ in., the maximum distance between hangers shall be 12 ft (3.6 m).

Exception No. 1: Threaded lightweight steel pipe shall have a maximum distance between hangers not exceeding 12 ft (3.6 m) for pipe sizes 3 in. or less.

Exception No. 2: The maximum distance between hangers may be modified in accordance with other paragraphs of Section 3-15.

3-15.1.11.2 For copper tubes as specified in Table 3-1.1.1 the maximum distance between hangers shall not exceed that in Table 3-15.1.11.2.

Table 3-15.1.11.2 Hanger Spacing for Copper Tube

Tube Size	Maximum Hanger Spacing
¾ in. — 1 in.	8 ft
1¼ in. — 1½ in.	10 ft
2 in. — 3 in.	12 ft
3½ in. — 8 in.	15 ft

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

3-15.1.12 When sprinkler piping is installed in storage racks as defined in NFPA 231C, *Standard for Rack Storage of Materials*, piping shall be substantially supported from the storage rack structure or building in accordance with all applicable provisions of Section 3-15.

3-15.2 Hangers in Concrete.

3-15.2.1 Listed inserts set in concrete may be installed for the support of hangers. Wood plugs shall not be used.

3-15.2.2 Listed expansion shields for supporting pipes under concrete construction may be used in a horizontal position in the sides of beams. In concrete having gravel or crushed stone aggregate, expansion shields may be used in the vertical position to support pipes 4 in. or less in diameter.

3-15.2.3 For the support of pipes 5 in. and larger, expansion shields if used in the vertical position shall alternate with hangers connected directly to the structural members such as trusses and girders, or to the sides of concrete beams. In the absence of convenient structural members, pipes 5 in. and larger may be supported entirely by expansion shields in the vertical position, but spaced not over 10 ft (3 m) apart.

3-15.2.4 Expansion shields shall not be used in ceilings of gypsum or similar soft material. In cinder concrete, expansion shields shall not be used except on branch lines where they shall alternate with through bolts or hangers attached to beams.

3-15.2.5 When expansion shields are used in the vertical position, the holes shall be drilled to provide uniform contact with the shield over its entire circumference. Depth of the hole shall be not less than specified for the type of shield used.

3-15.2.6 Holes for expansion shields in the side of concrete beams shall be above the center line of the beam or above the bottom reinforcement steel rods.

3-15.3 Powder-Driven Studs and Welding Studs.

3-15.3.1* Powder-driven studs, welding studs, and the tools used for installing these devices shall be listed by a testing laboratory and installed within the limits of pipe

size, installation position, and construction material into which they are installed as expressed in individual listings or approvals.

3-15.3.2 The ability of concrete to hold the studs varies widely according to type of aggregate and quality of concrete, and it shall be established in each case by testing concrete on the job to determine that the studs will hold a minimum load of 750 lb (341 kg) for 2-in. or smaller pipe, 1000 lb (454 kg) for 2½-, 3-, or 3½-in. pipe, and 1200 lb (545 kg) for 4- or 5-in. pipe.

3-15.3.3 When increaser couplings are used, they shall be attached directly to the powder-driven stud or welding stud.

3-15.3.4 Welded studs or other hanger parts shall not be attached by welding to steel less than U.S. Standard, 12 gage.

3-15.4 Rods and "U" Hooks.

3-15.4.1 Hanger rod size shall be the same as that approved for use with the hanger assembly and the size of rods shall not be less than that given in Table 3-15.4.1.

Exception: Rods of smaller diameter may be used when the hanger assembly has been tested and listed by a testing laboratory and installed within the limits of pipe sizes expressed in individual listings or approvals. For rolled threads, the rod size shall not be less than the root diameter of the thread.

Table 3-15.4.1 Hanger Rod Sizes

Pipe Size	Dia. of Rod in.	mm	Pipe Size	Dia of Rod in.	mm
Up to and including 4 in.	⅜	9.5	5, 6 and 8 in.	½	12.7
			10 and 12 in.	⅝	15.9

For SI Units. 1 in. = 25.4 mm

3-15.4.2 U Hooks. The size of the rod material of U hooks shall not be less than that given in Table 3-15.4.2.

Table 3-15.4.2 U Hook Rod Sizes

Pipe Size	Hook Material Diameter in.	mm
Up to 2 in.	5/16	7.9
2½ in. to 6 in.	⅜	9.5
8 in.	½	12.7

For SI Units: 1 in = 25.4 mm.

3-15.4.3 The size of the rod material for eye rods shall not be less than that specified in Table 3-15.4.3.

3-15.4.4 Threaded sections of rods shall not be formed or bent.

3-15.4.5 Screws. For ceiling flanges and U hooks, screw dimensions shall not be less than those given in Table 3-15.4.5.

Exception: When the thickness of planking and thickness of flange do not permit the use of screws 2 in. (51 mm) long, screws of 1¾ in. (44 mm) long may be permitted with hangers spaced not over 10 ft (3 m) apart. When the thickness of beams or joists does not permit the use of screws 2½ in. (64 mm) long, screws 2 in. (51 mm) long may be permitted with hangers spaced not over 10 ft (3 m) apart.

Table 3-15.4.3 Eye Rod Sizes

Pipe Size	Diameter of Rod With Bent Eye in.	mm	With Welded Eye in.	mm
Up to 4 in.	⅜	9.5	⅜	9.5
5-6 in.	½	12.7	½	12.7
8 in.	⅝	19.1	½	12.7

For SI Units: 1 in = 25.4 mm.

Table 3-15.4.5 Screw Dimension for Ceiling Flanges and U Hooks

Pipe Size	2 Screw Flanges
Up to 2 in.	Wood Screw No. 18 x 1½ in.
Pipe Size	**3 Screw Flanges**
Up to 2 in.	Wood Screw No. 18 x 1½ in.
2½ in., 3 in., 3½ in.	Lag Screw ⅜ in. x 2 in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 2 in.
8 in.	Lag Screw ⅝ in. x 2 in.
Pipe Size	**4 Screw Flanges**
Up to 2 in.	Wood Screw No. 18 x 1½ in.
2½ in., 3 in., 3½ in.	Lag Screw ⅜ in. x 1½ in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 2 in.
8 in.	Lag Screw ⅝ in. x 2 in.
Pipe Size	**U Hooks**
Up to 2 in.	Drive Screw No. 16 x 2 in.
2½ in., 3 in., 3½ in.	Lag Screw ⅜ in. x 2½ in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 3 in.
8 in.	Lag Screw ⅝ in. x 3 in.

For SI Units. 1 in. = 25.4 mm.

3-15.4.6 The size bolt or lag (coach) screw used with an eye rod or flange on the side of the beam shall not be less than specified in Table 3-15.4.6.

Exception: When the thickness of beams or joists does not permit the use of screws 2½ in. (64 mm), screws 2 in. (51 mm) may be permitted with hangers spaced not over 10 ft (3 m) apart.

Table 3-15.4.6 Minimum Bolt or Lag Screw Sizes

Size of Pipe	Size of Bolt or Lag Screw in.	mm	Length of Lag Screw Used with Wood Beams in.	mm
Up to and including 2 in.	⅜	9.5	2½	64
2½ to 6 in. (inclusive)	½	12.7	3	76
8 in.	⅝	15.9	3	76

For SI Units: 1 in. = 25.4 mm.

3-15.4.7 Drive screws shall be used only in a horizontal position as in the side of a beam. Wood screws shall not

be driven. Nails are not acceptable for fastening hangers.

3-15.4.8 Screws in the side of a timber or joist shall be not less than 2½ in. (64 mm) from the lower edge when supporting branch lines, and not less than 3 in. (76 mm) when supporting main lines. This shall not apply to 2-in. (51-mm) or thicker nailing strips resting on top of steel beams.

3-15.4.9 The minimum plank thickness and the minimum width of the lower face of beams or joists in which lag screw rods are used shall be as given in Table 3-15.4.9.

Table 3-15.4.9 Minimum Plank Thicknesses and Beam Widths

Pipe Size	Nominal Plank Thickness in.	Nominal Plank Thickness mm	Nominal Width of Beam Face in.	Nominal Width of Beam Face mm
Up to 2 in.	3	76	2	51
2½ in. to 3½ in.	4	102	2	51
4 in. and 5 in.	4	102	3	76
6 in.	4	102	4	102

For SI Units: 1 in = 25.4 mm

3-15.4.10 Lag screw rods shall not be used for support of pipes larger than 6 in. All holes for lag screw rods shall be predrilled ⅛ in. (3.2 mm) less in diameter than the root diameter of the lag screw thread.

3-15.5 Location of Hangers on Branch Lines. This subsection applies to the support of steel pipe or copper tube as specified in 3-1.1.1, subject to the provisions of 3-15.1.11.

3-15.5.1 On branch lines, there shall be not less than one hanger for each length of pipe.

Exception: Hangers may be located as provided in 3-15.5.2 to 3-15.5.5 inclusive.

3-15.5.2* When sprinklers are spaced less than 6 ft (1.8 m) apart, hangers may be spaced up to a maximum of 12 ft (3.7 m). (*See Figure A-3-15.5.2.*)

3-15.5.3 Starter lengths less than 6 ft (1.8 m) do not require a hanger, except on the end line of a side-feed system or where an intermediate cross main hanger has been omitted.

3-15.5.4 The distance between a hanger and the centerline of an upright sprinkler shall not be less than 3 in. (76 mm).

3-15.5.5* The unsupported length between the end sprinkler and the last hanger on the line shall not be greater than 36 in. (914 mm) for 1-in. pipe or 48 in. (1219 mm) for 1¼-in. or larger pipe. When either of these limits is exceeded, the pipe shall be extended beyond the end sprinkler and supported by an additional hanger. (*See 3-13.1.2.1.*)

Exception: When the maximum pressure at the sprinkler exceeds 100 psi (6.9 bars), and a branch line above a ceiling supplies sprinklers in a pendent position below the ceiling the hanger assembly supporting the pipe supplying an end sprinkler in a pendent position shall be of a type that prevents upward movement of the pipe. [See Figure A-3-15.5.5(a).]

The unsupported length between the end sprinkler in a pendent position or drop nipple and the last hanger on the branch line shall not be greater than 12 in. (305 mm) for steel pipe or 6 in. (152 mm) for copper pipe. When this limit is exceeded, the pipe shall be extended beyond the end sprinkler and supported by an additional hanger. The hanger closest to the sprinkler shall be of a type that clamps to and prevents upward movement of the piping. [See Figure A-3-15.5.5(a).]

3-15.5.6* The length of an unsupported armover to a sprinkler shall not exceed 24 in. (610 mm) for steel pipe or 12 in. (305 mm) for copper tube. (*See 3-13.1.2.1.*)

Exception: When the maximum pressure at the sprinkler exceeds 100 psi and a branch line above a ceiling supplies sprinklers in a pendent position below the ceiling, the length of an unsupported armover to a sprinkler or drop nipple shall not exceed 12 in. (305 mm) for steel pipe and 6 in. (152 mm) for copper tube.

When the limits of unsupported armover lengths of 3-15-5.6 or this exception are exceeded, the hanger closest to the sprinkler shall be of a type that prevents upward movement of the piping. [See Figure A-3-15.5.5(a).]

3-15.5.7 Wall-mounted sidewall sprinklers shall be restrained to prevent movement.

3-15.6 Location of Hangers on Cross Mains. This subsection applies to the support of steel pipe only as specified in 3-1.1.1, subject to the provisions of 3-15.1.11. Intermediate hangers shall not be omitted for copper tube.

3-15.6.1* On cross mains, there shall be at least one hanger between each two branch lines.

Exception No. 1: In bays having two branch lines, the intermediate hanger may be omitted provided that a hanger attached to a purlin is installed on each branch line located as near to the cross main as the location of the purlin permits. [See Figure A-3-15.6.1(a).] Remaining branch line hangers shall be installed in accordance with 3-15.5.

Exception No. 2: In bays having three or more branch lines, either side or centerfeed, one (only) intermediate hanger may be omitted provided that a hanger attached to a purlin is installed on each branch line located as near to the cross main as the location of the purlin permits. [See Figures A-3-15.6.1(b) and A-3-15.6.1(c).] Remaining branch line hangers shall be installed in accordance with 3-15.5.

3-15.6.2 At the end of the cross main, intermediate trapeze hangers shall be installed unless the cross main is extended to the next framing member with an ordinary hanger installed at this point, in which event an intermediate hanger may be omitted in accordance with 3-15.6.1, Exceptions No. 1 and No. 2.

3-15.7 Support of Risers.

3-15.7.1 Risers shall be supported by attachments directly to the riser or by hangers located on the horizontal connections close to the riser.

3-15.7.2 In multistory buildings, riser supports shall be provided at the lowest level, at each alternate level above, above and below offsets, and at the top of the riser. Supports above the lowest level shall also restrain the pipe to prevent movement by an upward thrust when flexible fittings are used. Where risers are supported from the ground, the ground support constitutes the first level or riser support. Where risers are offset or do not rise from the ground, the first ceiling level above the offset constitutes the first level of riser support.

3-15.7.3 Sprinkler and tank risers in vertical shafts, or in buildings with ceilings over 25 ft (7.6 m) high, shall have at least one support for each riser pipe section.

3-15.7.4 Clamps supporting pipe by means of set screws shall not be used.

3-16 Sprinklers.

3-16.1 Types of Sprinklers. Some of the commonly used sprinklers are as follows:

(a) *Upright Sprinklers.* Sprinklers designed to be installed in such a way that the water spray is directed upwards against the deflector.

(b) *Pendent Sprinklers.* Sprinklers designed to be installed in such a way that the water stream is directed downward against the deflector.

(c) *Sidewall Sprinklers.* Sprinklers having special deflectors that are designed to discharge most of the water away from the nearby wall in a pattern resembling one quarter of a sphere, with a small portion of the discharge directed at the wall behind the sprinkler.

(d) *Extended Coverage Sidewall Sprinklers.* Sprinklers with special extended, directional, discharge patterns.

(e) *Open Sprinklers.* Sprinklers from which the actuating elements have been removed.

(f) *Corrosion-Resistant Sprinklers.* Sprinklers with special coatings or platings to be used in an atmosphere that would corrode an uncoated sprinkler.

(g) *Nozzles.* Devices for use in applications requiring special discharge patterns, directional spray, fine spray, or other unusual discharge characteristics.

(h) *Dry Pendent Sprinklers.* Sprinklers for use in a pendent position in a dry-pipe system or a wet-pipe system with the seal in a heated area.

(i) *Dry Upright Sprinklers.* Sprinklers that are designed to be installed in an upright position, on a wet-pipe system, to extend into an unheated area with a seal in a heated area.

(j) *Ornamental Sprinklers.* Sprinklers that have been painted or plated by the manufacturer.

(k) *Flush Sprinklers.* Sprinklers in which all or part of the body, including the shank thread, is mounted above the lower plane of the ceiling.

(l) *Recessed Sprinklers.* Sprinklers in which all or part of the body, other than the shank thread, is mounted within a recessed housing.

(m) *Concealed Sprinklers.* Recessed sprinklers with cover plates.

(n) *Old-Style Sprinklers.* Sprinklers that direct only from 40 to 60 percent of the total water initially in a downward direction and that are designed to be installed with the deflector either upright or pendent.

(o) *Residential Sprinklers.* Sprinklers that have been specifically listed for use in residential occupancies.

(p) *Intermediate Level Sprinklers.* Sprinklers equipped with integral shields to protect their operating elements from the discharge of sprinklers installed at higher elevations.

(q) *Special Sprinklers.* Sprinklers that have been tested and listed as prescribed in 4-1.1.3.

(r) *Quick-Response Sprinklers.* A type of special sprinkler.

(s) *Large-Drop Sprinklers.* Listed large-drop sprinklers are characterized by a K factor between 11.0 and 11.5, and proven ability to meet prescribed penetration, cooling, and distribution criteria prescribed in large-drop sprinkler examination requirements. The deflector/discharge characteristics of large-drop sprinklers generate drops of such size and velocity as to enable effective penetration of the high-velocity fire plume.

3-16.2 Use of Sprinklers.

3-16.2.1* Only listed sprinklers shall be used and shall be installed in accordance with their listing.

Exception: When construction features or other special situations require unusual water distribution, listed sprinklers may be installed in other positions than anticipated by their listing to achieve specific results.

3-16.2.2 Sprinklers shall not be altered in any respect or have any type of ornamentation or coating applied after shipment from the place of manufacture.

3-16.2.3 Sprinklers shall not be used for system working pressures exceeding 175 psi (12.1 bars).

Exception: Higher design pressures may be used when sprinklers are listed for those pressures.

3-16.2.4 Old-style sprinklers shall not be used in a new installation.

Exception No. 1: For installation under piers and wharves where construction features require an upward discharge to wet the underside of decks and structural members supporting the decks, a sprinkler that projects water upward to wet the overhead shall be used. This can be accomplished by using standard pendent sprinklers installed in an upright position or by the use of old-style sprinklers. See NFPA 307, Standard for the Construction and Fire Protection of Marine Terminals, Piers, and Wharves.

Exception No. 2: Old-style sprinklers shall be installed in fur storage vaults. See 4-4.17.3. Also see NFPA 81, Standard for Fur Storage, Fumigation and Cleaning.

Exception No. 3: Listed old-style sprinklers may be

used when construction features or other special situations require unique water distribution.

3-16.2.5 Sidewall sprinklers shall be installed only in Light Hazard Occupancies.

Exception: Sidewall sprinklers specifically listed for use in Ordinary Hazard Occupancies.

3-16.2.6* Extended coverage sidewall sprinklers shall be installed only in accordance with their listing.

3-16.2.7 Open sprinklers may be used to protect special hazards, for protection against exposures, or in other special locations.

3-16.2.8 When nonmetallic ceiling plates (escutcheons) are used they shall be listed.

3-16.2.9 Residential Sprinklers.

3-16.2.9.1 Residential sprinklers may be used in dwelling units located in any occupancy provided they are installed in conformance with their listing and the positioning requirements of NFPA 13D, *Standard for the Installation of Sprinkler Systems in One- and Two-Family Dwellings and Mobile Homes*. One-half inch or larger orifice residential sprinklers may be used in dry-pipe systems when the design area is in compliance with Chapter 2.

3-16.2.9.2 When residential sprinklers are installed within a compartment as defined in 7-4.4, all sprinklers shall be from the same manufacturer and have the same heat response element including temperature rating.

3-16.3 Replacement of Sprinklers.

3-16.3.1 When sprinklers are replaced, the replacement sprinkler shall be of the same type, orifice, and temperature rating unless conditions require a different type sprinkler be installed. The replacement sprinkler shall then be of a type, orifice, and temperature rating to suit the new conditions.

3-16.3.2 Old-style sprinklers may be replaced with old-style sprinklers, or with the appropriate pendent or upright sprinkler.

3-16.3.3 Old-style sprinklers shall not be used to replace pendent or upright sprinklers.

3-16.3.4 Extreme care shall be exercised when replacing horizontal sidewall and extended coverage sidewall sprinklers to assure the correct replacement sprinkler is installed.

3-16.3.5 Sprinklers that have been painted or coated, except by the manufacturer, shall be replaced and shall not be cleaned by use of chemicals, abrasives, or other means. (*See 3-16.9.2.*)

3-16.4 Corrosion-Resistant, Wax-Coated, or Similar Sprinklers.

3-16.4.1* Listed corrosion-resistant or special coated sprinklers shall be installed in locations where chemicals, moisture, or other corrosive vapors sufficient to cause corrosion of such devices exist.

3-16.4.2 Care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating.

3-16.4.3 Corrosion-resistant coatings shall be applied only by the manufacturer of the sprinkler.

Exception: Any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in the approved manner so that none of the sprinkler will be exposed after installation has been completed.

3-16.5* Sprinkler Discharge Characteristics and Identification.

3-16.5.1 Table 3-16.5 shows the K factor, relative discharge, and identification for sprinklers having different orifice sizes.

Exception: Special listed sprinklers may have pipe threads different from those shown in Table 3-16.5.

Table 3-16.5 Sprinkler Discharge Characteristics Identification

Nominal Orifice Size (in.)[1]	Orifice Type	K[2] Factor	Percent of Nominal ½ In. Discharge	Thread Type	Pintle	Nominal Orifice Size Marked On Frame
1/4	Small	1.3-1.5	25	½ in. NPT	Yes	Yes
5/16	Small	1.8-2.0	33.3	½ in. NPT	Yes	Yes
3/8	Small	2.6-2.9	50	½ in. NPT	Yes	Yes
7/16	Small	4.0-4.4	75	½ in. NPT	Yes	Yes
½	Standard	5.3-5.8	100	½ in. NPT	No	No
17/32	Large	7.4-8.2	140	¾ in NPT or ½ in. NPT	No Yes	No Yes

[1]See A-3-16.5.2

[2]K factor is the constant in the formula $Q=K\sqrt{P}$

Where Q=Flow in gpm
P=Pressure in psi

For SI Units: $Qm=Km\sqrt{Pm}$

Where Qm=Flow in L/min
Pm=Pressure in bars
Km=14 K

3-16.5.2* For Light Hazard Occupancies not requiring as much water as is discharged by a nominal ½ in. (12.7 mm) orifice sprinkler, sprinklers having a smaller orifice may be used subject to the following restrictions:

(a) Small orifice sprinklers shall not be used on dry-pipe, preaction or combined dry-pipe and preaction systems.

Exception: Outside sprinklers for protection from exposure fires. See Chapter 6.

(b) An approved strainer shall be provided in the riser or feed main that supplies sprinklers having orifices smaller than ⅜ in. (9.5 mm).

3-16.5.3 For locations or conditions requiring more water than is discharged by a nominal ½ in. (12.7 mm) orifice sprinkler, a sprinkler having a larger orifice may be used. Special sprinklers having an orifice larger than 17/32 in. (13.5 mm) may be installed in accordance with 4-1.1.3.

3-16.5.4 Sprinklers having orifice sizes exceeding ½ in. (12.7 mm) and having ½ in. NPT shall not be installed in new sprinkler systems.

3-16.6* Temperature Ratings, Classifications, and Color Coding.

3-16.6.1 The standard temperature ratings of automatic sprinklers are shown in Table 3-16.6.1. Automatic sprinklers shall have their frame arms colored in accordance with the color code designated in Table 3-16.6.1 with the following exceptions:

Exception No. 1: The color identification for coated sprinklers may be a dot on the top of the deflector, the color of the coating material, or colored frame arms.

Exception No. 2: Color identification is not required for plated sprinklers, flush, recessed, and concealed sprinklers, or similar decorative types.

Table 3-16.6.1 Temperature Ratings, Classifications, and Color Codings

Max. Ceiling Temp. °F	Max. Ceiling Temp. °C	Temperature Rating °F	Temperature Rating °C	Temperature Classification	Color Code	Glass Bulb Colors
100	38	135 to 170	57 to 77	Ordinary	Uncolored	Orange or Red
150	66	175 to 225	79 to 107	Intermediate	White	Yellow or Green
225	107	250 to 300	121 to 149	High	Blue	Blue
300	149	325 to 375	163 to 191	Extra-High	Red	Purple
375	191	400 to 475	204 to 246	Very Extra-High	Green	Black
475	246	500 to 575	260 to 302	Ultra-High	Orange	Black
625	329	650	343	Ultra-High	Orange	Black

3-16.6.2 Ordinary temperature rated sprinklers shall be used throughout buildings.

Exception No. 1: Where maximum ceiling temperatures exceed 100°F (38°C), sprinklers with temperature ratings in accordance with the maximum ceiling temperatures of Table 3-16.6.1 shall be used.

Exception No. 2: Intermediate and high-temperature sprinklers may be used throughout Ordinary and Extra Hazard Occupancies.

Exception No. 3: Sprinklers of intermediate and high temperature classifications shall be installed in specific locations as required by 3-16.6.3.

Exception No. 4: When permitted by other NFPA standards.

3-16.6.3 The following practices shall be observed to provide sprinklers of other than ordinary temperature classification unless maximum expected temperatures are otherwise determined, or unless high-temperature sprinklers are used throughout:

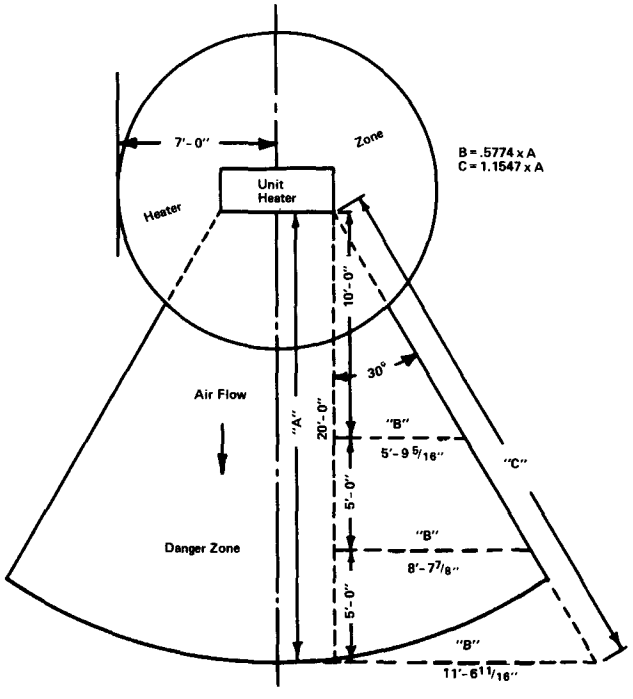


Figure 3-16.6.3(a) Heater and Danger Zones at Unit Heaters.

Table 3-16.6.3(a) Distance of Sprinklers from Heat Sources

Type of Heat Condition	Ordinary Degree Rating	Intermediate Degree Rating	High Degree Rating
1. Heating Ducts (a) Above	More than 2 ft 6 in.	2 ft 6 in. or less	—
(b) Side and Below	More than 1 ft 0 in.	1 ft 0 in. or less	—
(c) Diffuser Downward Discharge Horizontal Discharge	Any distance except as shown under Intermediate	*Downward:* Cylinder with 1 ft 0 in. radius from edge, extending 1 ft 0 in. below and 2 ft 6 in. above *Horizontal:* Semi-cylinder with 2 ft 6 in. radius in direction of flow, extending 1 ft 0 in. below and 2 ft 6 in. above	—
2. Unit Heater (a) Horizontal Discharge	—	*Discharge Side:* 7 ft 0 in. to 20 ft 0 in. radius pie-shaped cylinder [see Figure 3-16.6.3(a)] extending 7 ft 0 in. above and 2 ft 0 in. below heater; also 7 ft 0 in. radius cylinder more than 7 ft 0 in. above unit heater	7 ft 0 in. radius cylinder extending 7 ft 0 in. above and 2 ft 0 in. below unit heater
(b) Vertical Downward Discharge [Note: For sprinklers below unit heater, see Figure 3-16.6.3(a).]	—	7 ft 0 in. radius cylinder extending upward from an elevation 7 ft 0 in. above unit heater	7 ft 0 in. radius cylinder extending from the top of the unit heater to an elevation 7 ft 0 in. above unit heater
3. Stream Mains (Uncovered) (a) Above	More than 2 ft 6 in.	2 ft 6 in. or less	—
(b) Side and Below	More than 1 ft 0 in.	1 ft 0 in. or less	—
(c) Blowoff Valve	More than 7 ft 0 in.	—	7 ft 0 in. or less

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.03048 m.

Table 3-16.6.3(b) Ratings of Sprinklers in Specified Locations

Location	Ordinary Degree Rating	Intermediate Degree Rating	High Degree Rating
Skylights	—	Glass or plastic	—
Attics	Ventilated	Unventilated	—
Peaked Roof: Metal or thin boards; concealed or not concealed; insulated or uninsulated	Ventilated	Unventilated	—
Flat Roof: Metal, not concealed; insulated or uninsulated	Ventilated or unventilated	Note: For uninsulated roof, climate and occupancy may require Intermediate sprinklers. Check on job.	—
Flat Roof: Metal; concealed: insulated or uninsulated	Ventilated	Unventilated	—
Show Windows	Ventilated	Unventilated	—

Note: A check of job condition by means of thermometers may be necessary.

(a) Sprinklers near unit heaters. Where steam pressure is not more than 15 psi (1 bar), sprinklers in the heater zone shall be high and sprinklers in the danger zone intermediate temperature classification.

(b) Sprinklers located within 12 in. (305 mm) to one side or 30 in. (762 mm) above an uncovered steam main, heating coil, or radiator shall be intermediate temperature classification.

(c) Sprinklers within 7 ft (2.1 m) of a low pressure blowoff valve that discharges free in a large room shall be high temperature classification.

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

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

(f) Sprinklers in unventilated show windows having high-powered electric lights near the ceiling shall be intermediate temperature classification.

(g) For sprinklers protecting commercial-type cooking equipment and ventilation systems, temperature classifications of intermediate, high, or extra high shall be provided as determined by use of a temperature measuring device (*see 4-4.18.2*).

3-16.6.4 In case of change of occupancy involving temperature change, the sprinklers shall be changed accordingly.

3-16.7* Stock of Spare Sprinklers.

3-16.7.1 There shall be maintained on the premises a supply of spare sprinklers (never less than six) so that any sprinklers that have operated or been damaged in any way may be promptly replaced. These sprinklers shall correspond to the types and temperature ratings of the sprinklers in the property. The sprinklers shall be kept in a cabinet located where the temperature to which they are subjected will at no time exceed 100°F (38°C).

3-16.7.2 A special sprinkler wrench shall also be provided and kept in the cabinet, to be used in the removal and installation of sprinklers.

3-16.7.3 The stock of spare sprinklers shall be as follows:

(a) For equipments not over 300 sprinklers, not less than 6 sprinklers

(b) For equipments 300 to 1,000 sprinklers, not less than 12 sprinklers

(c) For equipments above 1,000 sprinklers, not less than 24 sprinklers

(d) Stock of spare sprinklers shall include all types and ratings installed.

3-16.8* Guards and Shields. Sprinklers that are so located as to be subject to mechanical injury (in either the upright or the pendent position) shall be protected with listed guards.

3-16.9 Painting and Ornamental Finishes.

3-16.9.1* When the sprinkler piping is given any kind of coating, such as whitewash or paint, care shall be exercised to see that no automatic sprinklers are coated.

3-16.9.2* Sprinklers shall not be painted and any sprinklers that have been painted shall be replaced with new listed sprinklers of the same characteristics.

Exception: Factory-applied coatings to sprinkler frames for identifying sprinklers of different temperature ratings in accordance with 3-16.6.1.

3-16.9.3 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.

3-17 Sprinkler Alarms.

3-17.1 Definition. A local alarm unit is an assembly of apparatus approved for the service and so constructed and installed that any flow of water from a sprinkler system equal to or greater than that from a single automatic sprinkler of the smallest orifice size installed on the system will result in an audible alarm on the premises within 5 minutes after such flow begins. For remote sprinkler water flow alarm transmission see 3-17.7.1.

3-17.2* Where Required. Local waterflow alarms shall be provided on all sprinkler systems having more than 20 sprinklers.

3-17.3 Waterflow Detecting Devices.

3-17.3.1 Wet-Pipe Systems. The alarm apparatus for a wet-pipe system shall consist of a listed alarm check valve or other listed waterflow detecting alarm device with the necessary attachments required to give an alarm.

3-17.3.2 Dry-Pipe Systems. The alarm apparatus for a dry-pipe system shall consist of listed alarm attachments to the dry-pipe valve. When a dry-pipe valve is located on the system side of an alarm valve, the actuating device of the alarms for the dry-pipe valve may be connected to the alarms on the wet-pipe system.

3-17.3.3* Preaction and Deluge Systems. In addition to the waterflow alarms required for systems having more than 20 sprinklers, all deluge and preaction systems shall be provided with listed alarm attachments actuated by the detection system.

3-17.3.4* Waterflow alarm indicators (paddle-type) shall not be installed in dry-pipe, preaction, or deluge systems.

3-17.4 Attachments — General.

3-17.4.1* An alarm unit shall include a listed mechanical alarm, horn or siren, or a listed weatherproof electric gong, bell, horn, or siren.

3-17.4.2* Outdoor mechanical or electrically operated bells shall be of weatherproof and guarded type.

3-17.4.3 On each alarm check valve used under conditions of variable water pressure, a retarding device shall be installed. Valves shall be provided in the connections to retarding devices, to permit repair or removal without shutting off sprinklers; these valves shall be so arranged that they may be locked or sealed in the open position.

3-17.4.4 Alarm valves, dry-pipe, preaction, and deluge valves shall be fitted with an alarm bypass test connection for an electric alarm switch, water-motor gong, or both. This pipe connection shall be made on the water supply side of the system and provided with a control valve and drain for the alarm piping. A check valve shall be installed in the pipe connection from the intermediate chamber of a dry-pipe valve.

3-17.4.5 A control valve shall be installed in connection with a pressure-type contactor or water-motor-operated alarm devices, and such valves shall be of the type that will clearly indicate whether they are open or closed and be so constructed that they may be locked or sealed in the open position. The control valve for the retarding chamber on alarm check valves of wet-pipe systems may be accepted as complying with this paragraph.

3-17.5* Attachments — Mechanically Operated. For all types of sprinkler systems employing water-motor-operated alarms, an approved ¾-in. (1.9-cm) strainer shall be installed at the alarm outlet of the waterflow detecting device except that when a retarding chamber is used in connection with an alarm valve, the strainer shall be located at the outlet of the retarding chamber unless the retarding chamber is provided with an approved integral strainer in its outlet. Water-motor-operated devices shall be protected from the weather, and shall be properly aligned and so installed as not to get out of adjustment. All piping to these devices shall be galvanized or brass or other approved corrosion-resistant material of a size not less than ¾ in. (1.9 cm).

3-17.6 Alarm Attachments — High-rise Buildings. When a fire must be fought internally due to the height of a building, the following additional alarm supervision must be provided:

(a) When each sprinkler system on each floor is equipped with a separate waterflow device, it shall be connected to an alarm system in such a manner that operation of one sprinkler will actuate the alarm system, and the location of the operated flow device shall be indicated on an annunciator and/or register. The annunciator or register shall be located at grade level at the normal point of fire department access, at a constantly attended building security control center, or both locations.

Exception: When the location within the protected buildings where supervisory or alarm signals are received is not under constant supervision by qualified personnel in the employ of the owner, a connection shall be provided to transmit a signal to a remote or central station.

(b) A distinct trouble signal shall be provided to indicate a condition that will impair the satisfactory operation of the sprinkler system. This shall include but not be limited to, monitoring control valves, building temperatures, fire pump power supplies and running conditions, and water tank levels and temperatures. Pressure supervision shall also be provided on pressure tanks.

3-17.7 Attachments — Electrically Operated.

3-17.7.1 Electrically operated alarm attachments forming part of an auxiliary, central station, proprietary, or remote station signaling system shall be installed in accordance with the following applicable NFPA standards.

(a) NFPA 71, *Standard for the Installation, Maintenance, and Use of Central Station Signaling Systems,*

(b) NFPA 72B, *Standard for the Installation, Maintenance, and Use of Auxiliary Protective Signaling Systems,*

(c) NFPA 72C, *Standard for the Installation, Maintenance, and Use of Remote Station Protective Signaling Systems,*

(d) NFPA 72D, *Standard for the Installation, Maintenance, and Use of Proprietary Protective Signaling Systems.*

3-17.7.2* The circuits of electrical alarm attachments forming part of a local sprinkler waterflow alarm system need not be supervised.

Exception: If the local sprinkler waterflow alarm system is part of a required local fire alarm system, it shall be installed in accordance with NFPA 72A, Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems.

3-17.7.3 Waterflow detecting devices, including the associated alarm circuits, shall be tested by an actual waterflow through use of a test connection. (*See 3-17.8.*)

3-17.7.4 Outdoor electric alarm devices shall be of a type specifically listed for outdoor use, and the outdoor

wiring shall be in approved conduit, properly protected from the entrance of water in addition to the requirements of 3-17.7.1 and 3-17.7.2.

3-17.8 Drains. Drains from alarm devices shall be so arranged that there will be no danger of freezing, and so that there will be no overflowing at the alarm apparatus at domestic connections or elsewhere with the sprinkler drains wide open and under system pressure. (*See 3-11.4.*)

Chapter 4 Spacing, Location, and Position of Sprinklers

4-1 General Information.

4-1.1* Basic Requirements.

4-1.1.1* The basic requirements for spacing, location, and position of sprinklers are specified in this chapter and are based on the following principles:

(a) Sprinklers installed throughout the premises,

(b) Sprinklers located so as not to exceed maximum protection area per sprinkler,

(c) Sprinklers positioned and located so as to optimize performance with respect to activation time and distribution,

(d) And as specified herein.

Exception No. 1: See 4-4.3 and 4-4.4 for locations from which sprinklers may be omitted.

Exception No. 2: Special sprinklers may be installed in accordance with 4-1.1.3.

Exception No. 3: When sprinklers are specifically tested and test results prove that deviations from clearance requirements to structural members offer no obstruction to spray discharge, they may be positioned and located accordingly.

Exception No. 4: Clearance between sprinklers and ceilings may exceed the maximum specified in Sections 4-3 and 4-5.4 provided that, for the conditions of occupancy protected, tests or calculations show comparable sensitivity and performance of the sprinklers to those installed in conformance with Section 4-3.

4-1.1.2 Residential sprinklers shall be installed in conformance with their listing and the positioning requirements of NFPA 13D, *Standard for the Installation of Sprinkler Systems for One- and Two-Family Dwellings and Mobile Homes.*

4-1.1.3 Special sprinklers may be installed with protection areas, locations, and distances between sprinklers differing from those specified in Sections 4-2 and 4-5 when found suitable for such use based on fire tests related to the hazard category; tests to evaluate distribution, wetting of floors and walls, interference to distribution by structural elements; and tests to characterize response sensitivity, when installed in accordance with any special sprinkler listing limitation.

Exception No. 1: No sprinkler shall be installed to protect an area greater than 400 sq ft (36 m²).

Exception No. 2: Maximum area of coverage for individual extended coverage pendent and upright sprinklers shall be limited to areas having coverage with equal-sided dimensions.

4-1.2* When partial sprinkler systems are installed, the requirements of this standard shall be used insofar as they are applicable. The authority having jurisdiction shall be consulted in each case.

4-1.3 Definitions.

4-1.3.1 Smooth Ceiling Construction. The term *smooth ceiling construction* as used in this standard includes:

(a) Flat slab, pan-type reinforced concrete, concrete joist less than 3 ft (0.9 m) on centers.

(b) Continuous smooth bays formed by wood, concrete, or steel beams spaced more than 7½ ft (2.9 m) on centers — beams supported by columns, girders, or trusses.

(c) Smooth roof or floor decks supported directly on girders or trusses spaced more than 7½ ft (2.9 m) on centers.

(d) Smooth monolithic ceilings of at least ¾ in. (19 mm) of plaster on metal lath or a combination of materials of equivalent fire-resistive rating attached to the underside of wood or bar joists.

(e) Open web-type steel beams regardless of spacing.

(f) Smooth shell-type roofs, such as folded plates, hyperbolic paraboloids, saddles, domes, and long barrel shells.

(g) In (b) through (f) above, the roof and floor decks may be noncombustible or combustible. Item (b) would include standard mill construction.

(h) Suspended ceilings of noncombustible construction.

(i) Suspended ceilings of combustible construction where there is a full complement of sprinklers in the space immediately above such a ceiling and the space is unfloored and unoccupied.

(j) Smooth monolithic ceilings with fire resistance less than that specified under item (d) attached to the underside of wood or bar joists.

(k) Combustible suspended ceilings arranged other than as specified under item (i).

4-1.3.2 Beam and Girder Construction. The term *beam and girder construction* as used in this standard includes noncombustible and combustible roof or floor decks supported by wood beams of 4 in. (102 mm) or greater nominal thickness, or concrete or steel beams spaced 3 to 7½ ft (0.9 to 2.3 m) on centers and either supported on or framed into girders. [When supporting a wood plank deck, this includes semi-mill and panel construction, and when supporting (with steel framing) gypsum plank, steel deck, concrete, tile, or similar material, would include much of the so-called noncombustible construction.]

4-1.3.3 Bar Joist Construction. The term *bar joist construction* refers to construction employing joists consisting of steel truss-shaped members. This definition includes noncombustible and combustible roof and floor decks supported on bar joists.

4-1.3.4 Panel Construction. The term *panel construction* as used in this standard includes ceiling panels formed by members capable of trapping heat to aid the operation of sprinklers and limited to a maximum of 300 sq ft (27.9 m²) in area. Beams spaced more than 7½ ft (2.3 m) apart and framed into girders qualify for panel construction provided the 300 sq ft (27.9 m²) area limitation is met.

4-1.3.5 Standard Mill Construction. The term *standard mill construction* as used in this standard refers to heavy timber construction as defined in NFPA 220, *Standard on Types of Building Construction.*

4-1.3.6 Semi-Mill Construction. The term *semi-mill construction* as used in this standard refers to a modified standard mill construction where greater column spacing is used and beams rest on girders.

4-1.3.7 Wood Joist Construction. The term *wood joist construction* refers to wood members of rectangular cross section, which may vary from 2 to 4 in. (51 to 102 mm) nominal width and up to 14 in. (356 mm) nominal depth, spaced up to 3 ft (0.9 m) on centers, and spanning up to 40 ft (12 m) between supports, supporting a floor or roof deck. Wood members less than 4 in. (102 mm) nominal thickness spaced more than 3 ft (0.9 m) on centers and open wood trusses with spacing up to 3 ft (0.9 m) on centers are also considered as wood joist construction.

4-1.3.8* Composite Wood Joist Construction. The term *composite wood joist construction* refers to wood beams of I cross-section constructed of wood flanges and solid wood web, supporting a floor or roof deck. Composite wood joists may vary in depth up to 48 in. (1.2 m), may be spaced up to 48 in. (1.2 m) on centers, and may span up to 60 ft (18 m) between supports. Joist channels shall be fire-stopped to the full distance between joists with material equivalent to the joist construction, and be limited to 300 sq ft (27.9 m²) channel area.

4-1.3.9 High-Piled Storage. The term *high-piled storage* refers to solid piled, palletized, rack storage, bin box, and shelf storage in excess of 12 ft (3.7 m) in height. See 9-1.2 for availability of information for sprinkler protection of high-piled storage.

4-2 Spacing and Location of Upright and Pendent Sprinklers. (*See also Sections 4-3 and 4-4.*)

4-2.1 Distance Between the Branch Lines and Between Sprinklers on the Branch Lines.

4-2.1.1 For Light Hazard Occupancies the distance between branch lines and between sprinklers on the branch lines shall not exceed 15 ft (4.6 m).

4-2.1.2* For Ordinary Hazard Occupancies, the distance between the branch lines and between sprinklers on branch lines shall not exceed 15 ft (4.6 m).

4-2.1.3 For Extra Hazard Occupancies, the distance between the branch lines and between sprinklers on the branch lines shall not exceed 12 ft (3.7 m).

4-2.1.4 In buildings used for high-piled storage (as defined in 4-1.3.9) the distance between the branch lines and between sprinklers on the branch lines shall not exceed 12 ft (3.7 m) except, in bays 25 ft (7.6 m) wide, a spacing of 12 ft 6 in. (3.8 m) between branch lines is permitted.

4-2.1.5 Distance from Walls.

4-2.1.5.1 The distance from the walls to the end sprinklers on the branch lines shall not exceed one-half of the allowable distance between sprinklers on the branch lines. The distance from the walls to the end branch lines shall not exceed one-half the allowable distance between the branch lines. For exception relating to small rooms, refer to 4-4.20.

4-2.1.5.2 Sprinklers shall be located a minimum of 4 in. (102 mm) from a wall.

4-2.2 Protection Area Limitations. (*See 3-3.*)

4-2.2.1 Light Hazard Occupancy.

4-2.2.1.1 Under smooth ceiling, beam and girder, and bar joist construction, [as defined in 4-1.3.1 items (a) through (i), 4-1.3.2, and 4-1.3.3] the protection area per sprinkler shall not exceed 200 sq ft (18.6 m²). For hydraulically designed sprinkler systems the protection area per sprinkler may be increased to 225 sq ft (20.9 m²).

4-2.2.1.2* Under open wood joist construction (as defined in 4-1.3.7) or under open composite wood joist construction (as defined in 4-1.3.8) of 16 in. (406 mm) nominal depth or less, the protection area per sprinkler shall not exceed 130 sq ft (12.1 m²).

4-2.2.1.3 For other types of construction the protection area per sprinkler shall not exceed 168 sq ft (15.6 m²).

4-2.2.2 Ordinary Hazard Occupancy. For all types of construction the protection area per sprinkler shall not exceed 130 sq ft (12.1 m²).

4-2.2.3 Extra Hazard Occupancy. The protection area per sprinkler shall not exceed 90 sq ft (8.4 m²) for any type of building construction, except protection area per sprinkler shall not exceed 100 sq ft (9.3 m²) where the system is hydraulically designed.

4-2.2.4 High-Piled Storage. In buildings used for high-piled storage (as defined in 4-1.3.9 or for storage covered by other NFPA standards) the protection area per sprinkler shall not exceed 100 sq ft (9.3 m²).

Exception No. 1: Sprinkler spacing may exceed 100 sq ft (9.3 m²) but shall not exceed 130 sq ft (12.1 m²) in systems hydraulically designed in accordance with NFPA 231, Standard for Indoor General Storage, and 231C, Standard for Rack Storage of Materials, for densities below 0.25 gpm per sq ft [(10.2 L/min)/m²)].

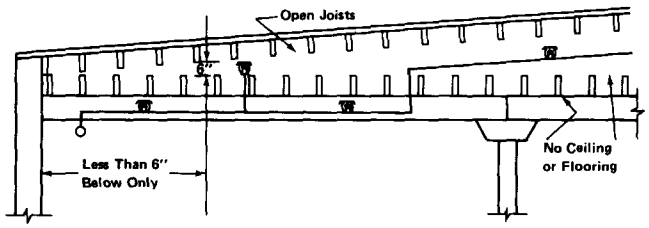
Exception No. 2: Where protection areas are specifically indicated in the design criteria of other NFPA standards.

4-2.2.5 Special Conditions. When other NFPA standards have developed more stringent sprinkler system spacing criteria, they shall take precedence when supported by valid fire tests.

4-2.3* Location of Sprinklers and Branch Lines with Respect to Structural Members.

4-2.3.1 Sprinklers may be located under beams, in bays, or both, in combination, but the locations must meet the provisions outlined in 4-2.4 and Section 4-3.

4-2.3.2 Where there are two sets of joists under a roof or ceiling and there is no flooring over the lower set, sprinklers shall be installed above and below the lower set of joists where there is a clearance of 6 in. (152 mm) or more between the top of the lower joist and bottom of the upper joist. (*See Figure 4-2.3.2.*) Sprinklers may be omitted from below the lower set of joists where at least 18 inches (457 mm) is maintained between sprinkler deflectors and tops of lower joists.



For SI Units: 1 in. = 25.4 mm.

Figure 4-2.3.2 Arrangement of Sprinklers under Two Sets of Open Joists — No Sheathing on Lower Joists.

4-2.4 Clearance Between Sprinklers and Structural Members.

4-2.4.1 Trusses. Sprinklers shall be at least 2 ft (0.6 m) laterally from truss members (web or chord) more than 4 in. (102 mm) wide, and at least 1 ft (0.3 m) laterally from truss members 4 in. (102 mm) or less in width. When sprinkler lines run above or through trusses, the sprinklers may be located on the center line of a truss, provided chord members are not more than 8 in. (203 mm) wide, and the deflector is at least 6 in. (152 mm) above the chord member. When sprinklers are located laterally beside chord members, clearances between the chord members and the sprinkler deflectors shall be in accordance with 4-2.4.6.

4-2.4.2 Girders. When sprinkler lines are located perpendicular to and above girders, sprinklers shall be at least 3 ft 9 in. (229 mm) from girders except that they may be located directly above girders with the top flange not more than 8 in. (203 mm) wide, in which case the deflectors shall be at least 6 in. (152 mm) above the top of the girder.

4-2.4.3 When sprinkler deflectors are in accordance with Table 4-2.4.6, the girders may be disregarded in the spacing of the branch lines.

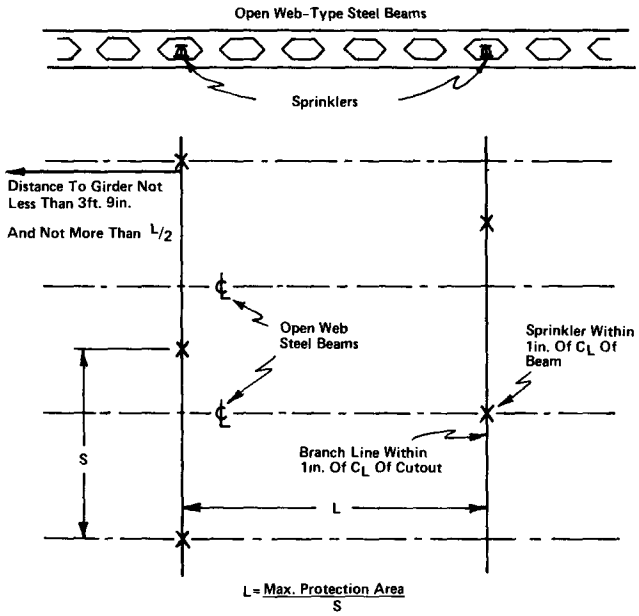
4-2.4.4 Open Web-Type Steel Beams. (*See Figure 4-2.4.4.*) When branch lines are run across and through openings of open web-type steel beams, sprinklers may be spaced "bay and beam" provided:

(a) The distance between sprinklers and between branch lines conforms to 4-2.1,

(b) Sprinklers in the beam openings are located within 1 in. (25 mm) horizontally of the opening center line,

(c) The branch line is located within 1 in. (25 mm) horizontally of the opening center line, and

(d) Sprinklers on alternate lines are staggered.



For SI Units: 1 in. = 25.4 mm.

Figure 4-2.4.4 Location of Branch Lines and Sprinklers.

4-2.4.5 Bar Joists. Sprinklers shall be at least 3 in. (76 mm) laterally from web members of open bar joists which do not exceed ½ in. (13 mm) or at least 6 in. (152 mm) laterally from web members which do not exceed 1 in. (25 mm). When the dimensions of the web member exceed 1 in. (25 mm), see 4-2.4.1.

4-2.4.6 Beams. Deflectors of sprinklers in bays shall be at sufficient distances from the beams, as shown in Table 4-2.4.6 and Figure 4-2.4.6, to avoid obstruction to the sprinkler discharge pattern. Otherwise the spacing of sprinklers on opposite sides of the beams shall be measured from the centerline of the beam and the distance shall not exceed ½ of the allowable distance between sprinklers.

4-2.4.7* Position of Deflectors. Deflectors of sprinklers shall be parallel to ceilings, roofs, or the incline of stairs, but when installed in the peak of a pitched roof they shall be horizontal. Low-pitched roofs having slopes

Table 4-2.4.6 *Position of Deflector when Located above Bottom of Beam*

Distance from Sprinkler to Side of Beam	Maximum Allowable Distance Deflector above Bottom of Beam
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.

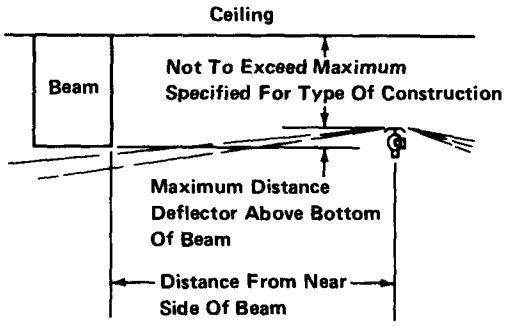


Figure 4-2.4.6 Position of Deflector, Upright, or Pendent Sprinkler When Located Above Bottom of Beam

not greater than 1 in. per ft (83 mm/m) may be considered level in the application of this rule, and sprinklers may be installed with deflectors horizontal.

4-2.5 Clear Space Below Sprinklers.

4-2.5.1 A minimum of 18 in. (457 mm) clearance shall be maintained between top of storage and ceiling sprinkler deflectors. For in-rack sprinklers, the clear space shall be in accordance with NFPA 231C, *Standard for Rack Storage of Materials.*

4-2.5.2* The clearance from sprinklers to privacy curtains, free-standing partitions, or room dividers shall not be less than the distances given in Table 4-2.5.2 as measured in Figure 4-2.5.2.

Table 4-2.5.2 Minimum Horizontal and Vertical Distances for Sprinklers

Horizontal Distance	Minimum Vertical Distance Below Deflector
6 in.	3 in.
9 in.	4 in.
12 in.	6 in.
15 in.	8 in.
18 in.	9½ in.
24 in.	12½ in.
30 in.	15½ in.
Greater than or equal to 36 in.	18 in.

For SI Units: 1 in. = 25.4 mm.

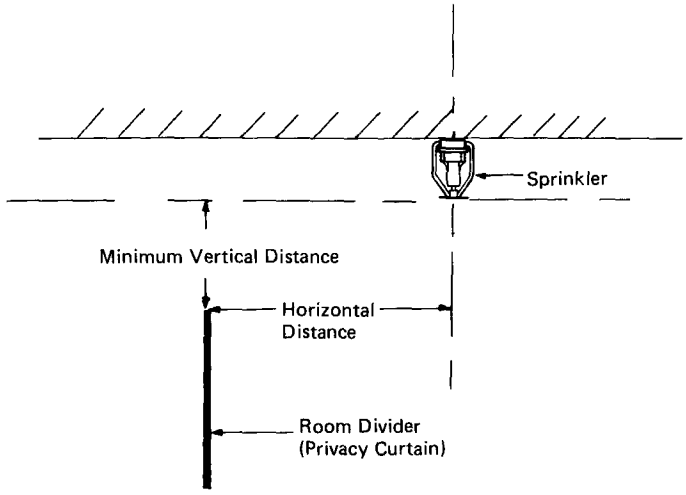


Figure 4-2.5.2 Standard Sprinkler Installed Near Privacy Curtain.

4-3 Position of Upright and Pendent Sprinklers.

4-3.1 Smooth Ceiling Construction (*as defined in 4-1.3.1*). Deflectors of sprinklers shall be located 1 to 10 in. (25 to 254 mm) below combustible ceilings or 1 to 12 in. (25 to 305 mm) below noncombustible ceilings. The operating elements of sprinklers shall be located below the ceiling.

Exception No. 1: Deflectors of sprinklers under beams shall be located 1 to 4 in. (25 to 102 mm) below beams, and not more than 14 in. (356 mm) below combustible ceilings or not more than 16 in. (406 mm) below noncombustible ceilings.

Exception No. 2: Special ceiling-type pendent sprinklers (concealed, recessed, and flush-types) may have the operating element above the ceiling and the deflector located nearer the ceiling when installed in accordance with their listing.

4-3.2 Beam and Girder Construction (*as defined in 4-1.3.2*).

4-3.2.1 Deflectors of sprinklers in bays shall be located 1 in. to 16 (25 to 406 mm) below combustible or noncombustible roof or floor decks.

4-3.2.2 Deflectors of sprinklers under beams shall be located 1 to 4 in. (25 to 102 mm) below beams and not more than 20 in. (508 mm) below combustible or noncombustible roof or floor decks.

4-3.2.3 Deflectors of sprinklers under concrete tee construction with stems spaced less than 7 ½ ft (2.3 m) but more than 3 ft (0.9 m) on centers shall, regardless of the depth of the tee, be located at or above a plane 1 in. (25 mm) below the level of the bottom of the stems of the tees and comply with Table 4-2.4.6.

4-3.3 Open Bar Joist Construction (*as defined in 4-1.3.3*). Deflectors of sprinklers shall be located 1 to 10 in. (25 to 254 mm) below combustible roof or floor decks or not more than 12 in. (305 mm) below noncombustible roof or floor decks.

4-3.4 Panel Construction (*as defined in 4-1.3.4*).

4-3.4.1 Deflectors of sprinklers in bays formed by members, such as beams framed into girders, resulting in panels up to 300 sq ft (27.9 m^2) shall be located 1 to 18 in. (25 to 457 mm) below combustible or noncombustible roof or floor decks.

4-3.4.2 Deflectors of sprinklers under the members, such as under beams framed into girders, forming panels up to 300 sq ft (27.9 m^2) shall be located 1 to 4 in. (25 to 102 mm) below such members and not more than 22 in. (559 mm) below combustible or noncombustible roof or floor decks.

4-3.5 Open Wood Joist Construction (*as defined in 4-1.3.7*). In open joist construction with joists spaced 3 ft (0.9 m) or less on centers, sprinklers shall be located with deflectors 1 to 6 in. (25 to 152 mm) below the bottom of the joists. If open joists are spaced more than 3 ft (0.9 m) on centers, sprinklers shall be located with deflectors placed in accordance with 4-3.1 or 4-3.2.

4-3.6 Location Under Sheathed or Suspended Ceiling Under Any Type of Construction. The position of sprinklers under sheathed or suspended ceilings with any type of construction shall be the same as for smooth-ceiling construction (*see 4-3.1*).

4-4* Locations or Conditions Involving Special Consideration.

4-4.1 Combustible Form Board. When roof or floor decks consist of poured gypsum or concrete on combustible form board supported on steel supports, the position of sprinkler deflectors shall be the same as for noncombustible construction as stated in Section 4-3. When combustible form board is located above suspended ceilings or in concealed spaces, see 4-4.4.1.

4-4.2 Metal Roof Decks. When roof decks are metal with combustible adhesives or vapor seal, the position of sprinklers shall be the same as for combustible construction.

4-4.3 Spaces Under Ground Floors. Sprinklers shall be installed in all spaces below combustible ground floors except that, by permission of the authority having jurisdiction, sprinklers may be omitted when all of the following conditions prevail:

(a) The space is not accessible for storage purposes or entrance of unauthorized persons and is protected against accumulation of windborne debris;

(b) The space contains no equipment such as steam pipes, electric wiring, shafting, or conveyors;

(c) The floor over the space is tight;

(d) No combustible or flammable liquids or materials that under fire conditions may convert into combustible or flammable liquids are processed, handled, or stored on the floor above.

4-4.4 Concealed Spaces.

4-4.4.1 All concealed spaces enclosed wholly or partly by exposed combustible construction shall be protected by sprinklers.

Exception No. 1: Spaces formed by studs or joists with less than 6 in. (152 mm) between the inside or near edges of the studs or joists. (See Figure 4-2.3.2.)

Exception No. 2: Spaces formed by bar joists with less than 6 in. (152 mm) between the roof or floor deck and ceiling.

Exception No. 3: Spaces formed by ceilings attached directly to or to within 6 in. (152 mm) of wood joist construction.

Exception No. 4: Spaces formed by ceilings attached directly to the underside of composite wood joist construction, provided the joist channels are fire-stopped into volumes each not exceeding 160 cu ft (4.53 m^3) using materials equivalent to the joists.

Exception No. 5: Spaces entirely filled with noncombustible insulation.

Exception No. 6: In wood joist construction and composite wood joist construction with noncombustible insulation filling the space from the ceiling up to the bottom edge of the joist of the roof or floor deck, provided that in composite wood joist construction, the joist channels are fire-stopped into volumes each not exceeding 160 cu ft (4.53 m^3) using materials equivalent to the joists.

Exception No. 7: Small spaces over rooms not exceeding 50 sq ft (4.6 m^2) in area.

Exception No. 8: When the exposed surfaces have a flame spread rating less than 25 and the materials have been demonstrated not to propagate fire in the form in which they are installed in the space or when the Btu content of the facing and substrate of insulation material does not exceed 1000 Btu per sq ft (11 356 kJ/m^2).

4-4.4.2 Sprinklers in concealed spaces having no access that will allow storage or other use may be installed on the basis of Light Hazard Occupancy.

4-4.4.3 When heat-producing devices such as furnaces or process equipment are located in the joist channels above a ceiling attached directly to the underside of composite wood joist construction that would not otherwise require sprinkler protection of the spaces, the joist channel containing the heat-producing devices shall be sprinklered by installing two sprinklers in each joist channel, one on each side, adjacent to the heat-producing device. The temperature rating of the sprinklers shall be as prescribed in Table 3-16.6.1 and Figure 3-16.3(a).

4-4.4.4* In concealed spaces having exposed combustible construction, or containing exposed combustibles, in localized areas, the combustibles shall be protected as follows:

(a) If the exposed combustibles are in the vertical partitions or walls around all or a portion of the enclosure, a single row of sprinklers spaced not over 12 ft (3.7 m) apart nor more than 6 ft (1.8 m) from the inside of the partition may be installed to protect the surface. The first and last sprinklers in such a row shall not be over 5 ft (1.5 m) from the ends of the partitions.

(b) If the exposed combustibles are in the horizontal plane, permission may be given to protect the area of the combustibles on a light hazard spacing and add a row of sprinklers not over 6 ft (1.8 m) outside the outline of the

area and not over 12 ft (3.7 m) on center along the outline. When the outline returns to a wall or other obstruction, the last sprinkler shall not be over 6 ft (1.8 m) from a wall or obstruction.

4-4.5 Spacing of Sprinklers Under Pitched Roofs.

4-4.5.1 Branch lines parallel to peaks of pitched roofs and sprinklers on lines perpendicular to peaks shall be spaced throughout the distance measured along the slope. This will place a row of sprinklers either in the peak or one-half the spacing down the slope from the peak.

4-4.5.2 Under saw-toothed roofs, the row of sprinklers at the highest elevation shall not be more than 3 ft (0.9 m) down the slope from the peak.

4-4.5.3 In 4-4.5.1 or 4-4.5.2, sprinklers in or near the peak shall have deflectors not more than 3 ft (0.9 m) vertically down from the peak. [*See Figures 4-4.5.3(a) and (b).*]

Exception: In a steeply pitched roof the distance from the peak to the deflectors may be increased to maintain a horizontal clearance of not less than 2 ft (0.6 m) from other structural members. [See Figure 4-4.5.3(c).]

4-4.6 Spacing of Sprinklers Under Curved Roof Buildings.

4-4.6.1 When roofs are curved down to the floor line, the horizontal distance measured at the floor level from the sidewall or roof construction to the nearest sprinklers shall not be greater than one-half the allowable distance between sprinklers in the same direction.

4-4.6.2 Deflectors of sprinklers shall be parallel with the curve of the roof or tilted slightly toward the peak of the roof. Deflectors of sprinklers shall be located as described for beam and girder construction or for the closest comparable type of ceiling construction.

4-4.6.3 When Extra Hazard Occupancy spacing of sprinklers is used under curved ceilings of other than fire-resistive construction, as in aircraft storage or servicing areas, the spacing as projected on the floor shall be not wider than required for Extra Hazard Occupancies, but in no case shall the spacing on the roof or ceiling be wider than required for Ordinary Hazard Occupancies.

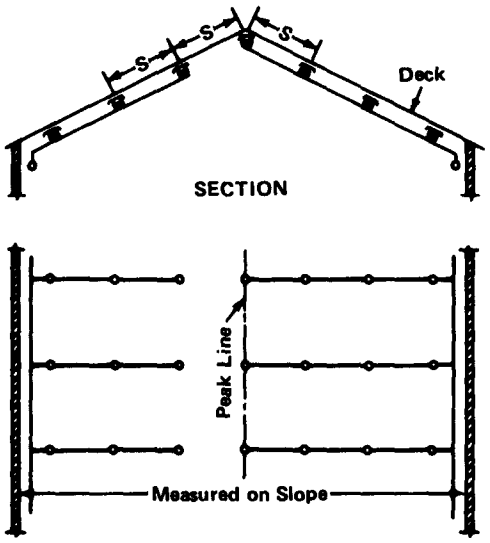
4-4.7 Narrow Pocket. Girders, beams, or trusses forming narrow pockets of combustible construction along walls when of a depth that will obstruct the spray discharge pattern, may require additional sprinklers positioned in accordance with Table 4-2.4.6.

4-4.8 Elevators, Stairs, and Floor Openings.

4-4.8.1 Vertical Shafts.

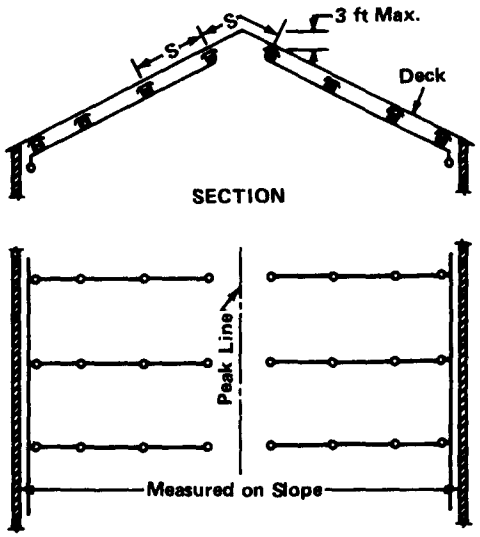
4-4.8.1.1 One sprinkler shall be installed at the top of all shafts.

4-4.8.1.2* When vertical shafts have combustible sides, one sprinkler shall be installed at each alternate floor level. When a shaft having combustible surfaces is



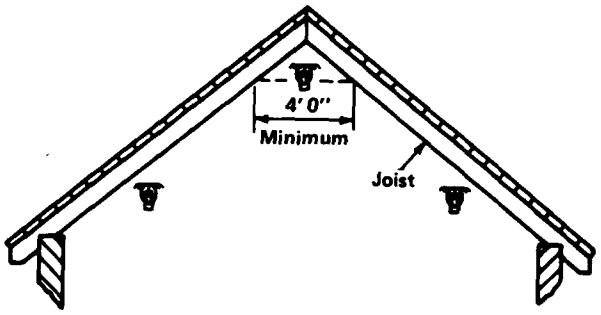
For SI Units: 1 in. = 25.4 mm.

Figure 4-4.5.3(a) Sprinklers at Pitched Roofs; Branch Lines Run Up the Slope



For SI Units: 1 in. = 25.4 mm.

Figure 4-4.5.3(b) Sprinklers at Pitched Roofs; Branch Lines Run Up the Slope.



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

Figure 4-4.5.3(c) Desirable Horizontal Clearance for Sprinklers at Peak of Pitched Roof.

trapped, an additional sprinkler shall be installed at the top of each trapped section.

4-4.8.1.3 When accessible shafts have noncombustible surfaces, one sprinkler shall be installed near the bottom.

4-4.8.1.4 When vertical openings are not protected by standard enclosures, sprinklers shall be so placed as to fully cover them. This necessitates placing sprinklers close to such openings at each floor level.

4-4.8.2* Stairways.

4-4.8.2.1 Stairways of combustible construction shall be sprinklered underneath whether risers are open or not.

4-4.8.2.2 Stairways of noncombustible construction with combustible storage beneath shall be sprinklered.

4-4.8.2.3* When moving stairways, staircases, or similar floor openings are unenclosed, the floor openings involved shall be protected by draft stops in combination with closely spaced sprinklers.

The draft stops shall be located immediately adjacent to the opening, shall be at least 18 in. (457 mm) deep, and shall be of substantially noncombustible material that will stay in place before and during sprinkler operation. Sprinklers shall be spaced not more than 6 ft (1.8 m) apart and placed 6 to 12 in. (152 to 305 mm) from the draft stop on the side away from the opening to form a water curtain. Sprinklers in this water curtain shall be hydraulically designed to provide a discharge of 3 gpm per lineal foot [(37 L/min)/m] of water curtain, with no sprinklers discharging less than 15 gpm (56.8 L/min). The number of sprinklers calculated in this water curtain shall be the number in the length corresponding to the length parallel to the branch lines in the design area determined by 7-4.3.1. These sprinklers shall be added to the design area when considering the hydraulic design. Sprinklers shall be nominal ½ in., 7/16 in., or 3/8 in. orifice. When sprinklers are closer than 6 ft (1.8 m), cross baffles shall be provided in accordance with 4-4.19. When sprinklers in the normal pattern are closer than 6 ft (1.8 m) from the water curtain, it may be preferable to locate the water curtain sprinklers in recessed baffle pockets.

Exception: Closely spaced sprinklers are not required around large openings such as those found in shopping malls, atrium buildings, and similar structures where all adjoining levels and spaces are protected by automatic sprinklers in accordance with this standard, when the openings have all horizontal dimensions between opposite edges of 20 ft (6 m) or greater, and an area of 1000 sq ft (93 m²) or greater.

4-4.8.2.4* In noncombustible stair shafts, sprinklers shall be installed at the top and under the first landing above the lowest level. When the stair shaft serves two or more separate fire sections, sprinklers shall also be installed at each floor landing.

4-4.9* Building Service Chutes. Building service chutes (linen, rubbish, etc.) shall be protected internally by automatic sprinklers. A sprinkler shall be provided above the top service opening of the chute, above the lowest service opening, and above service openings at alternate levels in buildings over two stories in height. The room or area into which the chute discharges shall also be protected by automatic sprinklers.

4-4.10* Exterior Canopies, Docks, and Platforms.

4-4.10.1 Sprinklers shall be installed under roofs or canopies over outside-loading platforms, docks, or other areas where combustibles are stored or handled.

4-4.10.2 Sprinklers shall be installed under exterior combustible roofs or canopies exceeding 4 ft (1.2 m) in width.

Exception: Sprinklers may be omitted where construction is noncombustible and areas under the roofs or canopies are not used for storage or handling of combustibles.

4-4.10.3 Sprinklers shall be installed under exterior docks and platforms of combustible construction unless such space is closed off and protected against accumulation of debris.

4-4.11* Decks. Sprinklers shall be installed under decks and galleries over 4 ft (1.2 m) wide. Slatting of decks, walkways, or the use of open gratings as a substitute for such sprinklers is not acceptable. Sprinklers installed under open gratings shall be of the listed intermediate level type or shielded from the discharge of overhead sprinklers.

4-4.12 Library Stack Rooms. Sprinklers shall be installed in every aisle and at every level of stacks with distance between sprinklers not to exceed 12 ft (10.8 m).

Exception No. 1: Sprinklers may be omitted in alternate aisles and alternate levels when vertical shelf dividers are incomplete (see Figure 4-4.12) and allow water distribution to adjacent aisles.

Exception No. 2: Install sprinklers without regard to aisles when there is more than 18 in. (457 mm) clearance between sprinkler deflectors and top of stacks.

4-4.13* Ducts. Sprinklers shall be installed beneath ducts over 4 ft (1.2 m) wide unless ceiling sprinklers can be spaced in accordance with Table 4-2.4.6.

4-4.14 Electrical Equipment. When sprinkler protection is provided in generator and transformer rooms, hoods or shields installed to protect important electrical equipment from water shall be noncombustible.

4-4.15* Open-Grid Ceilings. The following requirements are applicable to open-grid ceilings in which the openings are ¼ in. (6.4 mm) or larger in the least dimension, when the thickness or depth of the material does not exceed the least dimension of the openings, and when such openings constitute at least 70 percent of the area of the ceiling material. Other types of open-grid ceilings shall not be installed beneath sprinklers unless they are listed by a testing laboratory and are installed in accordance with the instructions contained in each package of the ceiling material. Ceilings made of highly flammable material may spread fire faster than sprinklers can control.

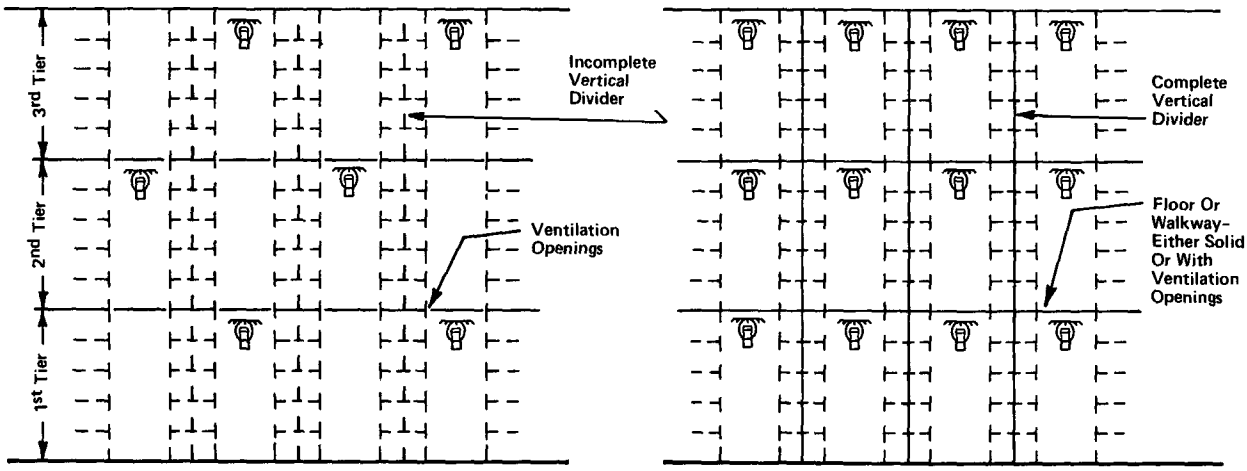


Figure 4-4.12 Sprinklers In Multitier Library Bookstacks.

(a) In Light Hazard Occupancies when spacing of sprinklers of either standard or old-style is not wider than 10 by 10 ft (3 × 3 m), a minimum clearance of at least 18 in. (457 mm) shall be provided between the sprinkler deflectors and the upper surface of the open-grid ceiling. When spacing is wider than 10 by 10 ft (3 × 3 m) but not wider than 10 by 12 ft (3 × 3.7 m), a clearance of at least 24 in. (610 mm) shall be provided from standard sprinklers and at least 36 in. (914 mm) from old-style sprinklers. When spacing is wider than 10 by 12 ft (3 × 3.7 m), a clearance of at least 48 in. (1219 mm) shall be provided.

(b) In Ordinary Hazard Occupancies, open-grid ceilings may be installed beneath sprinklers only where such use is approved by the authority having jurisdiction, and shall be installed beneath standard sprinklers only. When sprinkler spacing is not wider than 10 by 10 ft (3 × 3 m), a minimum clearance of at least 24 in. (610 mm) shall be provided between the sprinkler deflectors and the upper surface of the open-grid ceiling. When spacing is wider than 10 by 10 ft (3 × 3 m), a clearance of at least 36 in. (914 mm) shall be provided.

4-4.16 Drop-out Ceilings.

4-4.16.1 Drop-out ceilings may be installed beneath sprinklers when ceilings are listed for that service and are installed in accordance with their listing. The authority having jurisdiction shall be consulted in all cases.

Exception: Special sprinklers shall not be installed above drop-out ceilings unless specifically listed for this purpose.

4-4.16.2 Drop-out ceilings shall not be considered ceilings within the context of this standard.

4-4.16.3* Piping installed above drop-out ceilings shall not be considered concealed piping. (*See 3-12.4, Exception No. 2.*)

4-4.16.4* Sprinklers shall not be installed beneath drop-out ceilings.

4-4.17 Fur Vaults.

4-4.17.1 Sprinklers in fur storage vaults shall be located centrally over the aisles between racks and shall be spaced not over 5 ft (1.5 m) apart along the aisles.

4-4.17.2 When sprinklers are spaced 5 ft (1.5 m) apart along the sprinkler branch lines, pipe sizes may be in accordance with the following schedule:

1 in.	4 sprinklers	2 in.	20 sprinklers
1¼ in.	6 sprinklers	2½ in.	40 sprinklers
1½ in.	10 sprinklers	3 in.	80 sprinklers

4-4.17.3 Sprinklers shall be listed old-style having orifice sizes selected to provide as closely as possible but not less than 20 gal per min (76 L/min) per sprinkler, based on the water pressure available.

NOTE: See NFPA 81, *Standard on Fur Storage, Fumigation and Cleaning*. For tests of sprinkler performance in fur vaults see *Fact Finding Report on Automatic Sprinkler Protection for Fur Storage Vaults* of Underwriters Laboratories Inc., dated November 25, 1947.

4-4.18* Commercial-type Cooking Equipment and Ventilation.

4-4.18.1 In cooking areas protected by automatic sprinklers, additional sprinklers or automatic spray nozzles shall be provided to protect commercial-type cooking equipment and ventilation systems that are designed to carry away grease-laden vapors unless otherwise protected. (See NFPA 96, *Standard for the Installation of Equipment for the Removal of Smoke and Grease-Laden Vapors from Commercial Cooking Equipment.*)

4-4.18.2 Standard sprinklers or automatic spray nozzles shall be so located as to provide for the protection of exhaust ducts, hood exhaust duct collars, and hood exhaust plenum chambers.

Exception: Sprinklers or automatic spray nozzles in ducts, duct collars, and plenums may be omitted when all cooking equipment is served by listed grease extractors.

4-4.18.3 Exhaust ducts shall have one sprinkler or automatic spray nozzle located at the top of each vertical riser and at the mid-point of each offset. The first sprinkler or automatic spray nozzle in a horizontal duct shall be installed at the duct entrance. Horizontal exhaust ducts shall have such devices located on 10-ft centers beginning no more than 5 ft from the duct entrance. Sprinkler(s) or automatic spray nozzle(s) in exhaust ducts subject to freezing shall be properly protected against freezing by approved means. (*See 3-10.1.*)

Exception: Sprinklers or automatic spray nozzles may be omitted from a vertical riser located outside of a building provided the riser does not expose combustible material or the interior of a building and the horizontal distance between the hood outlet and the vertical riser is at least 25 ft (7.6 m)

4-4.18.4* Each hood exhaust duct collar shall have one sprinkler or automatic spray nozzle located 1 in. minimum to 12 in. maximum (2.54 cm min. to 30 cm max.) above the point of duct collar connection in hood plenum. Hoods that have listed fire dampers located in the duct collar shall be protected with a sprinkler or automatic spray nozzle located on the discharge side of the damper and be so positioned as not to interfere with damper operation.

4-4.18.5 Hood exhaust plenum chambers shall have one sprinkler or automatic spray nozzle centered in each chamber not exceeding 10 ft (6.9 m) in length. Plenum chambers greater than 10 ft (6.9 m) in length shall have two sprinklers or automatic spray nozzles evenly spaced with the maximum distance between the two sprinklers not to exceed 10 feet (6.9 m).

4-4.18.6 Sprinklers or automatic spray nozzles being used in duct, duct collar, and plenum areas shall be of the temperature classification *extra high* [325°F to 375°F (163°C to 191°C)] and have orifice sizes no less than ¼ in. (0.6 cm) and no more than ½ in. (1.3 cm).

Exception: When use of a temperature measuring device indicates temperatures above 300°F (149°C) a sprinkler or automatic spray nozzle of higher classification shall be used.

4-4.18.7 Access must be provided to all sprinklers or automatic spray nozzles for examination and replacement.

4-4.18.8 Cooking Equipment.

4-4.18.8.1 Cooking equipment, (such as deep fat fryers, ranges, griddles, and broilers) which may be a source of ignition, shall be protected in accordance with the provisions of 4-4.18.1.

4-4.18.8.2 A sprinkler or automatic spray nozzle used for protection of deep fat fryers shall be listed for that application. The position, arrangement, location, and water supply for each sprinkler or automatic spray nozzle shall be in accordance with its listing.

4-4.18.8.3 The operation of any cooking equipment sprinkler or automatic spray nozzle shall automatically shut off all sources of fuel and heat to all equipment requiring protection. Any gas appliance not requiring protection but located under ventilating equipment shall also be shut off. All shutdown devices shall be of the type that requires manual resetting prior to fuel or power being restored.

4-4.18.9 A listed indicating valve shall be installed in the water supply line to the sprinklers and spray nozzles protecting the cooking and ventilating system.

4-4.18.10 An approved line strainer shall be installed in the main water supply preceding sprinklers or automatic spray nozzles having orifices smaller than 3/8 in. (.9 cm).

4-4.18.11 A system test connection shall be provided to verify proper operation of equipment specified in 4-4.18.8.3.

4-4.18.12 Sprinklers and automatic spray nozzles used for protecting commercial-type cooking equipment and ventilating systems shall be replaced annually.

Exception: When automatic bulb-type sprinklers or spray nozzles are used and annual examination shows no buildup of grease or other material on the sprinklers or spray nozzles.

4-4.18.13 Other sprinklers shall be arranged so that their runoff does not fall into deep fat fryers. This may be accomplished by the use of a shield or unducted hood placed above the deep fat fryer. The shield or hood shall be placed above the sprinkler protecting the deep fat fryer and so located that it will not interfere with the sprinkler discharge.

4-4.19 Baffles. Baffles (*except for in-rack sprinklers, see NFPA 231C, Standard for Rack Storage of Materials*) shall be installed whenever sprinklers are less than 6 ft (1.8 m) apart to prevent the sprinkler first opening from wetting adjoining sprinklers, thus delaying their operation. Baffles shall be located midway between sprinklers and arranged to baffle the actuating elements. Baffles may be of sheet metal about 8 in. (203 mm) wide and 6 in. (152 mm) high. The top of baffles shall extend 2 to 3 in. (50 to 76 mm) above the deflectors of upright sprinklers; and the bottom of baffles shall extend downward to a level at least even with the deflectors of pendent sprinklers.

4-4.20 Small Rooms. Rooms with smooth ceilings, and having floor areas not exceeding 800 sq ft (74.3 m²), of Light Hazard Occupancy classification.

4-4.20.1* Within small rooms sprinklers may be located not over 9 ft (2.7 m) from any single wall; however, sprinkler spacing limitations of 4-2.1.1 and area limitations of 4-2.2.1.1 shall not be exceeded.

4-4.20.2 In hotels, sprinklers may be omitted from bathrooms not exceeding 55 sq ft (5.1 m²) with noncombustible plumbing fixtures and with walls and ceilings surfaced with noncombustible materials.

4-4.21 Theater Stages. Sprinklers shall be installed under the roof at the ceiling, in spaces under the stage either containing combustible materials or constructed of

combustible materials; in all adjacent spaces and dressing rooms, storerooms, and workshops. When proscenium opening protection is required a deluge system shall be provided within 3 ft (0.9 m) of the stage side of the proscenium arch, with open sprinklers spaced up to a maximum of 6 ft (1.8 m) on center and designed to provide a discharge of 3 gpm/lineal ft [(37 L/min)/m] of water curtain, with no sprinkler discharging less than 15 gpm (56.8 L/min).

4-5* Spacing, Location, and Position of Sidewall Sprinklers. (*See 3-16.2.5.*)

4-5.1 Sidewall sprinklers shall only be installed along walls, lintels, or soffits where the distance from the ceiling to the bottom of the lintel or soffit is at least 2 in. (50.8 mm) greater than the distances from the ceiling to sidewall sprinkler deflector. Sidewall sprinklers shall not be installed back to back without being separated by a lintel or soffit.

4-5.2 Distance Between Branch Lines and Sprinklers on Branch Lines.

4-5.2.1 Distance Between Branch Lines. Sidewall sprinklers shall be installed along the length of a single wall of rooms or bays not exceeding the width dimension specified in Table 4-5.2.1.

4-5.2.2 Sidewall sprinklers may be installed in Light Hazard Occupancies with smooth ceilings or in bays up to 30 ft (9 m) in width. When sidewall sprinklers are installed on two opposite walls or sides of bays, the spacing shall be as required in Section 4-5 with sprinklers regularly staggered (see Table 4-5.2.1).

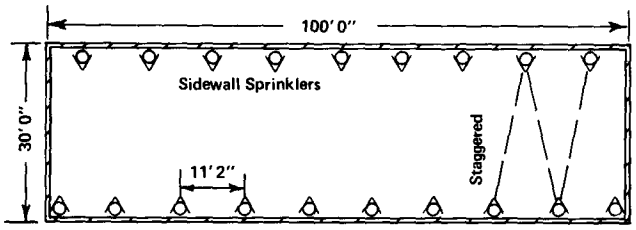


Figure 4-5.2.1 Spacing of Sidewall Sprinklers Under Combustible Smooth Ceilings, with Light Hazard Occupancy.

4-5.3 Protection Area Limitations for Light Hazard Occupancy.

4-5.3.1 With noncombustible smooth ceiling the protection area per sprinkler shall not exceed 196 sq ft (18.2 m^2).

4-5.3.2 With combustible ceiling construction sheathed with plasterboard, metal, or wood lath and plaster forming a smooth ceiling, the protection area per sprinkler shall not exceed 168 sq ft (15.6 m^2). (*See Figure 4-5.1.2.*) When sheathing is combustible such as wood, fiberboard, or other combustible material, the protection area per sprinkler shall not exceed 120 sq ft (11.1 m^2).

Exception: Noncombustible smooth ceiling spacing is permitted beneath a noncombustible smooth ceiling attached directly to the underside of a combustible sprinklered concealed space.

4-5.4 Protection Area Limitations for Ordinary Hazard Occupancy.

4-5.4.1 With noncombustible smooth ceiling the protection area per sprinkler shall not exceed 100 sq ft (9.3 m^2).

4-5.4.2 With combustible ceiling construction sheathed with plasterboard, metal, wood lath and plaster, wood fiberboard, or other combustible material forming a smooth ceiling, the protection area per sprinkler shall not exceed 80 sq ft (7.4 m^2).

Exception: Noncombustible smooth ceiling spacing is permitted beneath a noncombustible smooth ceiling attached directly to the underside of a combustible sprinklered concealed space.

4-5.5* Position of Sidewall Sprinklers. Sprinkler deflectors shall be at a distance from walls and ceilings not more than 6 in. (152 mm) or less than 4 in. (102 mm), unless special construction arrangements make a different position advisable for prompt operation and effective distribution.

Exception No. 1: Horizontal sidewall sprinklers may be positioned 6 to 12 in. (152 to 305 mm) below noncombustible ceilings when listed for these positions.

Table 4-5.2.1 Dimensions for Sidewall Sprinkler Installation

	Light Hazard Occupancy			Ordinary Hazard Occupancy	
	Combustible Construction with Combustible Sheathing	Combustible Construction Sheathed with Plasterboard, Metal, or Wood Lath and Plaster	Noncombustible Construction with Noncombustible Sheathing	Combustible Construction with Combustible Sheathing*	Noncombustible Smooth Ceiling
Maximum distance between sprinklers on branch line	14	14	14	10	10
Maximum room width for single branch line along wall (ft)	12	12	12	10	10
Maximum area coverage (ft^2)	120	168	196	80	100

For SI Units: 1 ft = 0.3048 m.
*See 4-5-4.2

Exception No. 2: Horizontal sidewall sprinklers may be positioned with their deflectors less than 4 in. (102 mm) from the wall on which they are mounted.

Chapter 5 Types of Systems

5-1 Wet-Pipe Systems.

5-1.1* Definition. 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.

5-1.2 Pressure Gages. An approved pressure gage conforming to 2-9.2.2 shall be installed in each system riser. Pressure gages shall be installed above and below each alarm check valve when such devices are present.

5-1.3 Relief Valves. A gridded wet-pipe system shall be provided with a relief valve not less than ¼ in. in size set to operate at pressure not greater than 175 psi (12.1 bars).

Exception No. 1: When the maximum system pressure exceeds 165 psi (11.4 bars), the relief valve shall operate at 10 psi (0.7 bar) in excess of the maximum system pressure.

Exception No. 2: When auxiliary air reservoirs are installed to absorb pressure increases.

5-2 Dry-Pipe Systems.

5-2.1* Definition. A system employing automatic sprinklers attached to a piping system containing air or nitrogen under pressure, the release of which (as from the opening of a sprinkler) permits the water pressure to open a valve known as a dry-pipe valve. The water then flows into the piping system and out the opened sprinklers.

5-2.2 Dry-Pendent Sprinklers. Automatic sprinklers installed in the pendent position shall be of the listed dry-pendent type if installed in an area subject to freezing.

Exception: Pendent sprinklers installed on return bends are permitted when both the sprinklers and the return bends are located in a heated area.

5-2.3* Size of Systems.

5-2.3.1 Volume Limitations. Not more than 750-gal (2839 L) system capacity shall be controlled by one dry-pipe valve. Gridded dry-pipe systems shall not be installed.

Exception: Piping volume may exceed 750 gal (2839 L) for nongridded systems if the system design is such that water is delivered to the system test connection in not more than 60 seconds, starting at the normal air pressure on the system and at the time of fully opened inspection test connection.

5-2.4 Quick-Opening Devices.

5-2.4.1 Dry-pipe valves shall be provided with a listed quick-opening device when system capacity exceeds 500 gal (1893 L).

5-2.4.2* The quick-opening device shall be located as close as practical to the dry-pipe valve. To protect the restriction orifice and other operating parts of the quick-opening device against submergence, the connection to the riser shall be above the point at which water (priming water and back drainage) is expected when the dry-pipe valve and quick-opening device are set, except where design features of the particular quick-opening device make these requirements unnecessary.

5-2.4.3 A soft disc globe or angle valve shall be installed in the connection between the dry-pipe sprinkler riser and the quick-opening device.

5-2.4.4 A check valve shall be installed between the quick-opening device and the intermediate chamber of the dry-pipe valve. If the quick-opening device requires pressure feedback from the intermediate chamber, a valve of the type that will clearly indicate whether it is opened or closed may be installed in place of that check valve. This valve shall be constructed so that it may be locked or sealed in the open position.

5-2.4.5 An approved antiflooding device shall be installed in the connection between the dry-pipe sprinkler riser and the quick-opening device, unless the particular quick-opening device has built-in antiflooding design features.

5-2.5* Location and Protection of Dry-Pipe Valve.

5-2.5.1 The dry-pipe valve and supply pipe shall be protected against freezing and mechanical injury.

5-2.5.2 Valve rooms shall be lighted and heated. The source of heat shall be of a permanently installed type. Heat tape shall not be used in lieu of heated valve enclosures to protect the dry-pipe valve and supply pipe against freezing.

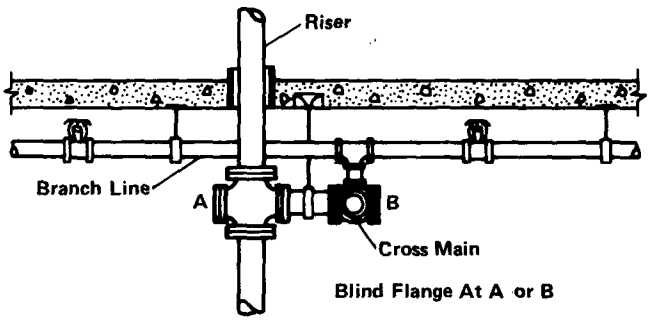
5-2.5.3 The supply for the sprinkler in the dry-pipe valve enclosure shall be from the dry side of the system.

5-2.5.4 Protection against accumulation of water above the clapper shall be provided for a low differential dry-pipe valve. This may be an automatic high water level signaling device or an automatic drain device.

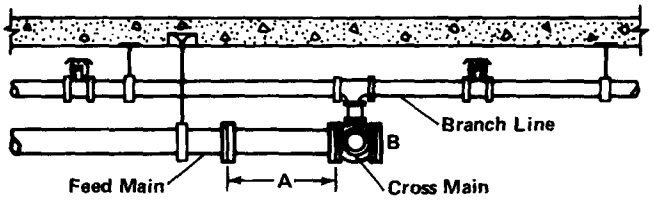
5-2.6* Cold Storage Rooms.

5-2.6.1 Fittings for Inspection Purposes.

5-2.6.1.1 Fittings for inspection purposes shall be provided whenever a cross main connects to a riser or feed main. This may be accomplished by a blind flange on a fitting (tee or cross) in the riser or cross main or a flanged removable section 24 in. (610 mm) long in the feed main as shown in Figure 5-2.6.1(A). Such fittings in conjunction with the flushing connections specified in 3-8.2 would permit examination of the entire lengths of the cross mains. Branch lines may be examined by backing the pipe out of fittings.



(a) Elevation At Riser And Cross Main



24 in. Flanged Removable Section
At A or Blind Flange At B

(b) Elevation At Feed Main And Cross Main

Figure 5-2.6.1(A) Fittings to Facilitate Examination of Feed Mains, Risers, and Cross Mains in Freezing Areas.

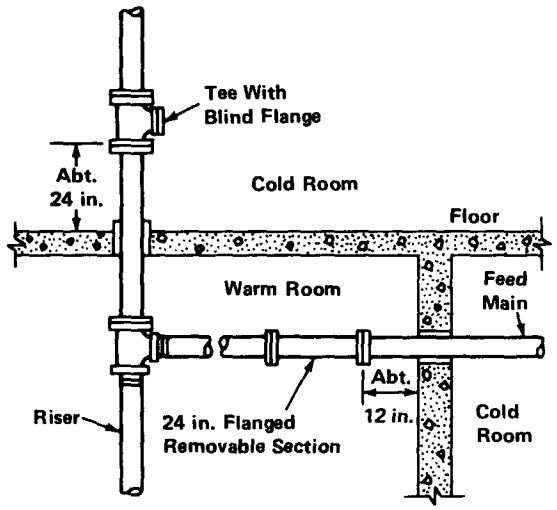


Figure 5-2.6.1(B) Fittings in Feed Main or Riser Passing through Wall or Floor from Warm Room to Cold Room.

5-2.6.1.2 Whenever feed mains change direction, facilities shall be provided for direct observation of every length of feed main within the refrigerated area. This may be accomplished by means of 2-in. capped nipples or blind flanges on fittings.

5-2.6.1.3 Fittings for inspection purposes shall be provided whenever a riser or feed main passes through a wall or floor from a warm room to a cold room. This may be accomplished at floor penetrations by a tee with a blind flange in the cold room and at wall penetrations by a 24-in. (610-mm) flanged removable section in the warm room as shown in Figure 5-2.6.1(B).

5-2.6.2 A local low air-pressure alarm shall be installed on sprinkler systems supplying freezer sections.

5-2.6.3 Piping in cold storage rooms shall be installed with pitch, as outlined in 3-11.1.3.

5-2.6.4 The air supply for dry-pipe systems in cold storage plants shall be taken from the freezers of lowest temperature or through a chemical dehydrator. Compressed nitrogen gas from cylinders may be used in place of air in dry-pipe systems to eliminate introducing moisture.

5-2.7 Air Pressure and Supply.

5-2.7.1 Maintenance of Air Pressure. Air or nitrogen pressure shall be maintained on dry-pipe systems throughout the year.

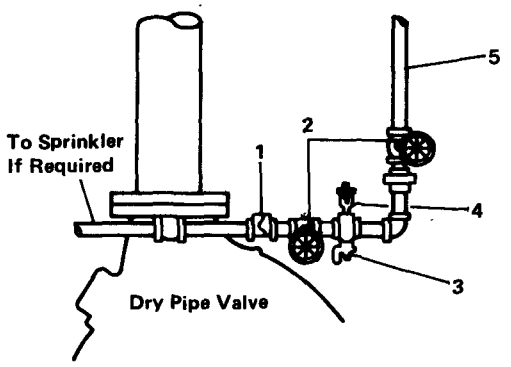
5-2.7.2* Air Supply. The compressed air supply shall be from a source available at all times and having a capacity capable of restoring normal air pressure in the system within 30 minutes, except for low differential dry-pipe systems where this time may be 60 minutes. Where low differential dry-pipe valves are used, the air supply shall be maintained automatically.

5-2.7.3 Air Filling Connection. The connection pipe from the air compressor shall not be less than ½ in. (12.7 mm) and shall enter the system above the priming water level of the dry-pipe valve. A check valve shall be installed in this air line and a shutoff valve of renewable disc type shall be installed on the supply side of this check valve and shall remain closed unless filling the system.

5-2.7.4 Relief Valve. An approved relief valve shall be provided between the compressor and controlling valve, set to relieve at a pressure 5 psi (0.3 bars) in excess of maximum air pressure that should be carried in the system.

5-2.7.5 Shop Air Supply. When the air supply is taken from a shop system having a normal pressure greater than that required for dry-pipe systems and an automatic air maintenance device is not used, the relief valve shall be installed between two control valves in the air line and a small air cock, which is normally left open, shall be installed in the fitting below the relief valve.

5-2.7.6 Automatic Air Compressor. When a dry-pipe system is supplied by an automatic air compressor or plant air system, any device or apparatus used for automatic maintenance of air pressure shall be of a type specifically approved for such service and capable of maintaining the required air pressure on the dry-pipe system. Automatic air supply to more than one dry-pipe system shall be connected to enable individual maintenance of air pressure in each system. A check valve or other positive backflow prevention device shall be installed in the air supply to each system to prevent air or water flow from one system to another.



1. Check Valve
2. Control Valve (renewable disc type)
3. Small Air Cock (normally open)
4. Relief Valve
5. Air Supply

Figure 5-2.7.5 Air Supply from Shop System.

5-2.7.7 Air Pressure to Be Carried. The air pressure to be carried shall be in accordance with the instruction sheet furnished with the dry-pipe valve, when available, or 20 psi (1.4 bars) in excess of the calculated trip pressure of the dry-pipe valve, based on the highest normal water pressure of the system supply. The permitted rate of air leakage shall be as specified in 1-11.3.2.

5-2.7.8 When used, nitrogen shall be introduced through a pressure regulator set to maintain system pressure in accordance with 5-2.7.7.

5-2.8 Pressure Gages. Approved pressure gages conforming to 2-9.2.2 shall be connected:

(a) On the water side and air side of the dry-pipe valve,

(b) At the air pump supplying the air receiver,

(c) At the air receiver,

(d) In each independent pipe from air supply to dry-pipe system, and

(e) At exhausters and accelerators.

5-3 Preaction and Deluge Systems.

5-3.1 Definitions.

Preaction System. A system employing automatic sprinklers attached to a piping system containing air that may or may not be under pressure, with a supplemental fire detection system installed in the same areas as the sprinklers. Actuation of the fire detection system (as from a fire) opens a valve that permits water to flow into the sprinkler piping system and to be discharged from any sprinklers that may be open.

Deluge System. A system employing open sprinklers attached to a piping system connected to a water supply through a valve that is opened by the operation of a fire detection system installed in the same areas as the sprinklers. When this valve opens water flows into the piping system and discharges from all sprinklers attached thereto.

5-3.2* Description. Preaction and deluge systems are normally without water in the system piping. The water supply is controlled by an automatic valve operated by means of fire detection devices and provided with manual means for operation that are independent of the sprinklers. Systems may have equipment of the types described in (a) through (f) below. (*See 5-3.6.2.*)

(a) Automatic sprinklers with both sprinkler piping and fire detection devices automatically supervised,

(b) Automatic sprinklers with sprinkler piping and fire detection devices not automatically supervised,

(c) Open sprinklers with only fire detection devices automatically supervised,

(d) Open sprinklers with fire detection devices not automatically supervised,

(e) Combination of open and automatic sprinklers with fire detection devices automatically supervised,

(f) Combination of open and automatic sprinklers with fire detection devices not automatically supervised.

5-3.3* General.

5-3.3.1 A supply of spare fusible elements for heat-responsive devices, not less than two of each temperature rating, shall be maintained on the premises for replacement purposes.

5-3.3.2 When hydraulic release systems are used, it is possible to water column the deluge valve or deluge-valve actuator if the heat-actuated devices (fixed temperature or rate-of-rise) are located at extreme heights above the valve. Refer to the manufacturer for height limitations of a specific deluge valve or deluge-valve actuator.

5-3.3.3 All new preaction or deluge systems shall be tested hydrostatically as specified in 1-11.2.1. In testing deluge systems, plugs shall be installed in fittings and replaced with open sprinklers after the test is completed, or automatic sprinklers may be installed and the operating parts removed after the test is completed.

5-3.4 Location and Protection of Preaction and Deluge Systems.

5-3.4.1 The preaction and deluge system water control valves and supply pipes shall be protected against freezing and mechanical injury.

5-3.4.2 Valve rooms shall be lighted and heated. The source of heat shall be of a permanently installed type.

5-3.4.3 Heat tape shall not be used in lieu of heated valve enclosure rooms to protect preaction and deluge valves and supply pipe against freezing.

5-3.5 Location and Spacing of Fire Detection Devices. Spacing of fire detection devices other than automatic sprinklers shall be in accordance with their listing by testing laboratories or in accordance with manufacturer's specifications. When automatic sprinklers are used as detectors, the distance between detectors and the area per detector shall not exceed the maximum permitted for suppression sprinklers as specified in 4-2.1 and 4-2.2; they shall be positioned in accordance with Section 4-3,

but need not conform with the clearance requirements of 4-2.4. (*See NFPA 72E, Standard on Automatic Fire Detectors.*)

5-3.6 Preaction Systems.

5-3.6.1 All components of pneumatic, hydraulic, or electrical preaction systems shall be compatible.

5-3.6.2 Size of Systems. Not more than 1,000 closed sprinklers shall be controlled by any one preaction valve.

5-3.6.3 Supervision. Sprinkler piping and fire detection devices shall be automatically supervised when there are more than 20 sprinklers on the system.

5-3.6.4 For pipe schedules see Sections 3-5, 3-6, 3-7, and Chapter 7.

5-3.6.5 Pendent Sprinklers. Automatic sprinklers on preaction systems installed in the pendent position shall be of the listed dry-pendent type if installed in an area subject to freezing.

Exception: Pendent sprinklers installed on return bends are permitted when both the sprinklers and the return bends are located in a heated area.

5-3.7* Deluge Systems. The fire detection devices or systems shall be automatically supervised when there are more than 20 sprinklers on the system.

5-3.8 Devices for Test Purposes and Testing Apparatus.

5-3.8.1 When fire detection devices installed in circuits are located where not readily accessible, an additional fire detection device shall be provided on each circuit for test purposes at an accessible location and shall be connected to the circuit at a point that will assure a proper test of the circuit.

5-3.8.2 Testing apparatus capable of producing the heat or impulse necessary to operate any normal fire detection device shall be furnished to the owner of the property with each installation. Where explosive vapors or materials are present, hot water, steam, or other methods of testing not involving an ignition source shall be used.

5-3.8.3 Pressure Gages. Approved pressure gages conforming to 2-9.2.2 shall be installed as follows:

(a) Above and below preaction valve and below deluge valve

(b) On air supply to preaction and deluge valves.

5-4 Combined Dry-Pipe and Preaction Systems.

5-4.1 General.

5-4.1.1* Definition. A combined dry-pipe and preaction sprinkler system is one employing automatic sprinklers attached to a piping system containing air under pressure with a supplemental fire detection system installed in the same areas as the sprinklers; operation of the fire detection system, as from a fire, actuates tripping devices that open dry-pipe valves simultaneously and without loss of air pressure in the system. Operation of the fire detection system also opens approved air exhaust valves at the end of the feed main, which facilitates the filling of the system with water, which usually precedes the opening of sprinklers. The fire detection system also serves as an automatic fire alarm system.

5-4.1.2 Combined automatic dry-pipe and preaction systems shall be so constructed that failure of the fire detection system shall not prevent the system from functioning as a conventional automatic dry-pipe system.

5-4.1.3 Combined automatic dry-pipe and preaction systems shall be so constructed that failure of the dry-pipe system of automatic sprinklers shall not prevent the fire detection system from properly functioning as an automatic fire alarm system.

5-4.1.4 Provisions shall be made for the manual operation of the fire detection system at locations requiring not more than 200 ft (61.0 m) of travel.

5-4.1.5 Except as indicated in 5-2.2, automatic sprinklers installed in the pendent position shall be of the approved dry-pendent type.

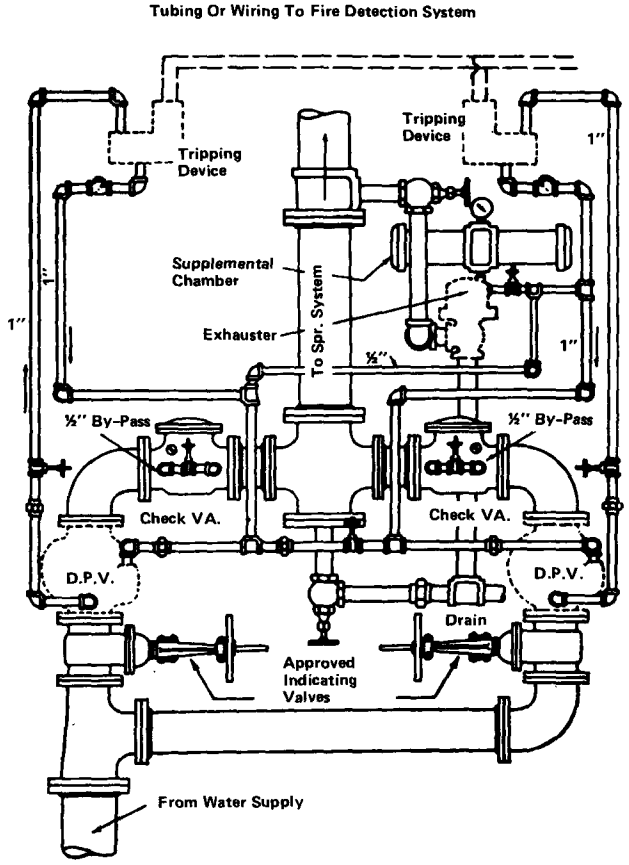


Figure 5-4.2 Header for Combined Dry-Pipe and Preaction Sprinkler System, Standard Trimmings not Shown.

5-4.2 Dry-Pipe Valves in Combined Systems.

5-4.2.1 Where the system consists of more than 600 sprinklers or has more than 275 sprinklers in any fire area, the entire system shall be controlled through two 6-in. (15.2-cm) dry-pipe valves connected in parallel and shall feed into a common feed main. These valves shall be checked against each other. (*See Figure 5-4.2.*)

5-4.2.2 Each dry-pipe valve shall be provided with an approved tripping device actuated by the fire detection system. Dry-pipe valves shall be cross connected through a 1-in. pipe connection to permit simultaneous tripping of both dry-pipe valves. This 1-in. pipe connection shall be equipped with a gate valve so that either dry-pipe valve can be shut off and worked on while the other remains in service.

5-4.2.3 The check valves between the dry-pipe valves and the common feed main shall be equipped with ½-in. bypasses so that a loss of air from leakage in the trimmings of a dry-pipe valve will not cause the valve to trip until the pressure in the feed main is reduced to the tripping point. A gate valve shall be installed in each of these bypasses so that either dry-pipe valve can be completely isolated from the main riser or feed main and from the other.

5-4.2.4 Each combined dry-pipe and preaction system shall be provided with approved quick-opening devices at the dry-pipe valves.

5-4.3* Air Exhaust Valves. One or more approved air exhaust valves of 2-in. (50-mm) or larger size controlled by operation of a fire detection system shall be installed at the end of the common feed main. (*See Figure A-5-4.3.*) These air exhaust valves shall have soft-seated globe or angle valves in their intakes; also, approved strainers shall be installed between these globe valves and the air exhaust valves.

5-4.4 Subdivision of System Using Check Valves.

5-4.4.1 Where more than 275 sprinklers are required in a single fire area, the system shall be divided into sections of 275 sprinklers or less by means of check valves. If the system is installed in more than one fire area or story, not more than 600 sprinklers shall be supplied through any one check valve. Each section shall have a 1¼-in. (6.4-mm) drain on the system side of each check valve supplemented by a drum drip.

5-4.4.2 Section drain lines and drum drips shall be located in heated areas or inside of thermostatically controlled electrically heated cabinets of sufficient size to enclose drain valves and drum drips for each section. Drum drips shall also be provided for all low points except that heated cabinets need not be required for systems of 20 sprinklers or less.

5-4.4.3 Air exhaust valves at the end of a feed main and associated check valves shall be protected against freezing.

5-4.5 Time Limitation. The sprinkler system shall be so constructed and the number of sprinkler heads controlled shall be so limited that water shall reach the farthest sprinkler within a period of time not exceeding 1 minute for each 400 ft (122 m) of common feed main from the time the heat-responsive system operates. Maximum time permitted not to exceed 3 minutes.

5-4.6 System Test Connection. The end section shall have a system test connection as required for dry-pipe systems.

5-5 Antifreeze Systems.

5-5.1 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.

5-5.2* Where Used. The use of antifreeze solutions shall be in conformity with any state or local health regulations.

5-5.3 Antifreeze Solutions.

5-5.3.1 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 5-5.3.1.

Table 5-5.3.1 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	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%.

5-5.3.2 If public water is not connected to sprinklers, the commercially available materials indicated in Table 5-5.3.2 are suitable for use in antifreeze solutions.

5-5.3.3* 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.

5-5.4* 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 5-5.4. The preferred arrangement is to have the sprinklers below the interface between the water and the antifreeze solution.

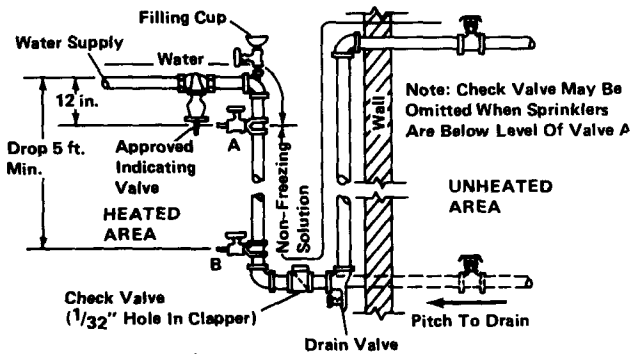
If sprinklers are above the interface, a check valve with

Table 5-5.3.2 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 5-5.3.1			
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 5-5.3.1			
Calcium Chloride 80% "Flake" *Fire Protection Grade** Add Corroison inhibitor of sodium bichromate ½ oz per gal water	Lb $CaCl_2$ per gal of Water			
	2.83	1.183	0	−17.8
	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.

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 5-5.4. An acceptable arrangement of a filling cup is also shown.



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 5-5.4 Arrangement of Supply Piping and Valves.

5-5.5* 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.

5-6 Automatic Sprinkler Systems with Nonfire Protection Connections.

5-6.1 Circulating Closed-Loop Systems.

5-6.1.1 Definition. A circulating closed-loop is one with nonfire protection connections to automatic sprinkler systems in a closed-loop piping arrangement for the purpose of utilizing sprinkler piping to conduct water for heating or cooling. Water is not removed or used from the system, but only circulated through the piping system.

5-6.1.2 System Components.

5-6.1.2.1 Basic Principle. A circulating closed-loop system is primarily a sprinkler system, and all provisions of this standard such as control valves, area limitation of a system, alarms, fire department connections, sprinkler spacing, etc., are to be satisfied.

Exception: Items as specifically detailed within 5-6.1.

5-6.1.2.2 Piping, fittings, valves, and pipe hangers shall meet requirements specified in Chapter 3.

5-6.1.2.3 A dielectric fitting shall be installed in the junction where dissimilar piping materials are joined, e.g., copper to steel.

Exception: Dielectric fittings are not required in the junction where sprinklers are connected to piping.

5-6.1.2.4 It is not required that other auxiliary devices be listed for sprinkler service; however, these devices, such as pumps, circulating pumps, heat exchangers, radiators, and luminaires shall be pressure rated at 175 or 300 psi (12.1 or 20.7 bars) (rupture pressure of 5 × rated water working pressure), to match the required rating of sprinkler system components.

5-6.1.2.5 Auxiliary devices shall incorporate materials of construction and be so constructed that they will maintain their physical integrity under fire conditions to avoid impairment to the fire protection system.

5-6.1.2.6 Auxiliary devices where hung from the building structure shall be supported independently from the sprinkler portion of the system, following recognized engineering practices.

5-6.1.3 Hydraulic Characteristics. Piping systems for attached heating and cooling equipment shall have auxiliary pumps or an arrangement made to return water to the piping system in order to assure the following:

(a)* Water for sprinklers shall not be required to pass through heating or cooling equipment. At least one direct path shall exist for water flow from the sprinkler water supply to every sprinkler. Pipe sizing in the direct path shall be in accordance with design requirements of this standard.

(b) No portions of the sprinkler piping shall have less than the sprinkler system design pressure regardless of the mode of operation of the attached heating or cooling equipment.

(c) There shall be no loss or outflow of water from the system due to or resulting from the operation of heating or cooling equipment.

(d) Shutoff valves and a means of drainage shall be provided on piping to heating or cooling equipment at all points of connection to sprinkler piping and shall be installed in such a manner as to make possible repair or removal of any auxiliary component without impairing the serviceability and response to the sprinkler system. All

auxiliary components including strainer shall be installed on the auxiliary equipment side of the shutoff valves.

5-6.1.4 Water Temperature.

5-6.1.4.1 Maximum. In no case shall maximum water temperature flowing through the sprinkler portion of the system exceed 120°F (49°C). Protective control devices listed for this purpose shall be installed to shut down heating or cooling systems when temperature of water flowing through the sprinkler portion of the system exceeds 120°F (49°C). When water temperature exceeds 100°F (37.8°C), intermediate or higher temperature rated sprinklers shall be used.

5-6.1.4.2 Minimum. Precaution shall be taken to ensure that temperatures below 40°F (4.4°C) will not be permitted.

5-6.1.5 Obstruction to Discharge. Automatic sprinklers shall not be obstructed by auxiliary devices, piping, insulation, etc., from detecting fire or from proper distribution of water.

5-6.1.6 Valve Supervision. Position of all valves controlling sprinkler system (post indicator, main gate, sectional control) shall be supervised open by one of the following methods:

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

(b) Local alarm service, which will cause the sounding of an audible signal at a constantly attended point.

5-6.1.7 Signs. Caution signs shall be attached to all controlling sprinkler valves. The caution sign shall be worded as follows:

"This valve controls fire protection equipment. Do not close until after fire has been extinguished. Use auxiliary valves when necessary to shut supply to auxiliary equipment. CAUTION: Automatic alarm will be sounded if this valve is closed."

5-6.1.8 Water Additives. Materials added to water shall not adversely affect the fire fighting properties of the water and shall be in conformity with any state or local health regulations. Due care and caution shall be given to the use of additives that may remove or suspend scale from older piping systems. When additives are necessary for proper system operation, due care shall be taken to ensure additives are replenished after alarm testing or whenever water is removed from the system.

5-6.1.9 Water Flow Detection. The supply of water from sprinkler piping through auxiliary devices, circulatory piping, and pumps shall not under any condition or operation, transient or static, cause false sprinkler water flow signals.

5-6.1.9.1 A sprinkler water flow signal shall not be impaired when water is discharged through an opened sprinkler or through the system test connection while auxiliary equipment is in any mode of operation (on, off, transient, stable).

5-6.1.10* Working Plans. Working plans shall be prepared and submitted in accordance with Section 1-9. Special symbols shall be used and explained for auxiliary piping, pumps, heat exchangers, valves, strainers, and the like, clearly distinguishing those devices and piping runs from those of the sprinkler system. Model number, type, and manufacturer's name shall be identified for each piece of auxiliary equipment.

5-6.1.11 Testing.

5-6.1.11.1 All sprinkler system and auxiliary system components shall be hydrostatically tested in accordance with 1-11.3.

5-6.1.11.2 Sprinkler system discharge tests shall be conducted using system test connections described in 3-9.1. Pressure gages shall be installed at critical points and readings taken under various modes of auxiliary equipment operation. Water flow alarm signals shall be responsive to discharge of water through system test pipes while auxiliary equipment is in each of the possible modes of operation.

5-6.1.12 Contractor's Material and Test Certificate. Additional information shall be appended to the Contractor's Material and Test Certificate described in Section 1-12 as follows:

(a) Certification that all auxiliary devices, such as heat pumps, circulating pumps, heat exchangers, radiators, and luminaires have a pressure rating of 175 or 300 psi (12.1 or 20.7 bars).

(b) All components of sprinkler system and auxiliary system have been pressure tested as a composite system in accordance with 1-11.3, *Hydrostatic Tests*.

(c) Waterflow tests have been conducted and waterflow alarms have operated while auxiliary equipment is in each of the possible modes of operation.

(d) With auxiliary equipment tested in each possible mode of operation and with no flow from sprinklers or test connection, waterflow alarm signals did not operate.

(e) Excess temperature controls for shutting down the auxiliary system have been properly field tested.

Chapter 6 Outside Sprinklers for Protection Against Exposure Fires

6-1 Water Supply and Control.

6-1.1 Water Supply.

6-1.1.1* Sprinklers installed for protection against exposure fires shall be supplied from a standard water supply as defined in Chapter 2, or other supply such as manual valves, pumps, or fire department connections when approved by the authority having jurisdiction.

6-1.1.2 When automatic systems of sprinklers are installed, water supplies shall be from an automatic source.

6-1.1.3 When the water supply feeds other fire protection appliances, it shall be capable of furnishing total demand for such appliances as well as the outside sprinkler demand.

6-1.1.4 When fire department connections are used for water supply, they shall be so located that they will not be affected by the exposing fire.

6-1.2 Control.

6-1.2.1 Each system of outside sprinklers shall have an independent control valve. Where more than one valve is required, the division between sprinklers on each valve shall be vertical and not horizontal, except as noted in Appendix B-6-2.3.

6-1.2.2 Manually controlled open sprinklers shall be used only where constant supervision is present.

6-1.2.3 Automatic systems may be of the open or closed sprinkler head type. Closed sprinklers in areas subject to freezing shall be on dry-pipe or nonfreezing systems when not prohibited by local public health authorities.

6-1.2.4* Automatic systems of open sprinklers shall be controlled by the operation of fire detection devices designed for the specific application.

6-2 System Components.

6-2.1* Valves.

6-2.1.1 Control valves shall be of the approved indicating type and shall be distinctively marked by letters not less than ½ in. (13 mm) high to clearly explain their use.

6-2.1.2 Drain Valve. Each system of outside sprinklers shall have a separate drain valve installed on the system side of each control valve. Drain valves shall be in accordance with 3-11.2, except that in no case shall valves be smaller than 1 in.

6-2.1.3 Check Valves. When sprinklers run on two adjacent sides of a building, protecting against two separate and distinct exposures, with separate control valves for each side, the end lines shall be connected with check valves located so that one sprinkler around the corner will operate. The intermediate pipe between the two check valves shall be arranged to drain. As an alternate solution, an additional sprinkler shall be installed on each system located around the corner from the system involved.

6-2.1.4 When one exposure affects two sides of the protected structure, the system shall not be subdivided between the two sides, but rather shall be arranged to operate as a single system.

6-2.2 Pipe and Fittings. Approved corrosion-resistant pipe and fittings shall be used for the equipment as far back as the control valve on the water supply.

6-2.3 Strainers. An approved strainer shall be provided in the riser or feed main, which supplies sprinklers having orifices smaller than ⅜ in. (9.5 mm).

6-2.4 Gage Connections. A pressure gage shall be installed just below the control valve of each system.

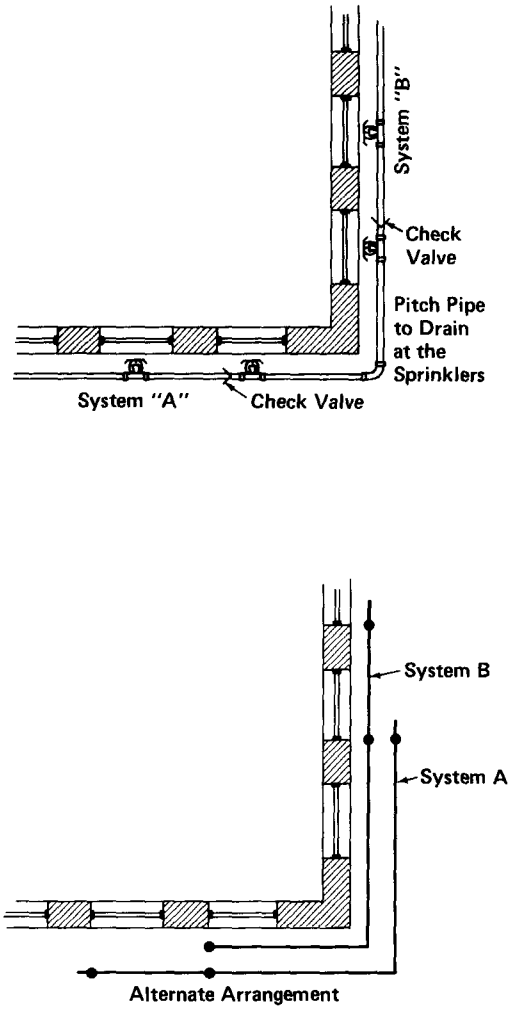


Figure 6-2.1.3 Arrangement of Check Valves.

6-3 Sprinklers.[1] Only sprinklers of such type as are approved for window, cornice, sidewall, or ridge pole service shall be installed for such use except where adequate coverage by use of other types of approved sprinklers and/or nozzles has been demonstrated. Sprinklers may be of small orifice [¼ in., 5/16 in., and ⅜ in. (6.4 mm, 7.9 mm, and 9.5 mm)] or large orifice [½ in., ⅝ in., and ¾ in. (12.7 mm, 15.9 mm, and 19.1 mm)].

6-4 Piping System.

6-4.1* Pipe sizes of lines, risers, feed mains, and water supply shall be hydraulically calculated in accordance with Chapter 7 to furnish a minimum of 7 psi (0.5 bars) at any sprinkler with all sprinklers facing the exposure operating, or pipe sizes shall be in accordance with 6-4.2 and 6-4.3.

[1]For additional information on outside sprinklers see Appendix B-6-1.

6-4.2 Branch line sizes on pipe schedule systems shall be as follows:

Table 6-4.2 Maximum Number of Sprinklers Supplied on Line

Size of Pipe Inches	Orifice Size — In. (mm)						
	¼ (6.4)	3/16 (7.9)	⅜ (9.5)	7/16 (11.1)	½ (12.7)	⅝ (15.9)	¾ (19.1)
1	4	3	2	2	1	1	1
1¼	8	6	4	3	2	2	1
1½		9	6	4	3	3	2
2				5	4	4	3

For SI Units: 1 in. = 25.4 mm.

6-4.3 Risers and feed main sizes on pipe schedule systems shall be as follows for central feed risers:

Table 6-4.3 Maximum Number of Sprinklers—Riser or Feed Mains

Pipe Size	Number of Sprinklers		
	⅜ in. (9.5 mm) or smaller orifice	½ in. (12.7 mm) orifice	¾ in. (19.1 mm) orifice
1½	6	3	2
2	10	5	4
2½	18	9	7
3	32	16	12
3½	48	24	17
4	65	33	24
5	120	60	43
6		100	70

For SI Units: 1 in. = 25.4 mm.

6-5 Testing and Flushing.

6-5.1 Tests.

6-5.1.1 All piping shall be tested hydrostatically as specified in 1-11.2.

6-5.1.2 Operating tests shall be made of the system when completed, except where such tests may risk water damage.

6-5.2 Flushing. Flushing shall be conducted in accordance with 1-11.1.

Chapter 7 Hydraulically Designed Sprinkler Systems

7-1 General.

7-1.1 Definition.

7-1.1.1 A hydraulically designed sprinkler system is one in which pipe sizes are selected on a pressure loss basis to provide a prescribed density [gal per min per sq ft (L/min)/m^2] distributed with a reasonable degree of uniformity over a specified area. This permits the selection of pipe sizes in accordance with the characteristics of the water supply available. The stipulated design density and area of application will vary with occupancy hazard.

7-1.1.2* The design basis for such a system or addition to an existing system supersedes the rules in the sprinkler standard governing pipe schedules, except that all systems continue to be limited by area, and pipe sizes shall be no less than 1-in. (25.4-mm) nominal for ferrous piping and ¾-in. (19.1-mm) nominal for copper tubing. The size of pipe, number of sprinklers per branch line, and number of branch lines per cross main are otherwise limited only by the available water supply. However, sprinkler spacing and all other rules covered in this and other applicable standards shall be observed.

7-1.2* Nameplate Data. The installer shall properly identify a hydraulically designed automatic sprinkler system by a permanently attached nameplate indicating the location(s) and the basis of design(s) [discharge density(ies) over designed area(s) of discharge, including gallons per minute and residual pressure demand at base of riser]. Such nameplates shall be placed at the controlling alarm, dry-pipe, or preaction valve, for the system containing the hydraulically designed layout(s).

7-2 Information Required.

7-2.1 Basic Design Information. Basic design criteria for hydraulically designed sprinkler systems shall be obtained from this or other applicable standards. Where no standards exist, the authority having jurisdiction shall be consulted.

7-2.2 Sprinkler System Requirements. The following information shall be included when applicable:

(a) Area of water application ..... sq ft

(b) Minimum rate of water application (density) ..... gpm/sq ft

(c) Area per sprinkler ..... sq ft

(d) Allowance for inside hose and outside hydrants ... gpm

(e) Allowance for in-rack sprinklers ..... gpm.

7-2.3* Water Supply Information. The following information shall be included: water flow data with existing or proposed water supply, dead-end or circulating:

(a) Location and elevation of static and residual test gage with relation to the riser reference point

(b) Flow location

(c) Static pressure, psi

(d) Residual pressure, psi

(e) Flow, gpm

(f) Date

(g) Time

(h) Test conducted by or information supplied by. . . .

7-2.4 Information Required on the Drawings.

7-2.4.1 In addition to the requirements of Section 1-9, the drawings shall also contain the information mentioned in the remainder of 7-2.4.

7-2.4.2 Hydraulic Reference Points. Reference points may be shown by a number and/or letter designation and shall correspond with comparable reference points shown on the hydraulic calculation sheets.

7-2.4.3 Sprinklers. Description of sprinklers used.

7-2.4.4 System Design Criteria. The minimum rate of water application (density), the design area of water application, in-rack sprinkler demand, and the water required for hose streams both inside and outside shall be included.

7-2.4.5 Actual Calculated Requirements. The total quantity of water and the pressure required shall be noted at a common reference point for each system.

7-2.4.6 Elevation Data. Relative elevations of sprinklers, junction points, and supply or reference points shall be noted.

7-3 Data Sheets and Abbreviations.

7-3.1 General. Hydraulic calculations shall be prepared on form sheets that include a summary sheet, detailed work sheets, and a graph sheet. (*See copy of typical forms, Figures A-7-3.3 and A-7-3.4.*)

7-3.2 Summary Sheet. The summary sheet shall contain the following information, when applicable:

(a) Date

(b) Location

(c) Name of owner and occupant

(d) Building number or other identification

(e) Description of hazard

(f) Name and address of contractor or designer

(g) Name of approving agency

(h) System design requirements

1. Design area of water application .....sq ft
2. Minimum rate of water application (density) .... gpm per sq ft
3. Area per sprinkler .....sq ft

(i) Total water requirements as calculated including allowance for inside hose and outside hydrants

(j) Water supply information.

7-3.3* Detailed Worksheets. Detailed worksheets (*for sample worksheet, refer to Figure A-7-3.3*) or computer printout sheets shall contain the following information:

(a) Sheet number

(b) Sprinkler description and discharge constant (K)

(c) Hydraulic reference points

(d) Flow in gpm

(e) Pipe size

(f) Pipe lengths, center to center of fittings

(g) Equivalent pipe lengths for fitting and devices

(h) Friction loss in psi per ft of pipe

(i) Total friction loss between reference points

(j) In-rack sprinkler demand

(k) Elevation head in psi between reference points

(l) Required pressure in psi at each reference point

(m) Velocity pressure and normal pressure if included in calculations

(n) Notes to indicate starting points, reference to other sheets or to clarify data shown

(o)* Sketch to accompany gridded system calculations to indicate flow quantities and directions for lines with sprinklers operating in the remote area. *[See Figure A-7-3.3(o).]*

7-3.4* Graph Sheet. Water supply curves and system requirements, plus hose and in-rack sprinkler demand when applicable, shall be plotted on semi-logarithmic graph paper ($Q^{1.85}$) so as to present a graphic summary of the complete hydraulic calculation.

7-3.5 Abbreviations and Symbols. The following standard abbreviations and symbols shall be used on the calculation form:

Symbol or Abbreviation	Item
p	Pressure in psi
gpm	U.S. Gallons per minute
q	Flow increment in gpm to be added at a specific location
Q	Summation of flow in gpm at a specific location
P_t	Total pressure in psi at a point in a pipe
P_f	Pressure loss due to friction between points indicated in location column
P_e	Pressure due to elevation difference between indicated points. This can be a plus value or a minus value. Where minus, the (—) shall be used; where plus, no sign need be indicated
P_v	Velocity pressure in psi at a point in a pipe
P_n	Normal pressure in psi at a point in a pipe
E	90° Ell
EE	45° Ell
Lt.E	Long Turn Elbow
Cr	Cross
T	Tee — flow turned 90 degrees
GV	Gate Valve
BV	Butterfly Valve
Del V	Deluge Valve
ALV	Alarm Valve
CV	Swing Check Valve
WCV	Butterfly (Wafer) Check Valve
St	Strainer
psi	pounds per square inch
v	Velocity of water in pipe in feet per second

7-4 Calculation.

7-4.1 Formulas.

7-4.1.1 Friction Loss Formula. Pipe friction losses shall be determined on the basis of the Hazen-Williams formula.

$$p = \frac{4.52\ Q^{1.85}}{C^{1.85}\ d^{4.87}}$$

where p is the frictional resistance in pounds pressure per square inch per foot of pipe, Q is the gallons per minute flowing, and d is the actual internal diameter of pipe in inches with C as the friction loss coefficient.

$$\text{For SI Units: } P_m = 6.05 \times \frac{Q_m^{1.85}}{C^{1.85}\ d_m^{4.87}} \times 10^5$$

P_m is the frictional resistance in bars per meter of pipe, Q_m is the flow in L/min and d_m is the actual internal diameter in mm with C as the friction loss coefficient.

7-4.1.2 Velocity Pressure Formula. Velocity pressure shall be determined on the basis of the formula

$$P_v = 0.001\ 123\ Q^2/D^4$$

P_v = velocity pressure psi.

where:

Q = flow in gpm.

D = the inside diameter in inches.

For SI units: 1 in. = 25.4 mm; 1 gal = 3.785 L; 1 psi = 0.0689 bar.

7-4.1.3 Normal pressure P_n shall be determined on the basis of the formula

$$P_n = P_t - P_v$$

where:

P_t = total pressure in psi (bars)

P_v = velocity pressure in psi (bars)

7-4.1.4 Hydraulic Junction Points. For gridded systems only, pressures at hydraulic junction points shall balance within 0.5 psi (0.03 bar). The highest pressure at the junction point shall be carried into the calculations.

7-4.2 Equivalent Pipe Lengths of Valves and Fittings.

7-4.2.1 Table 7-4.2 shall be used to determine the equivalent length of pipe for fittings and devices unless manufacturer's test data indicate other factors are appropriate. For saddle-type fittings having friction loss greater than that shown in Table 7-4.2, the increased friction loss shall be included in hydraulic calculations.

7-4.2.2 Use Table 7-4.2 with Hazen-Williams C = 120 only. For other values of C, the values in Table 7-4.2 shall be multiplied by the factors indicated below:

Value of C	100	130	140	150
Multiplying Factor	0.713	1.16	1.33	1.51

(This is based upon the friction loss through the fitting being independent of the C factor available to the piping.)

7-4.2.3 Specific friction loss values or equivalent pipe lengths for alarm valves, dry-pipe valves, deluge valves, strainers, and other devices shall be made available to the authority having jurisdiction.

7-4.3* Calculation Procedure.

7-4.3.1* For all systems the design area shall be the hydraulically most demanding *rectangular area* having a dimension parallel to the branch lines at least 1.2 times the square root of the area of sprinkler operation used. This may include sprinklers on both sides of the cross main. Any fractional sprinkler shall be carried to the next higher whole sprinkler.

Exception No. 1: Where the design area under consideration consists of a corridor protected by one row of sprinklers, the maximum number of sprinklers that need be calculated is 5, unless openings from the corridor are unprotected. (See 2-2.1.2.8.).

Exception No. 2: In systems having branch lines with an insufficient number of sprinklers to fulfill the 1.2 $\sqrt{A}$ requirement, the design area shall be extended to include sprinklers on adjacent branch lines supplied by the same cross main.

Exception No. 3: Where the design area is based on the largest room as per 2-2.1.2.8 [including the exceptions to subsection (a)] the above dimensional requirements do not apply.

Exception No. 4: Where the design area under consideration consists of a building service chute supplied by a separate riser, the maximum number of sprinklers that need be calculated is 3.

7-4.3.1.1* For gridded systems, the designer shall verify that the hydraulically most demanding area is being used. A minimum of two additional sets of calculations shall be submitted to demonstrate peaking of demand area friction loss when compared to areas immediately adjacent on either side along the same branch lines.

Exception: Computer programs that show the peaking of the demand area friction loss shall be acceptable based on a single set of calculations.

Table 7-4.2 Equivalent Pipe Length Chart

Fittings and Valves	Fittings and Valves Expressed in Equivalent Feet of Pipe.													
	¾ in.	1 in.	1¼ in.	1½ in.	2 in.	2½ in.	3 in.	3½ in.	4 in.	5 in.	6 in.	8 in.	10 in.	12 in.
45° Elbow	1	1	1	2	2	3	3	3	4	5	7	9	11	13
90° Standard Elbow	2	2	3	4	5	6	7	8	10	12	14	18	22	27
90° Long Turn Elbow	1	2	2	2	3	4	5	5	6	8	9	13	16	18
Tee or Cross (Flow Turned 90°)	3	5	6	8	10	12	15	17	20	25	30	35	50	60
Butterfly Valve	—	—	—	—	6	7	10	—	12	9	10	12	19	21
Gate Valve	—	—	—	—	1	1	1	1	2	2	3	4	5	6
Swing Check*	—	5	7	9	11	14	16	19	22	27	32	45	55	65

For SI Units: 1 ft = 0.3048 m.

*Due to the variations in design of swing check valves, the pipe equivalents indicated in the above chart to be considered average.
NOTE: This table applies to all types of pipe listed in Table 7-4.3.1.4.

7-4.3.1.2 System piping shall be hydraulically designed using design densities and areas of operation in accordance with Table 2-2.1 (b) as required for the occupancies involved.

(a)* The density shall be calculated on the basis of floor area. The area covered by any sprinkler for use in hydraulic design and calculations shall be determined as follows:

1. Along Branch Lines. Determine distance to next sprinkler (or to wall in case of end sprinkler on branch line) upstream and downstream. Choose larger of either twice the distance to the wall or distance to the next sprinkler. Call this "S."

2. Between Branch Lines. Determine perpendicular distance to branch lines (or to wall in case of the last branch line) on each side of branch on which the subject sprinkler is positioned. Choose the larger of (1) the larger distance to the next branch line, or (2) in the case of the last branch line, twice the distance to the wall. Call this "L."

Exception: For sidewall sprinklers, L will be the distance to the wall opposite the sprinklers, or in the case where sprinklers are provided on two sides, half the distance between the two sides.

3. Design Area for Sprinkler = S × L.

Exception: This does not apply to small rooms (see 4-4.20).

(b)* When sprinklers are installed above and below a ceiling or in a case where more than 2 areas are supplied from a common set of branch lines, the branch lines and supplies shall be calculated to supply the largest water demand.

(c) When sprinklers are installed above and below temporary obstructions such as overhead doors, the branch lines and the supply shall be calculated to supply the sprinklers both above and below the temporary obstruction.

7-4.3.1.3* Each sprinkler in the design area and the remainder of the hydraulically designed system shall discharge at a flow rate at least equal to the stipulated minimum water application rate (density). Begin calculations at the hydraulically most remote sprinkler. Discharge at each sprinkler shall be based on the calculated pressure at that sprinkler.

7-4.3.1.4 Calculate pipe friction loss in accordance with the Hazen-Williams formula with C values from Table 7-4.3.1.4.

(a) Include pipe, fittings, and devices such as valves, meters, and strainers, and calculate elevation changes that affect the sprinkler discharge.

(b) Calculate the loss for a tee or a cross where flow direction change occurs based on the equivalent pipe length of the piping segment in which the fitting is included. The tee at the top of a riser nipple shall be included in the branch line; the tee at the base of a riser nipple shall be included in the riser nipple; and the tee or cross at a cross main-feed main junction shall be included in the cross main. Do not include fitting loss for straight through flow in a tee or cross.

(c) Calculate the loss of reducing elbows based on the equivalent feet value of the smallest outlet. Use the equivalent feet value for the *standard elbow* on any abrupt ninety-degree turn, such as the screw-type pattern. Use the equivalent feet value for the *long-turn elbow* on any sweeping ninety-degree turn, such as a flanged, welded, or mechanical joint-elbow type. (*See Table 7-4.2.*)

(d) Friction loss shall be excluded for the fitting directly connected to a sprinkler.

Table 7-4.3.1.4 Hazen-Williams C Values

Pipe or Tube	C Value*
Unlined Cast or Ductile Iron	100
Black Steel (Dry Systems including Preaction)	100
Black Steel (Wet Systems including Deluge)	120
Galvanized (all)	120
Plastic (listed) — All	150
Cement Lined Cast or Ductile Iron	140
Copper Tube or Stainless Steel	150

*The authority having jurisdiction may recommend other C values.

7-4.3.1.5 Orifice plates or sprinklers of different orifice sizes shall not be used for balancing the system, except for special use such as exposure protection, small rooms or enclosures, or directional discharge. (*See 4-4.20 for definition of small rooms.*)

7-4.3.1.6 Sprinkler discharge in closets, washrooms, and similar small compartments requiring only one sprinkler may be omitted from hydraulic calculations within the area of application. [Sprinklers in these small compartments shall, however, be capable of discharging minimum densities in accordance with Table 2-2.1(b).]

Exception: This shall not apply when areas of application are selected in accordance with 2-2.1.2.8.

7-4.3.1.7* Velocity pressure P_v may or may not be included in the calculations at the discretion of the designer. If velocity pressures are used, they shall be used on both branch lines and cross mains where applicable.

7-4.3.2 Minimum operating pressure of any sprinkler shall be 7 psi (0.5 bar).

Exception: When higher minimum operating pressure for the desired application is specified in the listing of the sprinkler, it shall govern.

7-4.4 Dwelling Units. When residential sprinklers are used, design shall comply with this section.

7-4.4.1 Design Discharge. The system shall provide a discharge of not less than 18 gal/min (68 L/min) to any operating sprinkler and not less than 13 gal/min (49 L/min) per sprinkler to all operating sprinklers in the design area. Other discharge rates may be used in accordance with flow rates indicated in individual residential sprinkler listings.

7-4.4.2* Number of Design Sprinklers. The number of design sprinklers shall include all sprinklers within a compartment to a maximum of 4 sprinklers. When a

compartment contains less than 4 sprinklers, the number of design sprinklers shall include all sprinklers in that compartment plus sprinklers in adjoining compartments to a total of 4 sprinklers. Adjoining corridors may be considered compartments for purposes of these calculations. In all cases the design area shall include the 4 most hydraulically demanding sprinklers. (*See Figure A-7-4.4.2.*)

7-4.4.3 The definition of compartment for use in 7-4.4.2 to determine the number of design sprinklers is a space 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.

7-4.4.4 Water Demand. The water demand for the dwelling unit shall be determined by multiplying the design discharge of 7-4.4.1 by the number of design sprinklers specified in 7-4.4.2.

7-4.4.5 Other Areas. When areas such as attics, basements, or other types of occupancies are outside of dwelling units but within the same structure, these areas shall be protected in accordance with all sections of this standard including appropriate water supply requirements of Table 2-2.1(b).

Chapter 8 Large-Drop Sprinklers

8-1 General.

8-1.1 Applications. This chapter provides requirements for the installation of large-drop sprinklers. Listed sprinklers other than large-drop sprinklers are not covered by this chapter.

8-1.2* Definition. Large-Drop Sprinkler. A listed large-drop sprinkler is characterized by a K factor between 11.0 and 11.5, and proven ability to meet prescribed penetration, cooling and distribution criteria prescribed in the large-drop sprinkler examination requirements. The deflector/discharge characteristics of the large-drop sprinkler generate large drops of such size and velocity as to enable effective penetration of the high-velocity fire plume.

8-1.3* Applicability.

8-1.3.1* Large-drop sprinklers are suitable for use with the hazards listed in Table A-8-3 and may be used in other specific hazard classifications and configurations only when proven by large-scale fire testing.

8-1.3.2 Requirements of this standard shall apply, except those portions dealing with subjects specifically addressed in this chapter.

8-2 Installation.

8-2.1 Operating Pressure.

8-2.1.1 Large-drop sprinkler systems shall be designed such that the minimum operating pressure is not less than 25 psi (1.7 bar), unless large-scale testing proves a lesser pressure to be adequate for a particular hazard.

8-2.1.2 For design purposes, 95 psi (6.5 bar) shall be the maximum discharge pressure used at the starting point of the hydraulic calculations.

8-2.2 Type of System.

8-2.2.1 Large-drop sprinkler systems shall be limited to wet-pipe or preaction systems.

8-2.2.2 Galvanized steel or copper pipe and fittings shall be used in preaction systems to avoid scale accumulation.

8-2.3 System Design.

8-2.3.1 Pipe shall be sized by hydraulic calculation.

8-2.3.2* The nominal diameter of branch line pipes (including riser nipples) shall be not less than 1¼ in. (33 mm) or greater than 2 in. (50 mm), except starter pieces, which may be 2½ in. (64 mm).

Exception: When branch lines are larger than 2 in., the sprinkler shall be supplied by a riser nipple to elevate the sprinkler 13 in. (330 mm) for 2½ in. pipe and 15 in. (38 mm) for 3 in. pipe. These dimensions are measured from the centerline of the pipe to the deflector. In lieu of this, sprinklers may be offset horizontally a minimum of 12 in. (305 mm).

8-2.4 Temperature Rating. Sprinkler temperature ratings shall be the same as those used in large-scale fire testing to determine the protection requirements for the hazard involved.

Exception: Sprinklers of intermediate and high temperature ratings shall be installed in specific locations as required by 3-16.6.3.

8-2.5* Spacing.

8-2.5.1* The area of coverage shall be limited to a minimum of 80 ft² (7.4 m²) and a maximum of 130 ft² (12.18 m²).

8-2.5.2 The distance between branch lines and between sprinklers on the branch lines shall be limited to not more than 12 ft (3.7 m) nor less than 8 ft (2.4 m).

Exception: Under open wood joist construction, the maximum distance shall be limited to 10 ft (3.0 m).

8-2.6 Clear Space Below Sprinklers. At least 36 in. (914 mm) shall be maintained between sprinkler deflectors and the top of storage.

8-2.7* Distance Below Ceiling. Sprinklers shall be positioned so that the tops of deflectors are in conformance with Table 8-2.7

8-2.8 Location of Sprinklers in Beam and Girder and Panel Construction.

8-2.8.1 Under beam and girder construction and under panel construction, the branch lines may run across the beams, but sprinklers shall be located in the bays and not under the beams.

Table 8-2.7 Minimum and Maximum Distance of Deflectors Below Ceiling for Various Construction Types

Construction Type[1]	Minimum Distance, In. (mm)	Maximum Distance, In. (mm)
Smooth ceiling and bar joist	6 (152)	8 (203)
Beam and girder	6 (152)	12 (305)
Panel up to 300 ft² (27.9m²)	6 (152)	14 (358)
Open wood joist	1 (25) below bottom of joists	6 (152) below bottom of joists

For SI Units: 1 in = 25.4 mm; 1 ft = 0.3048 m.
[1]See Chapter 4 for definitions of construction types.

8-2.8.2 The maximum distance of deflector above the bottom of beams shall be limited to the values specified in Chapter 4.

8-2.9* Obstruction in Piping.

8-2.9.1 Screens located in the inlet piping directly connected to rivers, lakes, ponds, reservoirs, uncovered tanks, and similar sources (*see NFPA 24, Standard for the Installation of Private Fire Service Mains and Their Appurtenances*) shall be cleaned and serviced at least annually and after any work has been performed on nearby underground mains.

8-2.9.2* Visual and/or flushing investigations shall be conducted of all systems for foreign material at intervals not exceeding five years.

8-2.10* Obstructions to Distribution.

8-2.10.1 Obstruction Located at the Ceiling. When sprinkler deflectors are located above the bottom of beams, girders, ducts, fluorescent lighting fixtures, or other obstructions located at the ceiling, the sprinklers shall be positioned so that the maximum distance from the bottom of the obstruction to the deflectors does not exceed the value specified in Chapter 4.

8-2.10.2 Obstructions Located Below the Sprinklers.

8-2.10.2.1 Sprinklers shall be positioned with respect to fluorescent lighting fixtures, ducts, and obstructions more than 24 in. (610 mm) wide and located entirely below the sprinklers so that the minimum horizontal distance from the near side of the obstruction to the center of the sprinkler is not less than the value specified in Table 8-2.10.2.1. (*See Figure 8-2.10.2.1.*)

Table 8-2.10.2.1 Position of Sprinklers in Relation to Obstructions Located Entirely Below the Sprinklers

Distance of Deflector Above Bottom of Obstruction	Minimum Distance to Side of Obstruction, ft (m)
Less than 6 in. (152 mm)	1½ (0.5)
6 in. (152 mm) to less than 12 in. (305 mm)	3 (0.9) 3 (0.9)
12 in. (305 mm) to less than 18 in. (457 mm)	4 (1.2)
18 in. (457 mm) to less than 24 in. (610 mm)	5 (1.5)

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

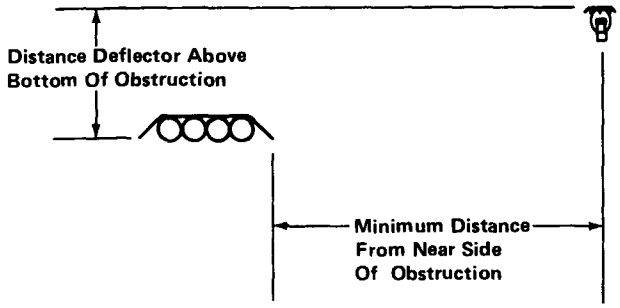


Figure 8-2.10.2.1 Position of Sprinklers in Relation to Obstructions Located Entirely below the Sprinklers (To be used with Table 8-2.10.2.1)

8-2.10.2.2 When the bottom of the obstruction is located 24 in. (610 mm) or more below the sprinkler deflectors:

(a) Sprinklers shall be positioned so that the obstruction is centered between adjacent sprinklers. (*See Figure 8-2.10.2.2.*)

(b) The obstruction shall be limited to a maximum width of 24 in. (610 mm). (*See Figure 8-2.10.2.2.*)

Exception: When obstruction is greater than 24 in. (610 mm) wide, one or more lines of sprinklers shall be installed below the obstruction.

(c) The obstruction shall not extend more than 12 in. (305 mm) to either side of the midpoint between sprinklers. (*See Figure 8-2.10.2.2.*)

Exception: When extensions exceed 12 in. (305 mm), one or more lines of sprinklers shall be installed below the obstruction.

(d) At least 18 in. (457 mm) clearance shall be maintained between the top of storage and the bottom of the obstruction. (*See Figure 8-2.10.2.2.*)

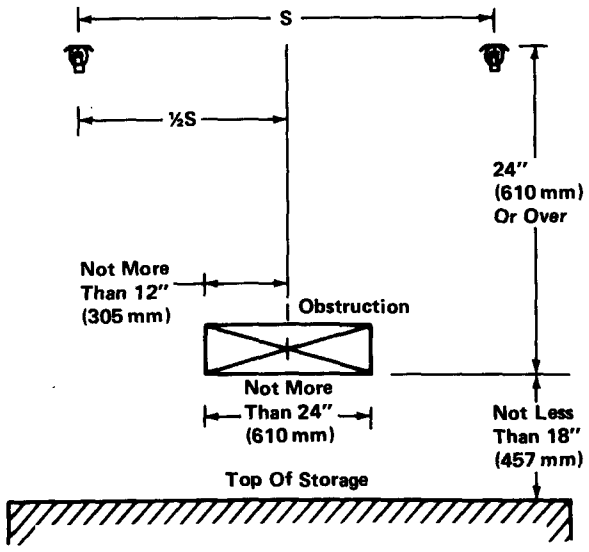


Figure 8-2.10.2.2 Position of Sprinklers in Relation to Obstructions Located 24 in. (610 mm) or More Below Deflectors

8-2.10.3 Obstructions Parallel to and Directly below Branch Lines. In the special case of an obstruction running parallel to and directly below a branch line:

(a) the sprinkler shall be located at least 36 in. (914 mm) above the top of the obstruction. (*See Figure 8-2.10.2.3.*)

(b) The obstruction shall be limited to a maximum width of 12 in. (305 mm). (*See Figure 8-2.10.2.3.*)

(c) The obstruction shall be limited to a maximum extension of 6 in. (152 mm) to either side of the centerline of the branch line. (*See Figure 8-2.10.2.3.*)

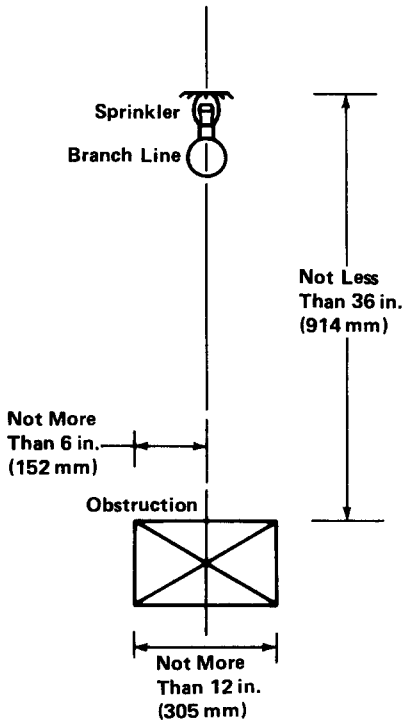


Figure 8-2.10.2.3 Position of Sprinklers in Relation to Obstructions Running Parallel to and Directly Below Branch Lines

8-3* Protection Requirements.

8-3.1* Protection shall be provided as specified in Table A-8-3 or appropriate NFPA standards in terms of minimum operating pressure and the number of sprinklers to be included in the design area.

Chapter 9 Referenced Publications

9-1 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 shall be the current edition as of the date of the NFPA issuance of this document. These references shall be listed separately to facilitate updating to the latest edition by the user.

9-1.1 NFPA Publications. National Fire Protection Association, Batterymarch Park, Quincy, MA 02269.

NFPA 13D-1985, *Installation of Sprinkler Systems for One- and Two-Family Dwellings and Mobile Homes*

NFPA 14-1986, *Installation of Standpipe and Hose Systems*

NFPA 20-1987, *Installation of Centrifugal Fire Pumps*

NFPA 22-1984, *Standard for Water Tanks for Private Fire Protection*

NFPA 24-1984, *Installation of Private Fire Service Mains and Their Appurtenances*

NFPA 51B-1984, *Standard for Fire Prevention in the Use of Cutting and Welding Processes*

NFPA 71-1985, *Standard for the Installation, Maintenance, and Use of Central Station Signaling Systems*

NFPA 72A-1985, *Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems for Guard's Tour, Fire Alarm, and Supervisory Service*

NFPA 72B-1986, *Standard for the Installation, Maintenance, and Use of Auxiliary Protective Signaling Systems*

NFPA 72C-1986, *Standard for the Installation, Maintenance, and Use of Remote Station Protective Signaling Systems*

NFPA 72D-1986, *Standard for the Installation, Maintenance, and Use of Proprietary Protective Signaling Systems*

NFPA 72E-1984, *Standard on Automatic Fire Detectors*

NFPA 81-1986, *Standard for Fur Storage, Fumigation and Cleaning*

NFPA 96-1984, *Standard on the Installation of Equipment for the Removal of Smoke and Grease Laden Vapors from Commercial Cooking Equipment*

NFPA 220-1985, *Standard on Types of Building Construction*

NFPA 231-1987, *Standard for Indoor General Storage*

NFPA 231C-1986, *Standard for Rack Storage of Materials*

NFPA 1963-1985, *Standard for Screw Threads and Gaskets for Fire Hose Connections.*

9-1.2 The following additional NFPA codes and standards contain specific sprinkler design criteria. (*See 2-2.1.3 and A-2-1.*)

NFPA 15-1985, *Standard for Water Spray Fixed Systems*

NFPA 16-1986, *Standard for the Installation of Deluge Foam-Water Sprinkler Systems and Foam-Water Spray Systems*

NFPA 43A-1980, *Code for the Storage of Liquid and Solid Oxidizing Materials*

NFPA 45-1986, *Standard on Fire Protection for Laboratories Using Chemicals*

NFPA 214-1983, *Standard on Water-Cooling Towers*

NFPA 231-1987, *Standard for Indoor General Storage*

NFPA 231C-1986, *Standard for Rack Storage of Materials*

NFPA 231D-1986, *Standard for Storage of Rubber Tires*

NFPA 231F-1986, *Standard for Storage of Roll Paper*

NFPA 307-1985, *Standard for Construction and Protection of Marine Terminals, Piers, and Wharves*

NFPA 409-1985, *Standard on Aircraft Hangars*

9-1.3 Other Codes and Standards.

9-1.3.1 ANSI Publications. American National Standards Institute, Inc., 1450 Broadway, New York, New York 10018.

ANSI B1-20.1-1983, *Pipe Threads, General Purpose*

ANSI B16.1-1975, *Cast-Iron Pipe Flanges and Flanged Fittings, Class 25, 125, 250 and 800*

ANSI B16.3-1977, *Malleable-Iron Threaded Fittings, Class 150 and 300*

ANSI B16.4-1977, *Cast-Iron Threaded Fittings, Class 125 and 250*

ANSI B16.5-1981, *Pipe Flanges and Flanged Fittings, Steel, Nickel, Alloy, and Other Special Alloys*

ANSI B16.9-1978, *Factory-Made Wrought Steel Butt-welding Fittings*

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

ANSI B16.18-1978, *Cast Copper Alloy Solder Joint Pressure Fittings*

ANSI B16.22-1980, *Wrought Copper and Copper Alloy Solder Joint Pressure Fittings*

ANSI B16.25-1979, *Buttwelding Ends*

ANSI B36.10-1979, *Welded and Seamless Wrought-Steel Pipe*

9-1.3.2 ASTM Publications. American Society for Testing and Materials, 1916 Race Street, Philadelphia, PA 19105.

ASTM 88-1981, *Specifications for Seamless Copper Water Tube*

ASTM A53-1980, *Specifications for Welded and Seamless Steel Pipe*

ASTM A120-1980, *Welded and Seamless Steel Pipe for Ordinary Uses, Specifications for Black and Hot-Dipped Zinc Coated (Galvanized)*

ASTM A234-1980, *Specifications for Piping Fittings of Wrought-Carbon Steel and Alloy for Moderate and Elevated Temperatures*

ASTM A795-1982, *Specification for Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection*

ASTM B32-1976, *Solder Metal, 95-5 (Tin-Antimony-Grade 95TA)*

ASTM B75-1981, *Specifications for Seamless Copper Tube*

ASTM B251-1976, *Specifications for General Requirements for Wrought Seamless Copper and Copper-Alloy Tube*

ASTM E380-1979, *Standard for Metric Practice*

9-1.3.3 AWS Publications. American Welding Society, 2501 N.W. 7th Street, Miami, FL 33125.

AWS A5.8-1981, *Specification for Brasing Filler Metal*

AWS D10.9-1980, *Qualification of Welding Procedures and Welders for Piping and Tubing*

Appendix A

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

A-1-3 A sprinkler system is considered to have a single system riser control valve.

A-1-5.1 Impairments. Before shutting off a section of the fire service system to make sprinkler system connections, notify the authority having jurisdiction, plan the work carefully, and assemble all materials to enable completion in the shortest possible time. Work started on connections should be rushed to completion without interruption, and protection restored as promptly as possible. During the impairment, provide emergency hose lines, additional fire pails and extinguishers, and maintain extra watch service in the areas affected.

When changes involve shutting off water from any considerable number of sprinklers for more than a few hours, temporary water supply connections should be made to sprinkler systems so that reasonable protection can be maintained. In adding to old systems or revamping them, protection should be restored each night so far as possible. The members of the private fire brigade as well as public fire department should be notified as to conditions.

A-1-7.1 Occupancy examples in the listings as shown in the various hazard classifications are intended to represent the norm for those occupancy types. Unusual or abnormal fuel loadings or combustible characteristics and susceptibility for changes in these characteristics, for a particular occupancy, are considerations that should be weighed in the selection and classification.

The Light Hazard classification is intended to encompass residential occupancies; however, this is not intended to preclude the use of listed residential sprinklers in residential occupancies or residential portions of other occupancies.

A-1-7.2.1 Light Hazard Occupancies include occupancies having conditions similar to:

Churches
Clubs
Eaves and overhangs, if combustible construction with no combustibles beneath
Educational
Hospitals
Institutional
Libraries, except large stack rooms
Museums
Nursing or Convalescent Homes
Office, including Data Processing

Residential
Restaurant seating areas
Theaters and Auditoriums excluding stages and prosceniums
Unused attics

A-1-7.3.1 Ordinary Hazard Occupancies (Group 1) include occupancies having conditions similar to:

Automobile parking garages
Bakeries
Beverage manufacturing
Canneries
Dairy products manufacturing and processing
Electronic plants
Glass and glass products manufacturing
Laundries
Restaurant service areas

A-1-7.3.2 Ordinary Hazard Occupancies (Group 2) include occupancies having conditions similar to:

Cereal Mills
Chemical Plants — Ordinary
Cold Storage warehouses
Confectionery products
Distilleries
Leather goods manufacturing
Libraries — large stack room areas
Machine shops
Metal working
Mercantiles
Printing and publishing
Textile manufacturing
Tobacco products manufacturing
Wood product assembly

A-1-7.3.3 Ordinary Hazard Occupancies (Group 3) include occupancies having conditions similar to:

Feed Mills
Paper and pulp mills
Paper process plants
Piers and wharves
Repair garages
Tire manufacturing
Warehouses (having moderate to higher combustibility of content, such as paper, household furniture, paint, general storage, whiskey, etc.)[1]
Wood machining

When hazards in those buildings or portions of buildings of this occupancy group are severe, the authority having jurisdiction should be consulted for special rulings regarding water supplies, types of equipment, pipe sizes, types of sprinklers, and sprinkler spacing.

A-1-7.4 New installations protecting Extra Hazard Occupancies should be hydraulically designed where standards giving design criteria are available.

A-1-7.4.1 Extra Hazard Occupancies (Group 1) include occupancies having conditions similar to:

Combustible Hydraulic Fluid use areas
Die Casting
Metal Extruding
Plywood and particle board manufacturing
Printing [using inks with below 100°F (37.8°C) flash points]
Rubber reclaiming, compounding, drying, milling, vulcanizing
Saw Mills
Textile picking, opening, blending, garnetting, carding, combining of cotton, synthetics, wool shoddy, or burlap
Upholstering with plastic foams

Extra Hazard Occupancies (Group 2) include occupancies having conditions similar to:

Asphalt saturating
Flammable liquids spraying
Flow coating
Mobile Home or Modular Building assemblies (where finished enclosure is present and has combustible interiors)
Open oil quenching
Solvent cleaning
Varnish and paint dipping

A-1-8 Sprinkler Systems in Buildings Subject to Flood. When sprinkler systems are installed in buildings subject to recurring floods, the location of control valves, alarm devices, dry-pipe valves, pumps, compressors, power and fuel supplies should be such that system operation will be uninterrupted by high water.

A-1-8.1.2 Under special conditions used equipment may be reused by the original owner, subject to the approval of the authority having jurisdiction. Second-hand alarm valves, retarding chambers, circuit closers, water-motor alarms, dry-pipe valves, quick-opening devices, and other devices may be used as replacement equipment in existing systems subject to the approval of the authority having jurisdiction.

[1]For high-piled storage as defined in 4-1.3.9, see Appendix D for separately published NFPA standards relating to water supply requirements, particularly NFPA 231, *Standard for Indoor General Storage*, and NFPA 231C, *Standard for Rack Storage of Materials*.

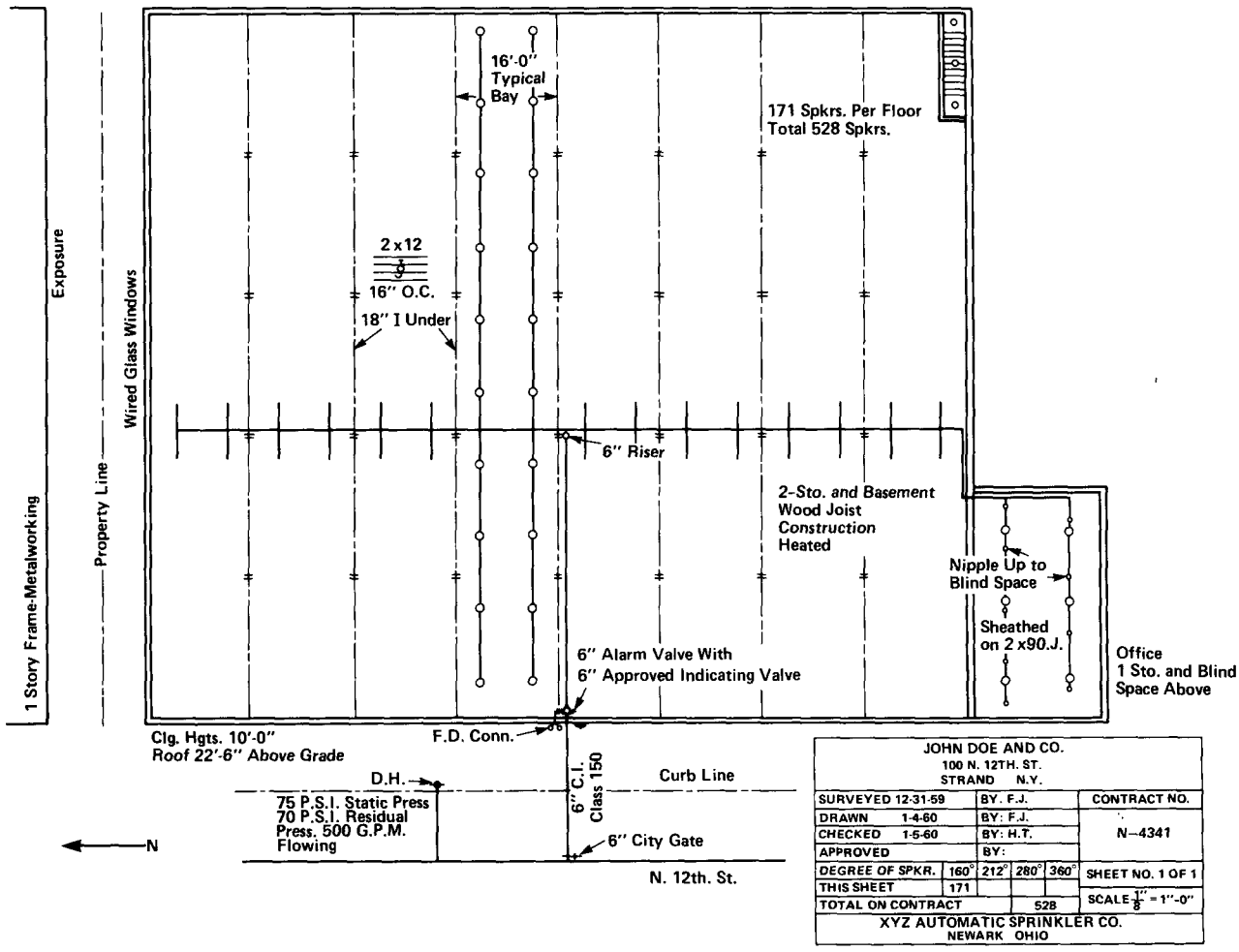


Figure A-1-9 Typical Preliminary Plan.

A-1-9 Preliminary layouts should be submitted for review to the authority having jurisdiction before any equipment is installed or remodeled in order to avoid error or subsequent misunderstanding. Any material deviation from approved plans will require permission of the authority having jurisdiction.

Preliminary layouts should show:

(a) Name of owner and occupant

(b) Location, including street address

(c) Point of compass

(d) Construction and occupancy of each building

NOTE: Date on special hazards should be submitted as they may require special rulings.

(e) Building height in feet

(f) If it is proposed to use a city main as a supply, whether the main is dead-end or circulating, size of the main and pressure in psi; and if dead-end, direction and distance to nearest circulating main

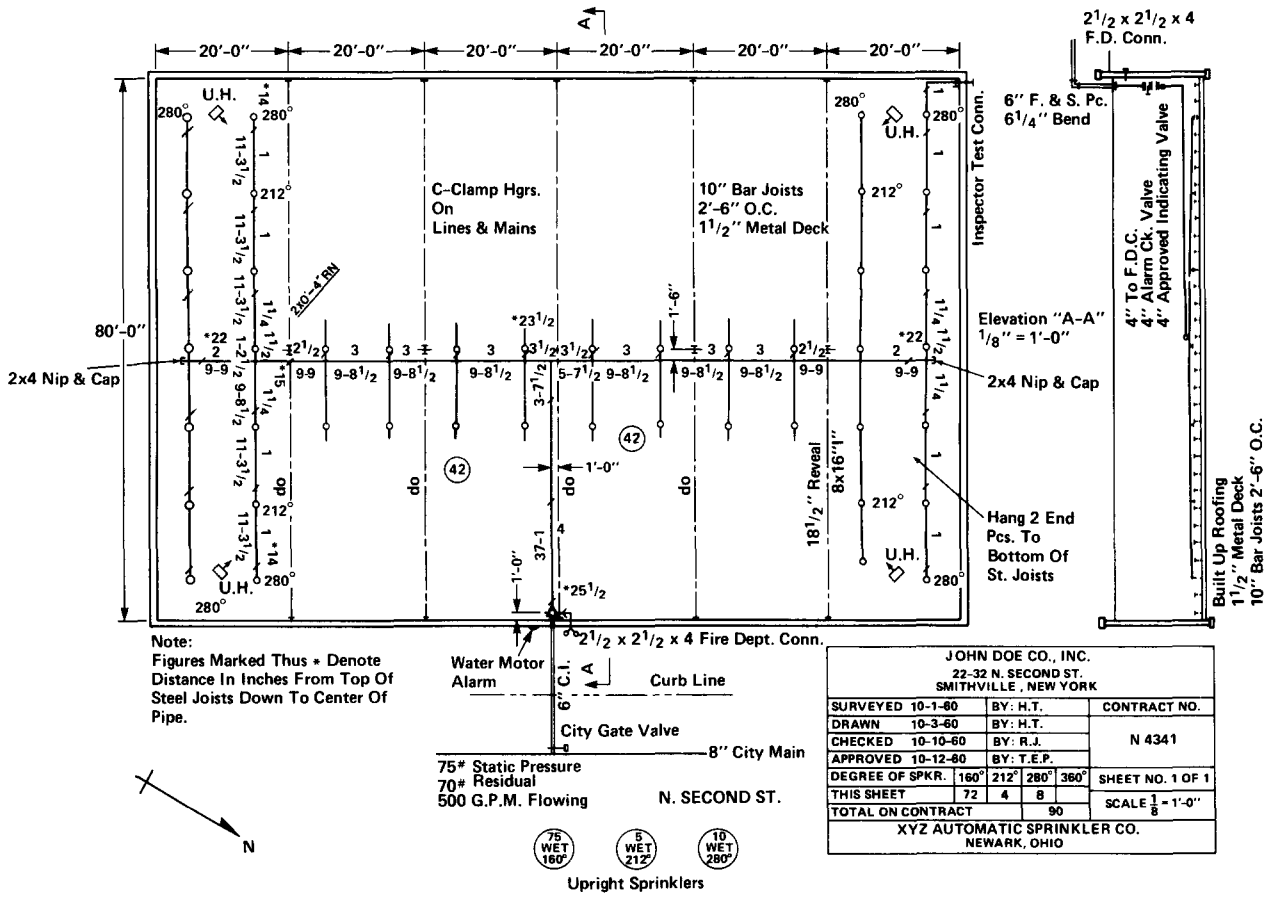


Figure A-1-9.2(a) Typical Working Plans

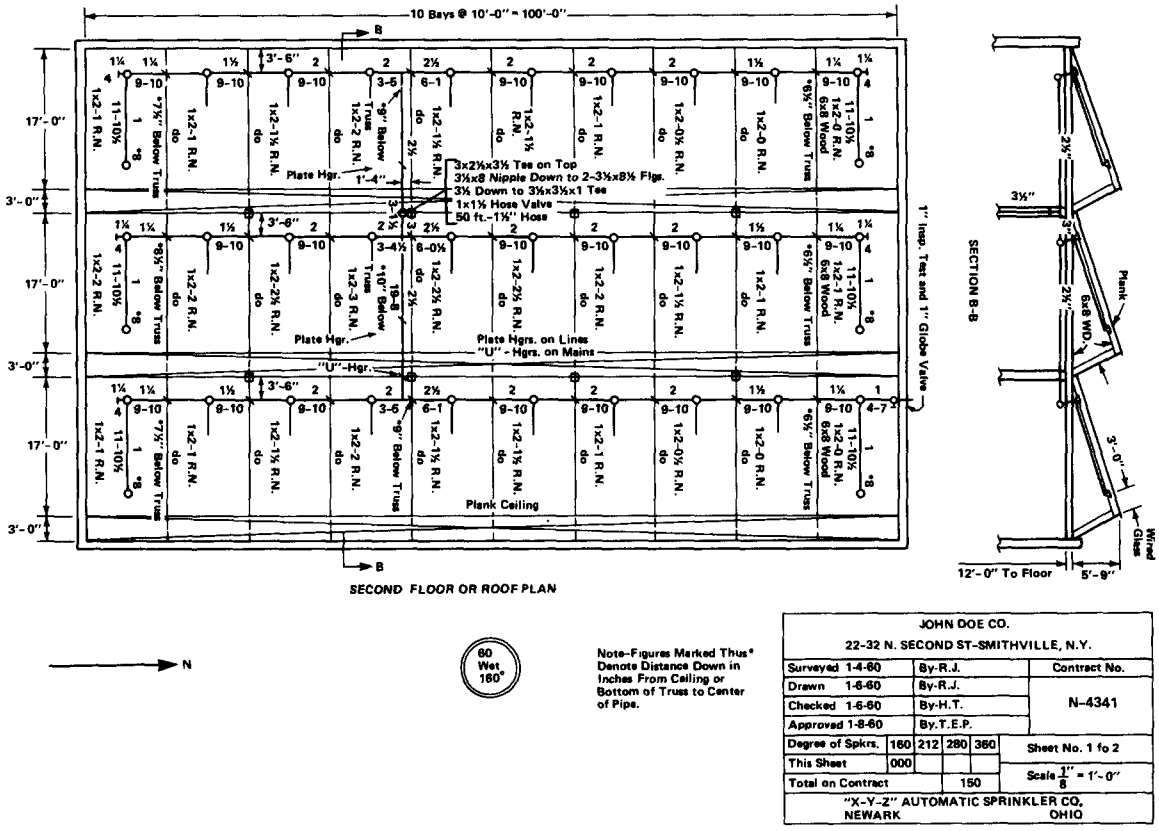
(g) Distance from nearest pumping station or reservoir

(h) In cases where reliable up-to-date information is not available, a water-flow test of the city main should be conducted in accordance with Appendix B-2-1.1. (The preliminary plan should specify who conducted the test, date and time, the location of the hydrants where flow was taken, and where static and residual pressure readings were recorded; the size of main supplying these hydrants, and the results of the test, giving size and number of open hydrant butts flowed; also data covering minimum pressure in the connection with the city main should be included.)

(i) Data covering waterworks systems in small towns in order to expedite the review of plans

(j) Fire walls, fire doors, unprotected window openings, large unprotected floor openings, and blind spaces

(k) Distance to and construction and occupancy of exposing buildings — e.g., lumber yards, brick mercantiles, fire-resistive office buildings, etc.



JOHN DOE CO. 22-32 N. SECOND ST-SMITHVILLE, N.Y.					
Surveyed 1-4-60	By-R.J.				Contract No.
Drawn 1-6-60	By-R.J.				N-4341
Checked 1-6-60	By-H.T.				
Approved 1-8-60	By.T.E.P.				
Degree of Spkrs.	160	212	280	360	Sheet No. 1 fo 2
This Sheet	000				Scale 1" = 1'-0"
Total on Contract				150	
"X-Y-Z" AUTOMATIC SPRINKLER CO. NEWARK OHIO					

Figure A-1-9.2(b) Typical Working Plans

(l) Spacing of sprinklers, number of sprinklers in each story or fire area and total number of sprinklers, number of sprinklers on each riser and on each system by floors, total area protected by each system on each floor, total number of sprinklers on each dry-pipe system or preaction or deluge system and if extension to present equipment, number of sprinklers on riser per floor, sprinklers already installed

(m) Capacities of dry-pipe systems with the bulk pipe included (*see Table A-5-2.3*), and if an extension is made to an existing dry-pipe system. The total capacity of the existing and also extended portion of the system

(n) Weight or class, size, and material of any proposed underground pipe

(o) Whether property is located in a flood area requiring consideration in the design of sprinkler system

(p) Name and address of party submitting the layout.

A-1-11.1

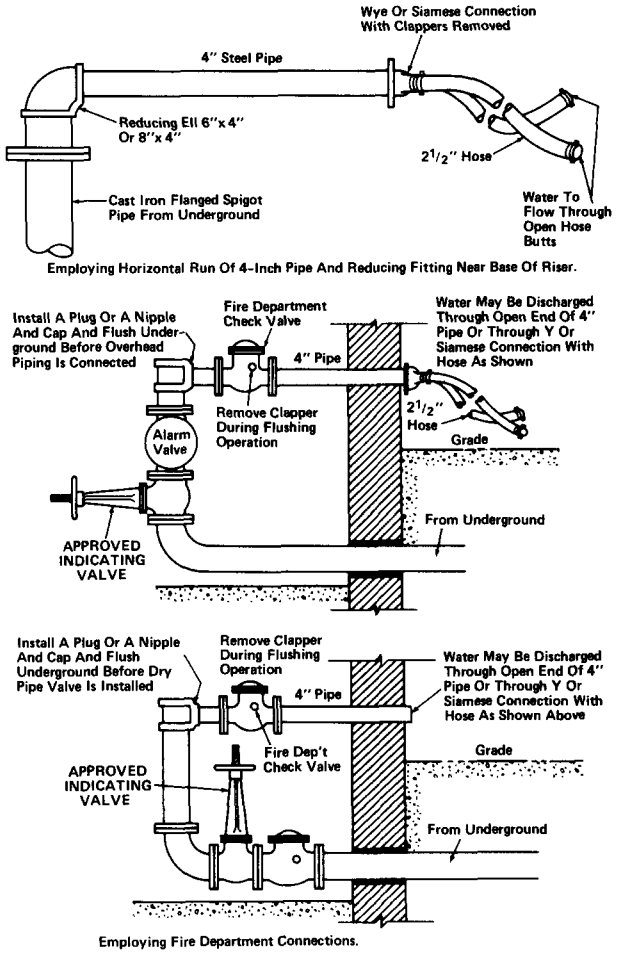


Figure A-1-11.1 Methods of Flushing Water Supply Connections.

A-1-11.1.2 Underground mains and lead-in connections to system risers should be flushed through hydrants at dead-ends of the system or through accessible aboveground flushing outlets allowing the water to run until clear. If water is supplied from more than one source or from a looped system, divisional valves should be closed to produce a high-velocity flow through each single line. The flows specified in Table 1-11.1.2 will produce a velocity of at least 6 ft/sec (1.8 m/s), which is necessary for cleaning the pipe and for lifting foreign material to an aboveground flushing outlet.

A-1-11.2.1 Example. A sprinkler system has for its water supply a connection to a public water service main. A 100 psi (6.9 bars) rated pump is installed in the connection. With a maximum normal public water supply of 70 psi (4.8 bars) at the low elevation point of the individual system or portion of the system being tested and a 120 psi (8.3 bars) pump (churn) pressure, the hydrostatic test pressure is 70 + 120 + 50 or 240 psi (16.5 bars).

Systems that have been modified or repaired to any appreciable extent should be hydrostatically tested at not less than 50 psi (3.4 bars) in excess of normal static pressure for 2 hours.

To reduce the possibility of serious water damage in case of a break, pressure may be maintained by a small pump, the main controlling gate meanwhile being kept shut during the test.

Polybutylene pipe will undergo expansion during initial pressurization. In this case a reduction in gage pressure may not necessarily indicate a leak. The pressure reduction should not exceed the manufacturer's specifications and listing criteria.

A-1-11.2.2 Valves isolating the section to be tested may not be "drop tight." When such leakage is suspected, test blanks of the type recommended in 1-11.2.5 should be used in a manner that includes the valve in the section being tested.

A-2-1 Water supplies should have adequate pressure, capacity, and reliability.

The water supply needed for various occupancies, including Extra Hazard Occupancies, is determined by evaluating the number of sprinklers that may be expected to operate from any one fire plus quantities needed simultaneously for hose streams.

Determination of the water supply needed for Extra Hazard Occupancies will require special consideration of four factors: (1) area of sprinkler operation, (2) density of discharge, (3) required time of discharge, and (4) amount of water needed simultaneously for hose streams.

When the occupancy presents a possibility of intense fires requiring extra heavy discharge, this may be obtained by an increase in the pressure and volume of the water supply, by a closer spacing of sprinklers, by the use of larger pipe sizing, or by a combination of these methods. In such cases, consideration should be given to hydraulically designed systems. (*See Chapter 7.*)

When separately published standards on various subjects contain specific provisions for water supplies, these should be consulted. (*See Chapter 9 for availability of standards.*)

A-2-2 The water supply requirement for sprinkler protection is determined by the number of sprinklers expected to operate in the event of fire. The primary factors affecting the number of sprinklers that might open are:

1. Occupancy
2. Combustibility of contents
3. Area shielded from proper distribution of water
4. Height of stock piles
5. Combustibility of construction (ceilings and blind spaces)
6. Ceiling heights and draft conditions
7. Horizontal and vertical cutoffs
8. Wet or dry sprinkler system
9. High water pressure
10. Housekeeping
11. Temperature rating of sprinklers
12. Water flow alarm and response thereto.

A-2-2.1.1 For occupancies with the potential for fast-spreading fire due to the presence of lint, combustible

residue, combustible hydraulic fluids under high pressure with ignition sources nearby, etc., the minimum area of operation should encompass the entire area likely to be involved in such a fire.

A-2-2.1.2.8 Corridors are rooms and should be considered as such. This section allows for calculation of the sprinklers in the largest room, so long as the calculation produces the greatest hydraulic demand among selection of rooms and communicating spaces. For example, in a case where the largest room has four sprinklers and a smaller room has two sprinklers but communicates through unprotected openings with three other rooms, each having two sprinklers, the smaller room and group of communicating spaces should also be calculated.

A-2-2.1.2.11 This section is included to compensate for possible delay in operation of sprinklers from fires in combustible concealed spaces found in wood frame, brick veneer, and ordinary construction.

A-2-3.1.1 Care should be taken in making water tests to be used in designing or evaluating the capability of sprinkler systems. The water supply tested should be representative of the supply that may be available at the time of a fire. For example, testing of public water supplies should be done at times of normal demand on the system. Public water supplies are likely to fluctuate widely from season to season and even within a 24-hour period. Allowance should be made for seasonal or daily fluctuations, for drought conditions, for possibility of interruption by flood, or for ice conditions in winter. Testing of water supplies also normally used for industrial use should be done while water is being drawn for industrial use. The range of industrial-use demand should be taken into account.

Future changes in water supplies should be considered. For example a large, established, urban supply is not likely to change greatly within a few years. However, the supply in a growing suburban industrial park may deteriorate quite rapidly as greater numbers of plants draw more water.

A-2-3.2 In private underground piping systems for buildings of other than Light Hazard Occupancy, any dead-end pipe supplying both sprinklers and hydrants should not be less than 8 in. in size. Also see NFPA 24, *Standard for the Installation of Private Fire Service Mains and Their Appurtenances.*

A-2-5.1 An automatically controlled vertical turbine pump taking suction from a reservoir, pond, lake, river, or well complies with 2-5.1.

A-2-5.2 See sections dealing with sprinkler equipment supervisory and water flow alarm services in NFPA 71, *Standard for the Installation, Maintenance, and Use of Central Station Signaling Systems*, NFPA 72A, *Standard for the Installation, Maintenance, and Use of Local Protective Signaling Systems for Guard's Tour Fire Alarm, and Supervisory Service*, NFPA 72B, *Standard for the Installation, Maintenance, and Use of Auxiliary Protective Signaling Systems for Fire Alarm Service*, NFPA 72C, *Standard for Remote Station Protective Signaling Systems*, or NFPA 72D, *Standard for the Installation, Maintenance, and Use Proprietary Protective Signaling Systems.*

A-2-6.3 The air pressure to be carried and the proper proportion of air in the tank may be determined from the following formulas, in which,

P = Air pressure carried in pressure tank.
A = Proportion of air in tank.
H = Height of highest sprinkler above tank bottom.

When tank is placed above highest sprinkler

$$P = \frac{30}{A} - 15.$$

A = ⅓ then P = 90 − 15 = 75 lbs per sq in.
A = ½ then P = 60 − 15 = 45 lbs per sq in.
A = ⅔ then P = 45 − 15 = 30 lbs per sq in.

When tank is below level of the highest sprinkler

$$P = \frac{30}{A} - 15 + \frac{0.434H}{A}$$

A = ⅓ then P = 75 + 1.30H.
A = ½ then P = 45 + 0.87H.
A = ⅔ then P = 30 + 0.65H.

The respective air pressures above are calculated to ensure that the last water will leave the tank at a pressure of 15 psi (1.03 bars) when the base of the tank is on a level with the highest sprinkler, or at such additional pressure as is equivalent to a head corresponding to the distance between the base of the tank and the highest sprinkler when the latter is above the tank.

The final pressure required at the pressure tank for systems designed from Table 2-2.1(b) will normally be higher than the 15 psi (1.03 bars) anticipated in the previous paragraph. The following formula should be used to determine the tank pressure and ratio of air to water in hydraulically designed systems.

$$P_i = \frac{P_f + 15}{A} - 15$$

where
P_i = Tank pressure
P_f = Pressure required from hydraulic calculations
A = Proportion of air

Example: Hydraulic calculations indicate 75 psi is required to supply the system. What tank pressure will be required?

$$P_i = \frac{75 + 15}{.5} - 15$$

$$P_i = 180 - 15 = 165 \text{ psi}$$

For SI Units: 1 ft = 0.3048 m; 1 psi = 0.0689 bar.

In this case the tank would be filled with 50 percent air and 50 percent water and the tank pressure would be 165 psi (11.4 bars). If the pressure is too high the amount of air carried in the tank will have to be increased.

Location of Pressure Tanks. Pressure tanks should be located above the top level of sprinklers but may be located in the basement or elsewhere.

A-2-7.1 The fire department connection should be located not less than 18 in. (457 mm) and not more than 5 ft (1.5 m) above the level of the adjacent grade or access level.

A-2-7.2 For hydraulically designed sprinkler systems, the size of the fire department connection should be sufficient to supply the sprinkler water demand developed from Table 2-2.1(b).

A-2-7.3 Fire department connections should be located and arranged so that hose lines can be readily and conveniently attached without interference from nearby objects including buildings, fences, posts, or other fire department connections. When a hydrant is not available, other water supply sources such as a natural body of water, a tank, or reservoir should be utilized. The water authority should be consulted when a nonpotable water supply is proposed as a suction source for the fire department.

A-2-8.2 When the system riser is close to an outside wall, underground fittings of proper length should be used in order to avoid pipe joints located in or under the wall. When the connection passes through the foundation wall below grade, a 1- to 3-in. (25- to 76-mm) clearance should be provided around the pipe and the clear space filled with asphalt mastic or similar flexible waterproofing material. (*Also see Appendix B-3-1.*)

A-2-9.1

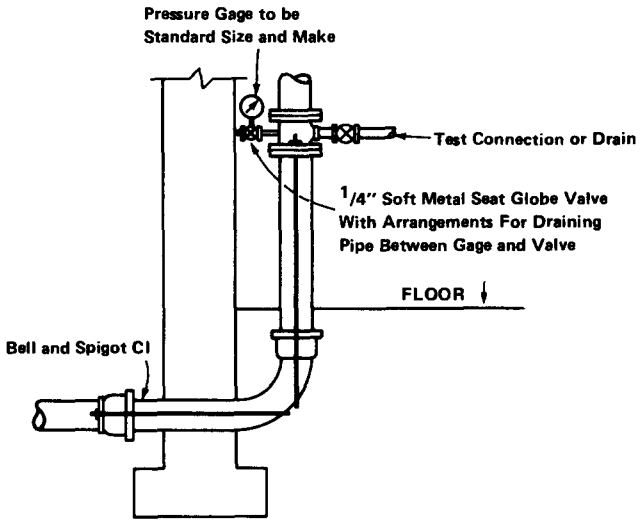


Figure A-2-9.1 Test Connection on Water Supply with Outside Control. (Also applicable to an interior riser.)

A-3-1.1.5 The investigation of pipe and tube other than that described in Table 3-1.1.1 should involve consideration of many factors:

(a) Pressure rating.

(b) Beam strength (hangers).

(c) Unsupported vertical stability.

(d) Movement during sprinkler operation (affecting water distribution).

(e) Corrosion (internal and external; chemical and electrolytic).

(f) Resistance to failure when exposed to elevated temperatures.

(g) Methods of joining (strength, permanence, fire hazard).

(h) Physical characteristics related to integrity during earthquakes.

A-3-4 Long Runs of Pipe. When the construction or conditions introduce unusually long runs of pipe or many angles in risers or feed mains, an increase in pipe size over that called for in the schedules may be required to compensate for increased friction losses.

A-3-5.3.1 For example, a 2½-in. (64-mm) steel pipe, which is permitted to supply 30 sprinklers, may supply a total of 50 sprinklers where not more than 30 sprinklers are above or below a ceiling.

A-3-6.3.1 For example, a 3-in. (76-mm) steel pipe, which is permitted to supply 40 sprinklers in an ordinary hazard area, may supply a total of 60 sprinklers when not more than 40 sprinklers protect the occupied area.

A-3-8.6 One and one-half (1½) in. hose connections for use in storage occupancies and other locations where standpipe systems are not required are covered by this standard. When Class II standpipe systems are required see the appropriate provisions of NFPA 14, *Standard for the Installation of Standpipe and Hose Systems*, with respect to hose stations and water supply for hose connections from sprinkler systems.

A-3-8.7 Combined automatic sprinkler and standpipe risers should not be interconnected by sprinkler system piping.

A-3-9.1.1 This test connection should be in the upper story, and the connection should preferably be piped from the end of the most remote branch line. The discharge should be at a point where it can be readily observed. In locations where it is not practical to terminate the test connection outside the building, the test connection may terminate into a drain capable of accepting full flow under system pressure. (*See A-3-11.4.1.*) In this event, the test connection should be made using an approved sight test connection containing a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler simulating the least flow from an individual sprinkler in the system. [*See Figures A-3-9.1.1(a) and A-3-9.1.1(b).*] The test valve should be located at an accessible point, and preferably not over 7 ft (2.1 m) above the floor. The control valve on the test connection should be located at a point not exposed to freezing.

A-3-10 Protection of Piping Against Damage Due to Impact. Sprinkler piping should be located so as to minimize the possibility of damage due to impact by mobile material handling equipment and other vehicles.

Table A-3-1.1.2 Steel Pipe Dimensions

Nominal Pipe Size in.	Outside Diameter in.	(mm)	Schedule 10[1] Inside Diameter in.	(mm)	Wall Thickness in.	(mm)	Schedule 30 Inside Diameter in.	(mm)	Wall Thickness in.	(mm)	Schedule 40 Inside Diameter in.	(mm)	Wall Thickness in.	(mm)
1	1.315	(33.4)	1.097	(27.9)	0.109	(2.8)	—	—	—	—	1.049	(26.6)	0.133	(3.4)
1¼	1.660	(42.2)	1.442	(36.6)	0.109	(2.8)	—	—	—	—	1.380	(35.1)	0.140	(3.6)
1½	1.900	(48.3)	1.682	(42.7)	0.109	(2.8)	—	—	—	—	1.610	(40.9)	0.145	(3.7)
2	2.375	(60.3)	2.157	(54.8)	0.109	(2.8)	—	—	—	—	2.067	(52.5)	0.154	(3.9)
2½	2.875	(73.0)	2.635	(66.9)	0.120	(3.0)	—	—	—	—	2.469	(62.7)	0.203	(5.2)
3	3.500	(88.9)	3.260	(82.8)	0.120	(3.0)	—	—	—	—	3.068	(77.9)	0.216	(5.5)
3½	4.000	(101.6)	3.760	(95.5)	0.120	(3.0)	—	—	—	—	3.548	(90.1)	0.226	(5.7)
4	4.500	(114.3)	4.260	(108.2)	0.120	(3.0)	—	—	—	—	4.026	(102.3)	0.237	(6.0)
5	5.563	(141.3)	5.295	(134.5)	0.134	(3.4)	—	—	—	—	5.047	(128.2)	0.258	(6.6)
6	6.625	(168.3)	6.357	(161.5)	0.134[2]	(3.4)	—	—	—	—	6.065	(154.1)	0.280	(7.1)
8	8.625	(219.1)	8.249	(209.5)	0.188[2]	(4.8)	8.071	(205.0)	0.277	(7.0)	—	—	—	—
10	10.75	(273.1)	10.37	(263.4)	0.188[2]	(4.8)	10.14	(257.6)	0.307	(7.8)	—	—	—	—

NOTE 1: Schedule 10 defined to 5 in. (127 mm) nominal pipe size by ASTM A 135.
NOTE 2: Wall thickness specified in 3-1.1.2.

Table A-3-1.1.4 Copper Tube Dimensions

Nominal Tube Size in.	Outside Diameter in.	(mm)	Type K Inside Diameter in.	(mm)	Wall Thickness in.	(mm)	Type L Inside Diameter in.	(mm)	Wall Thickness in.	(mm)	Type M Inside Diameter in.	(mm)	Wall Thickness in.	(mm)
¾	0.875	(22.2)	0.745	(18.9)	0.065	(1.7)	0.785	(19.9)	0.045	(1.1)	0.811	(20.6)	0.032	(0.8)
1	1.125	(28.6)	0.995	(25.3)	0.065	(1.7)	1.025	(26.0)	0.050	(1.3)	1.055	(26.8)	0.035	(0.9)
1¼	1.375	(34.9)	1.245	(31.6)	0.065	(1.7)	1.265	(32.1)	0.055	(1.4)	1.291	(32.8)	0.042	(1.1)
1½	1.625	(41.3)	1.481	(37.6)	0.072	(1.8)	1.505	(38.2)	0.060	(1.5)	1.527	(38.8)	0.049	(1.2)
2	2.125	(54.0)	1.959	(49.8)	0.083	(2.1)	1.985	(50.4)	0.070	(1.8)	2.009	(51.0)	0.058	(1.5)
2½	2.625	(66.7)	2.435	(61.8)	0.095	(2.4)	2.465	(62.6)	0.080	(2.0)	2.495	(63.4)	0.065	(1.7)
3	3.125	(79.4)	2.907	(73.8)	0.109	(2.8)	2.945	(74.8)	0.090	(2.3)	2.981	(75.7)	0.072	(1.8)
3½	3.625	(92.1)	3.385	(86.0)	0.120	(3.0)	3.425	(87.0)	0.100	(2.5)	3.459	(87.9)	0.083	(2.1)
4	4.125	(104.8)	3.857	(98.0)	0.134	(3.4)	3.905	(99.2)	0.110	(2.8)	3.935	(99.9)	0.095	(2.4)
5	5.125	(130.2)	4.805	(122.0)	0.160	(4.1)	4.875	(123.8)	0.125	(3.2)	4.907	(124.6)	0.109	(2.8)
6	6.125	(155.6)	5.741	(145.8)	0.192	(4.9)	5.845	(148.5)	0.140	(3.6)	5.881	(149.4)	0.122	(3.1)
8	8.125	(206.4)	7.583	(192.6)	0.271	(6.9)	7.725	(196.2)	0.200	(5.1)	7.785	(197.7)	0.170	(4.3)
10	10.13	(257.3)	9.449	(240.0)	0.338	(8.6)	9.625	(244.5)	0.250	(6.4)	9.701	(246.4)	0.212	(5.4)

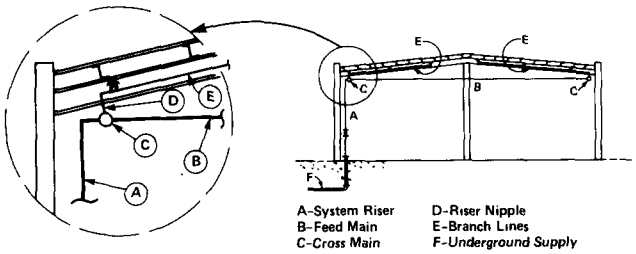


Figure A-3-2 Building Elevation Showing Parts of Sprinkler Piping System.

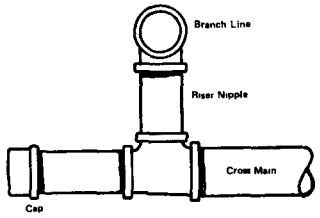


Figure A-3-8.2(a) Screw-type Cap.

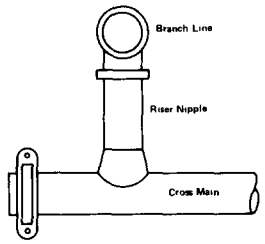
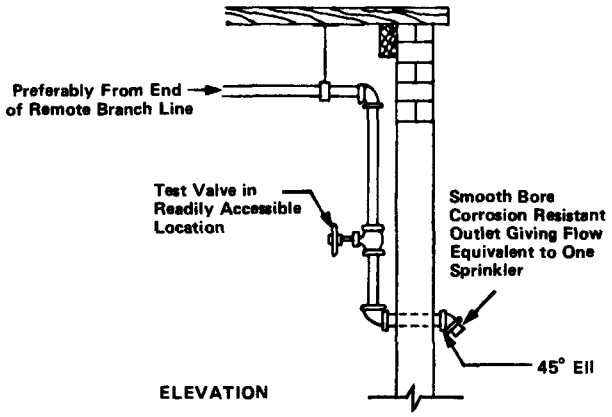


Figure A-3-8.2(b) Groove-type Cap.



For SI Units: 1 ft = 0.3048 m.
NOTE: Not Less Than 4ft (1.2 m) of Exposed Test Pipe in Warm Room Beyond Valve When Pipe Extends Through Wall to Outside.

Figure A-3-9-1.1(a) System Test Connection on Wet-Pipe System.

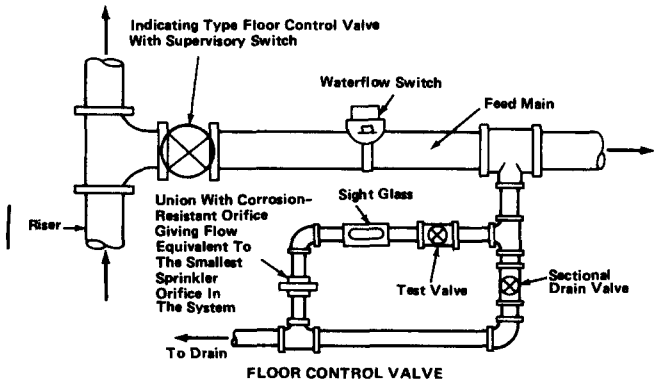
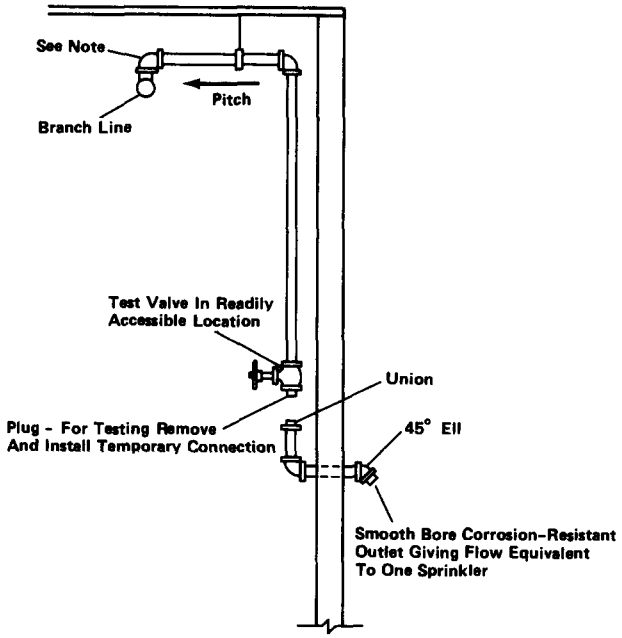


Figure A-3-9.1.1(b) Floor Control Valve.

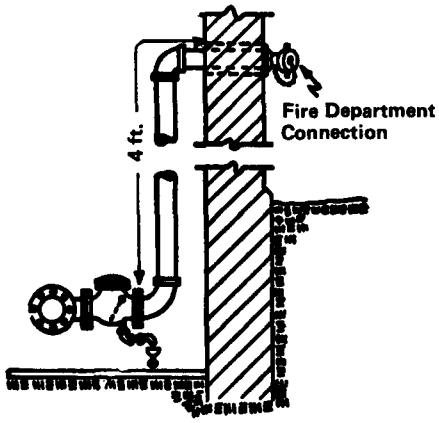


NOTE: To minimize condensation of water in the drop to the test connection, provide a nipple-up off of the branch line.

Figure A-3-9.2 System Test Connection on Dry-Pipe System.

For example, risers adjacent to structural columns and out of vehicle travel routes are generally safe, as are feed mains and cross mains shielded by heavy structural members such as girders.

A-3-10.1.2 In areas subject to freezing climates, when piping extends through an exterior wall, as for fire department connections, system test connection, or drains, a minimum of 4 ft (1.2 m) of pipe should be maintained between the wall and the section of piping containing water.



For SI Units: 1 ft = 0.3048 m.

Figure A-3-10.1.2 Minimum Clearance to Avoid Freezing

A-3-10.2.1 Types of locations where corrosive conditions may exist include bleacheries, dye-houses, metal-plating processes, animal pens, and certain chemical plants.

If corrosive conditions are not of great intensity and humidity is not abnormally high, good results can be obtained by a protective coating of red lead and varnish or by a good grade of commercial acid-resisting paint. The paint manufacturer's instructions should be followed in the preparation of the surface and in the method of application.

Where moisture conditions are severe but corrosive conditions are not of great intensity, copper tube or galvanized steel pipe, fittings, and hangers may be suitable. The threaded ends of steel pipe should be painted.

In instances where the piping is not readily accessible and where the exposure to corrosive fumes is severe, either a protective coating of high quality may be employed or some form of corrosion-resistant material used.

A-3-10.2.3 It is important when protected steel pipe (galvanized, dipped and wrapped, coated, etc.) is used that particular care is taken to see that all exposed threads, wrench marks, or abrasions that have penetrated through the protection be repaired, sealed, and/or properly coated.

A-3-10.3 Protection of Piping Against Damage Where Subject to Earthquakes.

A-3-10.3.1 Sprinkler systems are protected against earthquake damage by means of the following:

(a) Stresses that would develop in the piping due to differential building movement are minimized through the use of flexible joints or clearances.

(b) Bracing is used to keep the piping fairly rigid when supported from a building component expected to move as a unit, such as a ceiling.

Areas known to have a potential for earthquakes have been identified in building code and insurance maps. An example of such a map is shown in Figure A-3-10.3.1.

A-3-10.3.2 Strains on sprinkler piping can be greatly lessened and, in many cases, damage prevented by increasing the flexibility between major parts of the sprinkler system. One part of the piping should never be held rigidly and another part allowed to move freely without provision for relieving the strain. Flexibility can be provided by use of listed flexible couplings, joining grooved end pipe at critical points and by allowing clearances at walls and floors.

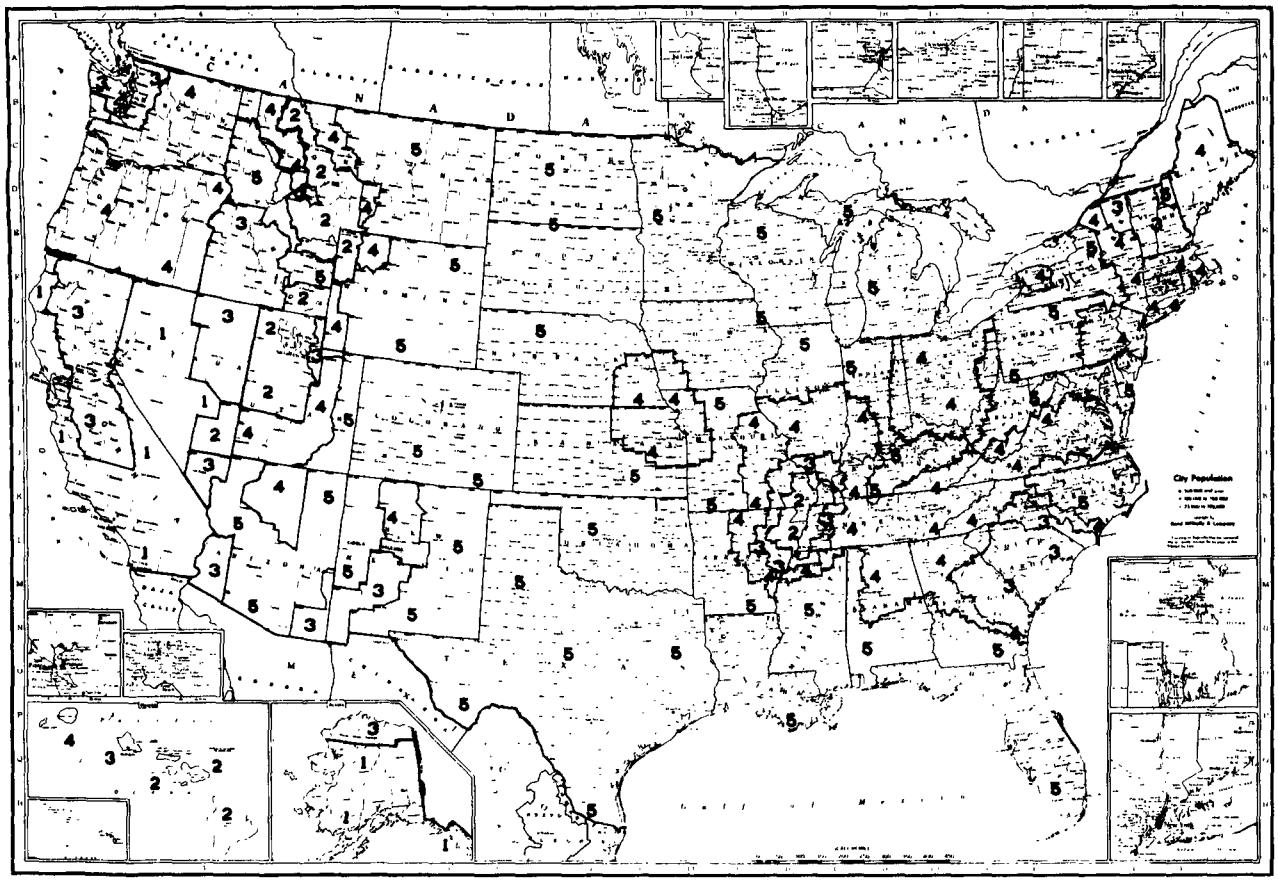
Tank or pump risers should be treated the same as sprinkler risers for their portion within a building. The discharge pipe of tanks on buildings should have a control valve above the roof line so any pipe break within the building can be controlled.

Piping 3 in. (76 mm) or smaller in size is pliable enough so that flexible couplings are not usually necessary.

A-3-10.3.2(d) Sprinkler piping above ground level may cross structural separations such as expansion joints if the piping is specifically designed with flexible connections at each crossing and able to accommodate the calculated differential motions during earthquakes, but not less than 4 in. (102 mm). In lieu of calculations, flexibility can be made at least twice the actual separations at right angles to the separation as well as parallel to it.

A building expansion joint is usually a bituminous fiber strip used to separate blocks or units of concrete to prevent cracking due to expansion as a result of temperature changes. In this case, the flexible coupling required on one side by section 3-10.3.2(d) will suffice.

For seismic separation joints, considerably more flexibility is needed, particularly for piping above the first



ISO EARTHQUAKE ZONES

1—Maximum potential for earthquake damage

2—Reasonable potential

3—Slight potential

Figure A-3-10.3.1 Seismic Map.

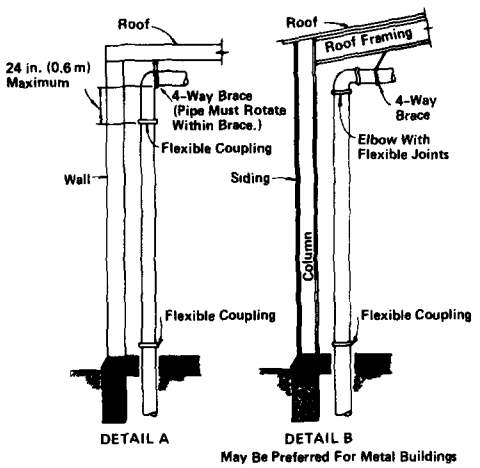


Figure A-3-10.3.2(a) Riser Details.

Note to Detail A: The four-way brace should be attached above the upper flexible coupling required for the riser, and preferably to the roof structure if suitable. The brace should not be attached directly to a plywood or metal deck.

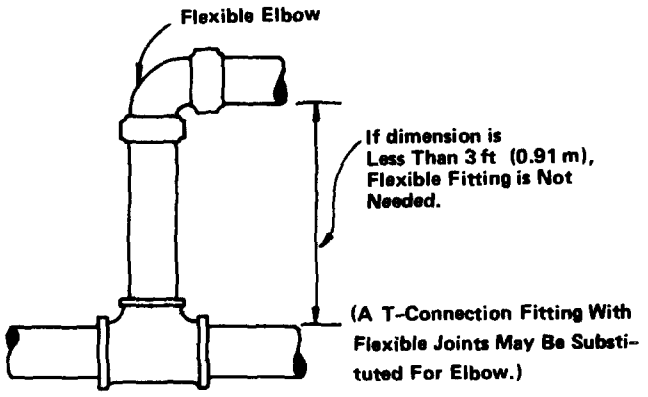


Figure A-3-10.3.2(b) Detail at Short Riser.

floor. The following figure shows a method of providing additional flexibility through the use of swing joints.

A-3-10.3.3 Plan and elevation views of a swing joint assembled with flexible elbows are shown in Figure A-3-10.3.2(d).

A-3-10.3.4 While clearances are necessary around the sprinkler piping to prevent breakage due to building movement, suitable provision should also be made to prevent passage of water, smoke, or fire.

Drains, fire department connections, and other auxiliary piping connected to risers should not be cemented into walls or floors; similarly, pipes that pass horizontally through walls or foundations should not be cemented solidly or strains will accumulate at such points.

When risers or lengths of pipe extend through suspended ceilings, they should not be fastened to the ceiling framing members.

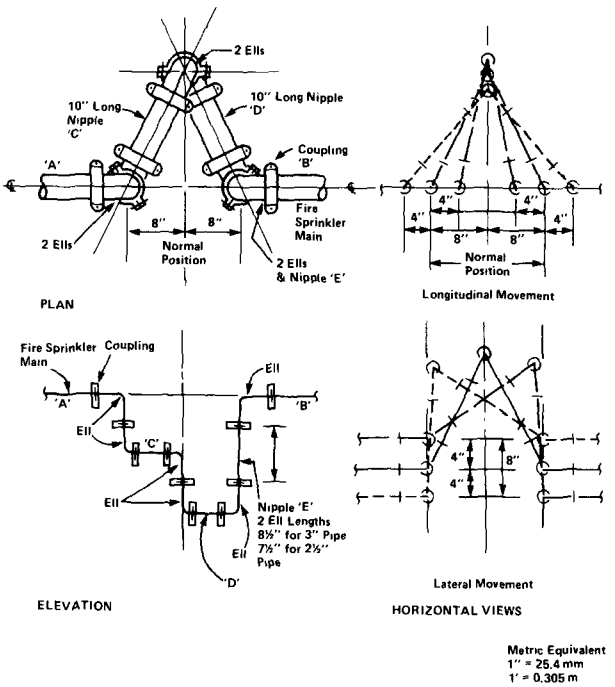


Figure A-3-10.3.2(d) Seismic Flexible Joint.

A-3-10.3.5 Sway Bracing.

Location of Bracing. [*See Figure A-3-10.3.5(a).*]

Two-way braces are either longitudinal or lateral depending on their orientation with the axis of the piping. [*See Figures A-3-10.3.5(a), (b), (c), and (d)*]. The simplest form of two-way brace is a piece of steel pipe or angle. Because the brace must act in both compression and tension, it is necessary to size the brace to prevent buckling.

An important aspect of sway bracing is its location.

In Building 1, the relatively heavy main will pull on the branch lines when shaking occurs. If the branch lines are held rigidly to the roof or floor above, the fittings can fracture due to the induced stresses.

Bracing should be on the main as indicated at Location B. With shaking in the direction of the arrows, the light branch lines will be held at the fittings. When a branch line can pound against a piece of equipment, such as a space heater or a structural member, a lateral brace should be installed on the branch line to help prevent rupture.

A four-way brace is indicated at Location A [*also see Figure A-3-10.3.2(a)*]. This keeps the riser and main lined up and also prevents the main from shifting.

In Building 1, the branch lines are flexible in a direction parallel to the main, regardless of building movement. The heavy main cannot shift under the roof or floor, and it also steadies the branch lines.

While the main is braced, the flexible couplings on the riser allow the sprinkler system to move with the floor or roof above, relative to the floor below.

Figures A-3-10.3.5(b), (c), and (d) show typical locations of sway bracing for pipe schedule, gridded, and looped sprinkler systems.

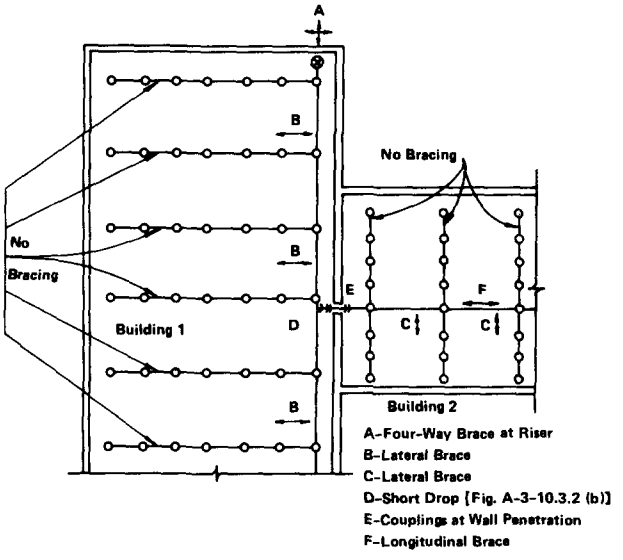


Figure A-3-10.3.5(a) Earthquake Protection for Sprinkler Piping.

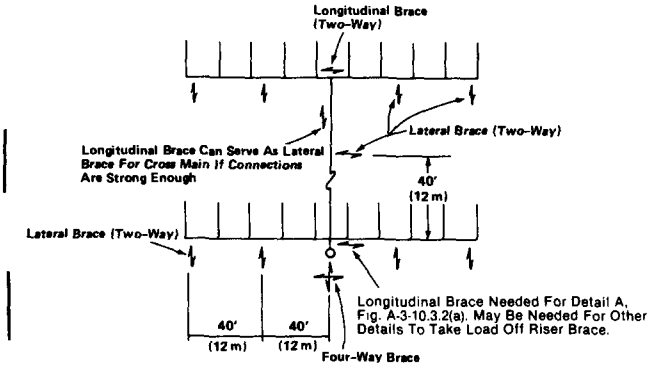


Figure A-3-10.3.5(b) Typical Location of Bracing on a Pipe Schedule System.

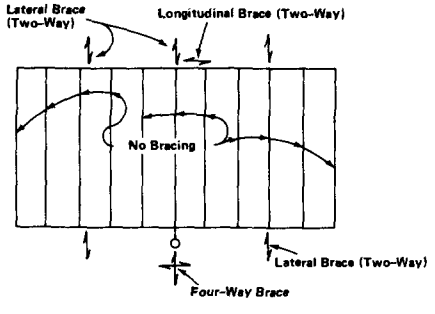


Figure A-3-10.3.5(c) Typical Location of Bracing on a Gridded System.

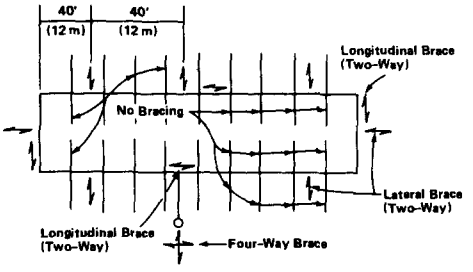


Figure A-3-10.3.5(d) Typical Location of Bracing on a Looped System.

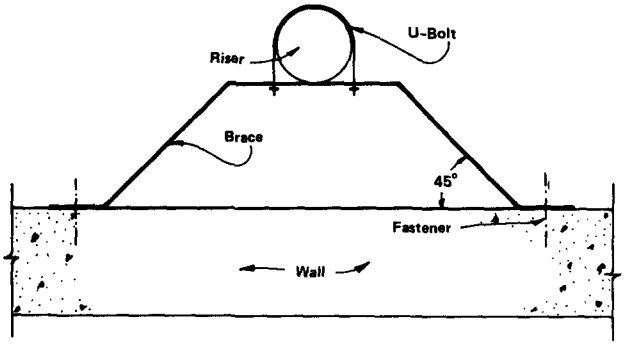


Figure A-3-10.3.5(e) Detail of Four-Way Brace at Riser.

A-3-10.3.5.1 Details of Bracing.

In the design of sway braces, the slenderness ratio l/r must not exceed 200 where l is the distance between the center lines of support and r is the least radius of gyration, both in inches (mm).

Sway bracing should be tight and concentric. Details should be laid out in advance so that suitable fittings are available on the job site. All parts and fittings of a brace should lie in a straight line to avoid eccentric loading on fittings and fasteners. [*See Figure A-3-10.3.5.1(a).*]

Connection to the pipe can be made with a pipe clamp or U-bolt. One bolt of the pipe clamp can pass through a flattened end of pipe or one leg of an angle. (The other leg and filet of the angle can be cut away.) Pipe rings should be avoided because they result in a loose fit. Once the pipe is able to vibrate within a loose fitting, the bolts in the ring assembly can be fractured.

The brace should not be connected to a tab welded to the pipe.

The brace can be attached to the structural system directly through a leg of an angle or a flattened portion of pipe. Where dimensions are tight or some play must be allowed, a special fitting can be used [*see Figure A-3-10.3.5.1(b)*]. This threads on an end of pipe. Rotation of the flat around the bolt allows play in the angle of the brace without sacrificing snugness.

Some adjustment can be provided in a pipe brace by use of a left-hand/right-hand coupling. However, this adds to the cost of earthquake protection, and care should be taken that sufficient thread is engaged or else the threads will shear.

To properly size and space braces, it is necessary to employ the following steps:

(a) Based on the distance of mains from the structural members that will support the braces, choose brace shapes and sizes from Table 1 such that the maximum slenderness ratios l/r do not exceed 200. The angle of the braces from the vertical should be at least 30 degrees, and preferably 45 degrees or more.

(b) Tentatively space lateral braces at 40 ft (12 m) maximum distances along mains and tentatively space longitudinal braces at 80 ft (24 m) maximum distances along mains. Lateral braces should meet the piping at right angles, and longitudinal braces should be aligned with the piping.

(c) Determine the total load tentatively applied to each brace in accordance with the examples shown in Figure A-3-10.3.5.1(c) and the following:

1. For the loads on lateral braces on cross mains, add one-half the weight of branch to one-half the weight of the portion of the cross main within the zone of influence of the brace. [*See examples 1, 3, 6, and 7 in Figure A-3-10.3.5.1(c).*]

2. For the loads on longitudinal braces on cross mains, consider only one-half the weight of the cross mains and feed mains within the zone of influence. [*See examples 2, 3, 5, and 8 in Figure A-3-10.3.5.1(c).*]

3. For the four-way brace at the riser, add the longitudinal and lateral loads within the zone of influence of the brace. [*See examples 2, 3, 4, 5, 7, and 8 in Figure A-3-10.3.5.1(c).*]

Use the information on weights of water-filled piping contained within Table A-3-10.3.5.1(2).

(d) If the total expected loads are less than the maximums permitted in Table A-3-10.3.5.1(1)for the particular brace and orientation, go on to step (e). If not, add additional braces to reduce the zones of influence of overloaded braces.

(e) Check that fasteners connecting the braces to structural supporting members are adequate to support the expected loads on the braces in accordance with Table A-3-10.3.5.1(3). If not, again add additional braces or additional means of support.

A-3-10.3.5.3 The four-way brace provided at the riser may also provide longitudinal and lateral bracing for adjacent mains.

A-3-11.1.1 All piping should be arranged where practicable to drain to the main drain valve.

A-3-11.3.2.3 An example of a suitable location would be a valve located approximately 7 ft (2 m) above the floor level to which a hose could be connected to discharge the water in an acceptable manner.

A-3-11.3.3.3 The size of tie-in drain lines should be increased as necessary to provide efficient removal of trapped water. Consideration should be given to the volume of water trapped, elevation head available, and the time required to discharge water. Water or condensation or both that remains after initial drain down should not be permitted to collect since freezing may cause failure of the drain/system piping.

A-3-11.4.1 When possible, the main sprinkler riser drain should discharge outside the building at a point free from the possibility of causing water damage. When not possible to discharge outside the building wall, the drain should be piped to a sump which in turn should discharge by gravity or be pumped to a waste water drain or sewer. The main sprinkler riser drain connection should be of a size to carry off water from the fully-open drain valve while it is discharging under normal water system pressures. When this is not possible, a supplementary drain of equal size should be provided for test purposes with free discharge, located at or above grade.

A-3-11.4.5 When exterior ambient temperatures are subject to freezing, 32°F (0°C) or less, at least 4 ft (1.2 m) of pipe should be installed beyond the valve, in a warm room.

A-3-12.1.2 Some steel piping material having lesser wall thickness than specified in 3-12.1.2 has been listed for use in sprinkler systems when joined with threaded connections. The service life of such products may be significantly less than that of Schedule 40 steel pipe and it should be determined if this service life will be sufficient for the application intended.

All such threads should be checked by the installer using working ring gages conforming to the Basic Dimensions of Ring Gages for USA (American) Standard Taper Pipe Threads, NPT as per ANSI/ASME B1.20.1, Table 8.

A-3-12.2.2 As used in this standard *shop* in the term *shop welded* means either:

(a) At the sprinkler contractor's or fabricator's premise.

(b) An approved welding area at the building site.

A-3-12.2.6(a) Listed shaped, contoured nipples meet the definition of fabricated fittings.

A-3-12.4 The fire hazard of the brazing process should be suitably safeguarded.

Self-cleaning fluxes should not be used. Continued corrosive action after the soldering process is completed could result in leaks from the seats of sprinklers.

A-3-13.1.2 Rubber-gasketed pipe fittings and couplings should not be installed where ambient temperatures can be expected to exceed 150°F (66°C) unless listed for this service. If the manufacturer further limits a given gasket compound, those recommendations should be followed.

A-3-13.1.2.1 Unless properly restrained, gravitational forces on unsupported nonvertical branches can cause the pipe to rotate out of position.

A-3-13.2 Approved flexible connections are permissible and encouraged for sprinkler installations in racks to reduce the possibility of physical damage. When flexible tubing is used it should be located so that it will be protected against mechanical injury.

Table A-3-10.3.5.1(1)

Shape and Size	Least Radius of Gyration	Maximum Length for l/r—200	Maximum Horizontal Load (lbs.) 30° Angle From Vertical	45° Angle From Vertical	60° Angle From Vertical
Pipe (schedule 10)	$=\frac{\sqrt{r_o^2 + r_i^2}}{2}$				
1 in.	.42	7′0″	1767	2500	3061
1¼ in.	.54	9′0″	2393	3385	4145
1½ in.	.623	10′4″	2858	4043	4955
2 in.	.787	13′1″	3828	5414	6630
Pipe (schedule 40)	$=\frac{\sqrt{r_o^2 + r_i^2}}{2}$				
1 in.	.43	7′2″	1477	2090	2559
1¼ in.	.55	9′2″	1900	2687	3291
1½ in.	.634	10′7″	2194	3103	3800
2 in.	.802	13′4″	2771	3926	4803
Angles					
1½ × 1½ × ¼	.292	4′10″	2461	3481	4263
2 × 2 × ¼	.391	6′6″	3356	4746	5813
2½ × 2 × ¼	.424	7′0″	3792	5363	6569
2½ × 2½ × ¼	.491	8′2″	4257	6021	7374
3 × 2½ × ¼	.528	8′10″	4687	6628	8118
3 × 3 × ¼	.592	9′10″	5152	7286	8923
Rods	$=\frac{r}{2}$				
⅜	.094	1′6″	395	559	685
½	.125	2′6″	702	993	1217
⅝	.156	2′7″	1087	1537	1883
¾	.188	3′1″	1580	2235	2737
⅞	.219	3′7″	2151	3043	3726
Flats	= 29 h (where h is smaller of two side dimensions)				
1½ × 1¼	.0725	1′2″	1118	1581	1936
2 × ¼	.0725	1′2″	1789	2530	3098
2 × ⅜	.109	1′9″	2683	3795	4648

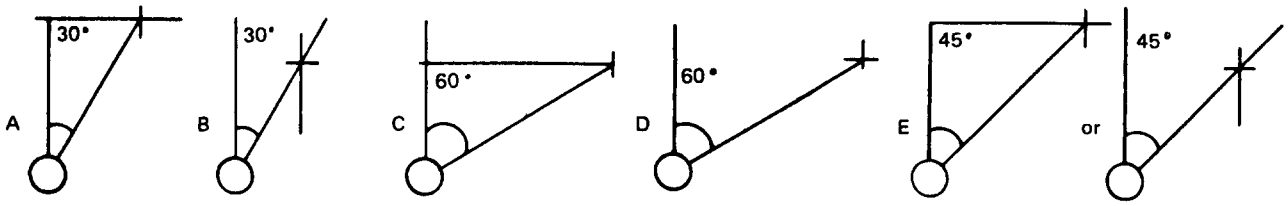
Table A-3-10.3.5.1(2)
Piping Weights for Determining Horizontal Load

Schedule 40 Pipe	Weight of Water-Filled Pipe (lbs per ft)	½ Weight of Water-Filled Pipe (lbs per ft)
1	2.05	1.03
1¼	2.93	1.47
1½	3.61	1.81
2	5.13	2.57
2½	7.89	3.95
3	10.82	5.41
3½	13.48	6.74
4	16.40	8.20
5	23.47	11.74
6	31.69	15.85
8*	47.70	23.85
Schedule 10 Pipe		
1	1.81	0.91
1¼	2.52	1.26
1½	3.04	1.52
2	4.22	2.11
2½	5.89	2.95
3	7.94	3.97
3½	9.78	4.89
4	11.78	5.89
5	17.30	8.65
6	23.03	11.52
8	40.08	20.04

*Schedule 30

Table A-3-10.3.5.1(3)
Maximum Loads for Various Types of Fasteners to Structure

NOTE: Loads (given in pounds) are keyed to vertical angles of braces and orientation of connecting surface. Use figures to determine proper reference within table. For angles between those shown, use most restrictive case. Braces should not be attached to light structure members.



Lag Screws to Wood (load perpendicular to grain — holes predrilled using good practice)
Shank Diameter of Lag (in.)

		⅜					½					⅝					¾				
		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Length	3	304	168	292	526	325	366	—	—	834	—	410	—	—	716	—	487	—	—	843	—
Under	4	392	183	317	678	354	473	264	456	818	509	538	—	—	532	—	548	—	—	1122	—
Head	5	476	194	336	824	375	582	282	488	1008	545	687	277	653	1154	728	813	—	—	1407	—
(inches)	6	564	196	342	976	382	689	209	501	1192	559	791	403	697	1360	778	971	—	—	1630	—
	8	—	—	—	—	—	905	296	513	1586	573	1044	416	723	1807	806	1297	685	1223	2244	1365

Through Bolts in Wood (load perpendicular to grain)
Diameter of Bolt (in.)

		⅜			½			⅝			¾		
		ACE	B	D	ACE	B	D	ACE	B	D	ACE	B	D
Length	1½	300	173	519	340	197	589	390	225	675	470	272	614
of	2	370	214	641	420	243	727	470	272	814	580	335	1004
Bolt	2½	460	266	796	550	318	952	620	358	1074	760	439	1316
in	3	480	277	831	630	364	1091	710	410	1229	870	503	1506
Timber	3½	460	268	797	720	416	1247	850	491	1472	1050	607	1818
(in.)	5½	—	—	—	680	393	1177	1020	590	1766	1580	913	2736

Expansion Shields in Concrete
Diameter of Bolt (in.)

		⅜					½					⅝					¾				
Min.		A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
Depth	2½	498	678	1173	962	962															
of	3¼						923	1200	2076	1597	1782										
Hole	3½											1480	1524	2637	2581	2857					
(in.)	4½																3070	2139	3702	5312	4130

Connections to Steel (values assume bolt perpendicular to mounting surface)
Diameter of Unfinished Steel Bolt (in.)

¼						⅜					½					⅝				
A	B	C	D	E	A	B	C	D	E	A	B	C	D	E	A	B	C	D	E
400	300	600	650	500	900	800	1400	1550	1200	1600	1450	2550	2850	2050	2500	2250	3950	4400	3300

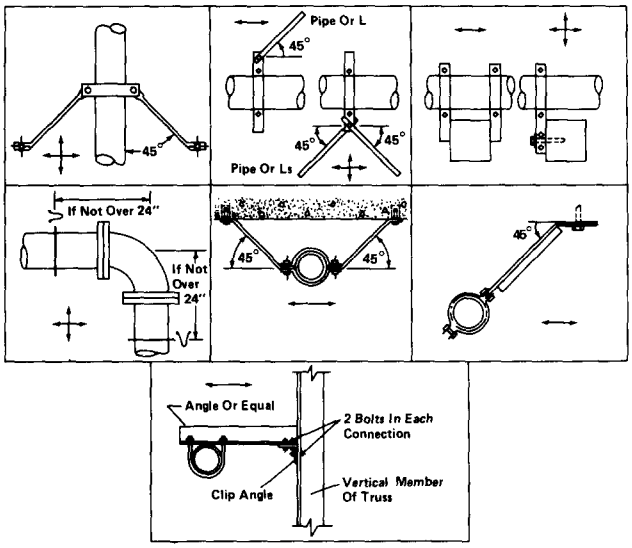


Figure A-3-10.3.5.1(a) Acceptable Types of Sway Bracing.

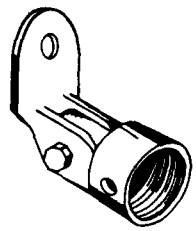


Figure A-3-10.3.5.1(b) Special Fitting.

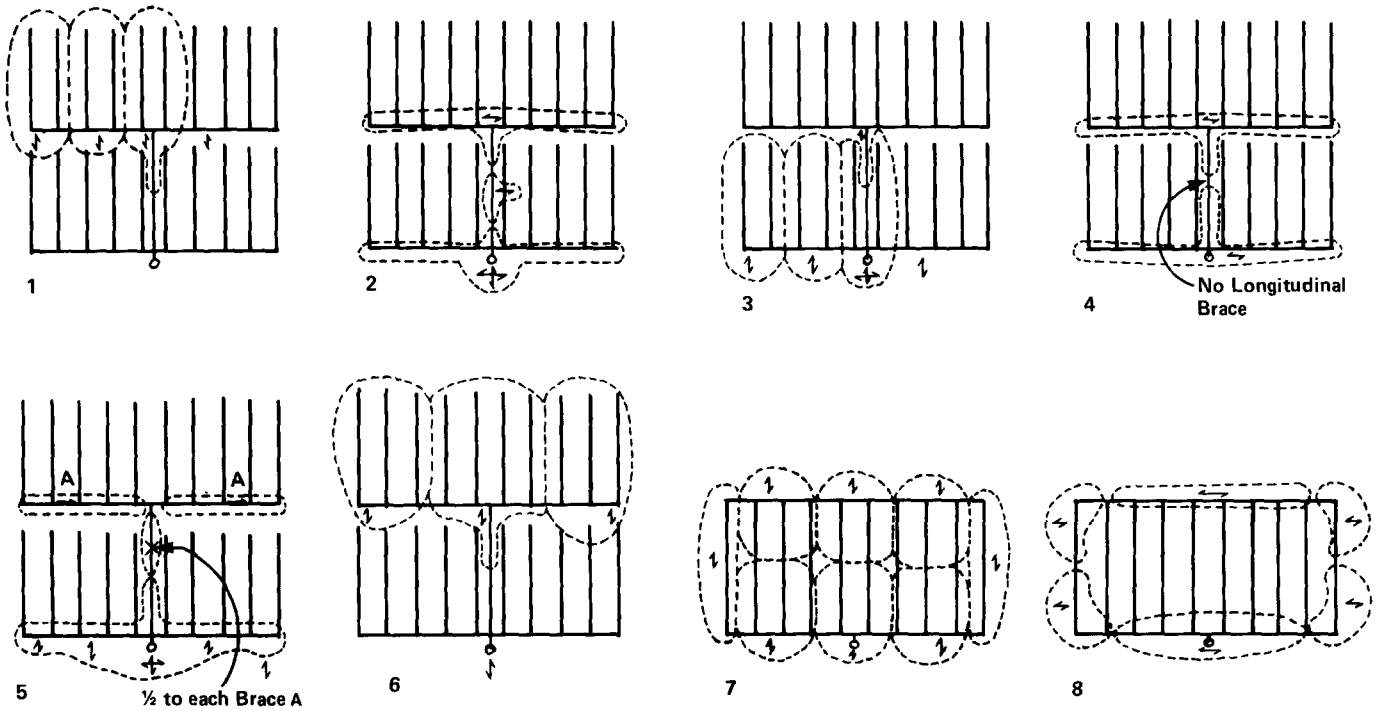


Figure A-3-10.3.5.1(c) Examples of Load Distribution to Bracing.

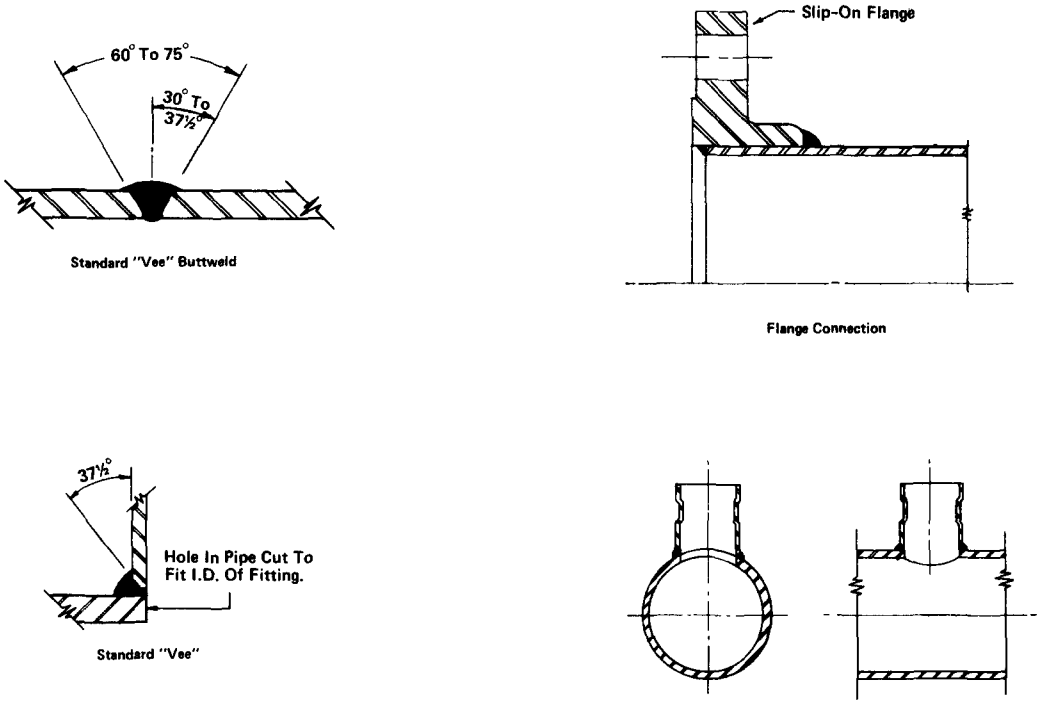


Figure A-3-12.2(a) Acceptable Weld Joints.

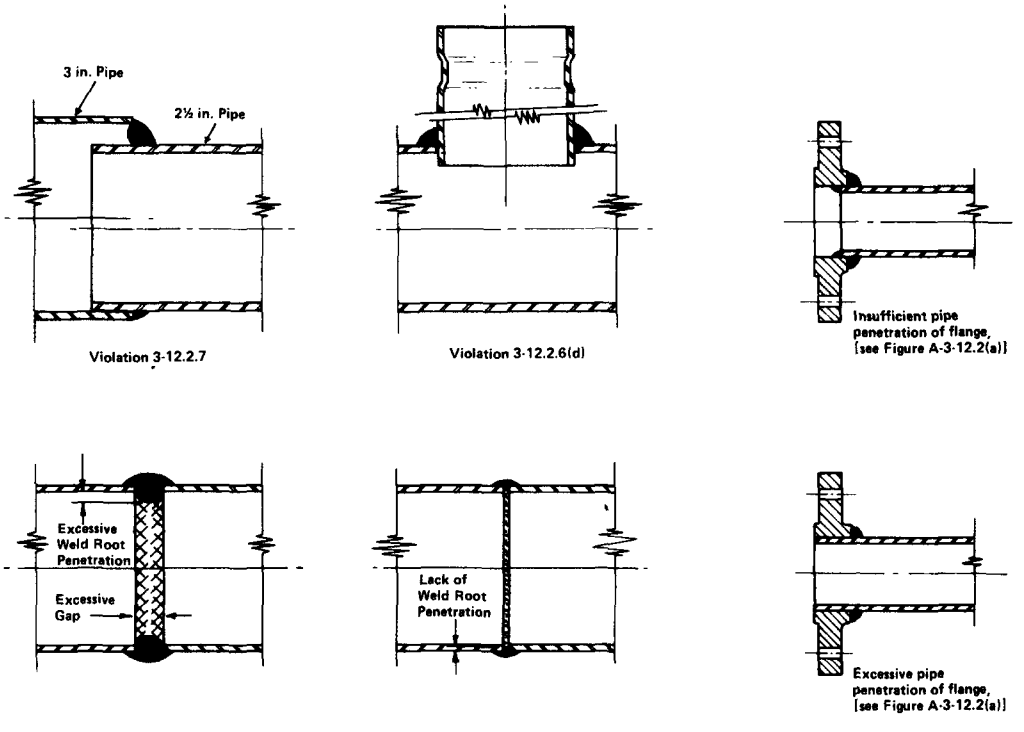


Figure A-3-12.2(b) Unacceptable Weld Joints.

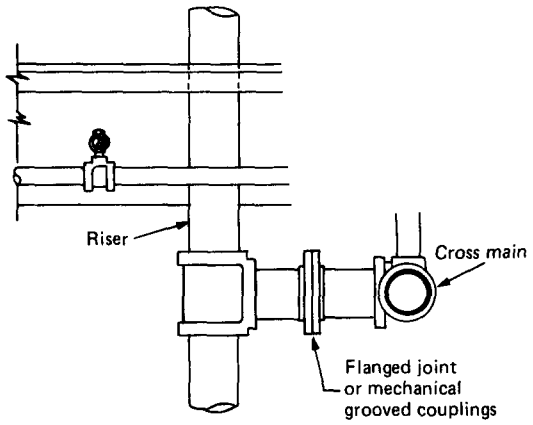


Figure A-3-13.1.5 One Arrangement of Flanged Joint at Sprinkler Riser.

A-3-14.2 Valves Controlling Water Supplies.

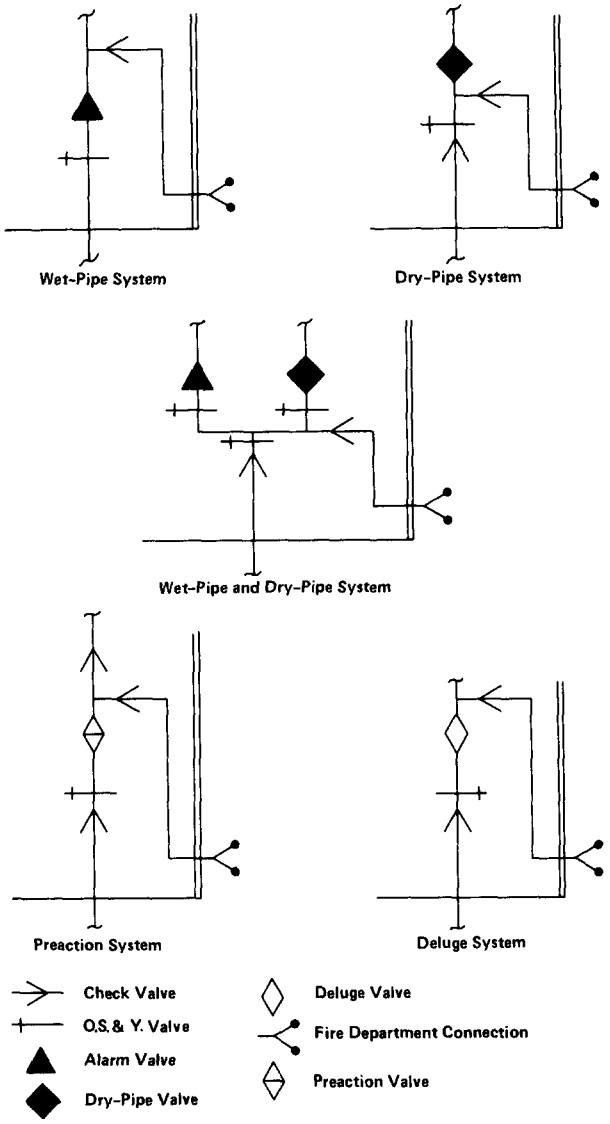


Figure A-3-14.2 Examples of Acceptable Valve Arrangements.

A-3-14.2.1 A water supply connection should not extend into or through a building unless such connection is under the control of an outside listed indicating valve or an inside listed indicating valve located near the outside wall of the building.

All valves controlling water supplies for sprinkler systems or portions thereof, including floor control valves, should be accessible to authorized persons during emergencies. Permanent ladders, clamped treads on risers, chain-operated hand wheels, or other accepted means should be provided when necessary.

Outside control valves are suggested in the following order of preference:

(a) Listed indicating valves at each connection into the building at least 40 ft (12.2 m) from buildings if space permits.

(b) Control valves installed in a cutoff stair tower or valve room accessible from outside.

(c) Valves located in risers with indicating posts arranged for outside operation.

(d) Key operated valves in each connection into the building.

A-3-14.2.5 Pits for underground valves, except those located at the base of a tank riser, are described in NFPA 24, *Standard for Installation of Private Fire Service Mains and Their Appurtenances*. For pits protecting valves located at the base of a tank riser, refer to NFPA 22, *Standard for Water Tanks for Private Fire Protection*.

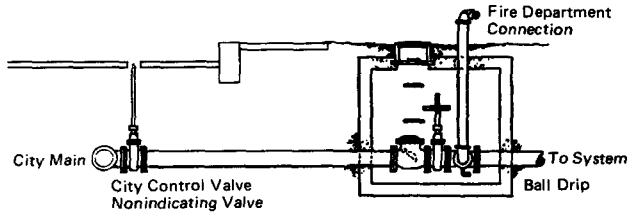


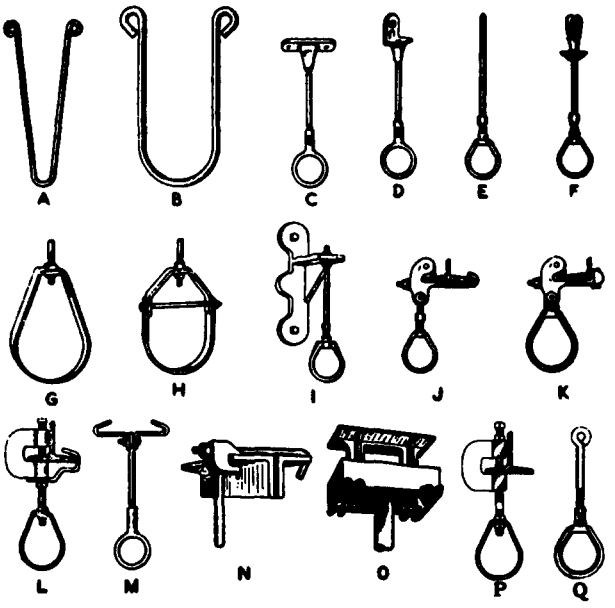
Figure A-3-14.2.5 Pit for Gate Valve, Check Valve, and Fire Department Connection.

A-3-14.2.6 When a system having only one dry-pipe valve is supplied with city water and fire department connection it will be satisfactory to install the main check valve in water supply connection immediately inside of the building; in case there is no outside control the system indicating valve should be placed at the wall flange ahead of all fittings.

A-3-14.3 All control, drain, and test connections should be provided with identification signs.

A-3-15.1 Branch line hangers under metal decking may be attached by drilling or punching vertical members and using through bolts. The distance from the bottom of the bolt hole to the bottom of the vertical member should be not less than $\frac{3}{8}$ in. (9.5 mm).

To take care of the thrust in a steeply-pitched roof branch line, a clamp should be installed on the pipe just above the lowest hanger.



A — U-type Hanger for Branch Lines.
B — U-type Hanger for Cross Mains and Feed Mains.
C — Adjustable Clip for Branch Lines.
D — Side Beam Adjustable Hanger.
E — Adjustable Coach Screw Clip for Branch Lines.
F — Adjustable Swivel Ring Hanger with Expansion Shield.
G — Adjustable Flat Iron Hanger.
H — Adjustable Clevis Hanger.
I — Cantilever Bracket.
J — "Universal" I-beam Clamp.
K — "Universal" Channel Clamp.
L — C-type Clamp with Retaining Strap.
M — Cener I-beam Clamp for Branch Lines.
N — Top Beam Clamp.
O — "CL-Universal" Concrete Insert.
P — C-type Clamp without Retaining Strap.
Q — Eye Rod and Ring Hanger.
R — Wrap-around U Hook.

Figure A-3-15.1 Common Types of Acceptable Hangers.

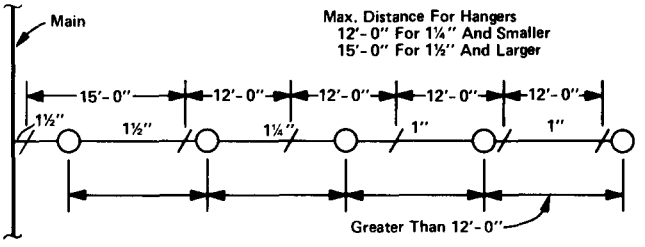
A-3-15.1.3 The rules covering the hanging of sprinkler piping take into consideration the weight of water-filled pipe plus a safety factor. No allowance has been made for the hanging of nonsystem components from sprinkler piping.

A-3-15.1.7 Table 3-15.1.7(b) assumes that the load from 15 ft (5 m) of water-filled pipe, plus 250 lb, is located at the midpoint of the span of the trapeze member, with a maximum allowable bending stress of 15 KSI (111 kg). If the load is applied at other than the midpoint, for the purpose of sizing the trapeze member, an equivalent length of trapeze may be used, derived from the formula

$$L = \frac{4ab}{a + b}$$

where "L" is the equivalent length, "a" is the distance from one support to the load and "b" is the distance from the other support to the load.

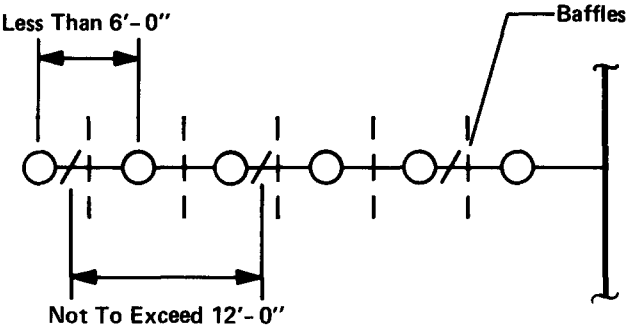
When multiple mains are to be supported or multiple trapeze hangers are provided in parallel, the required or available section modulus may be added.



For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3048 m.

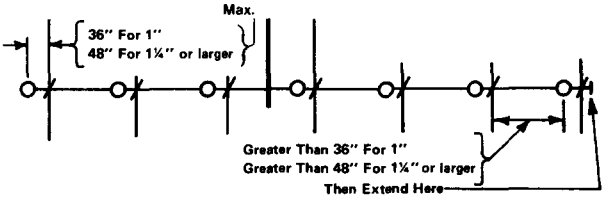
Figure A-3-15.1.11.1 Distance Between Hangers with Steel Pipe.

A-3-15.3.1 Powder-driven studs should not be used in steel less than $\frac{3}{16}$ in. total thickness.



For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3048 m.

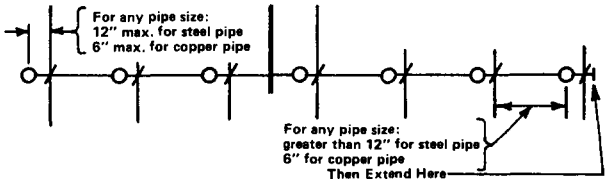
Figure A-3-15.5.2 Distance Between Hangers.



For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3048 m.

Figure A-3-15.5.5 Distance from Sprinkler to Hanger.

NOTE: For pendent sprinklers below a ceiling and exposed to maximum pressure greater than 100 psi, see Figure A-3-15.5.5 Exception.

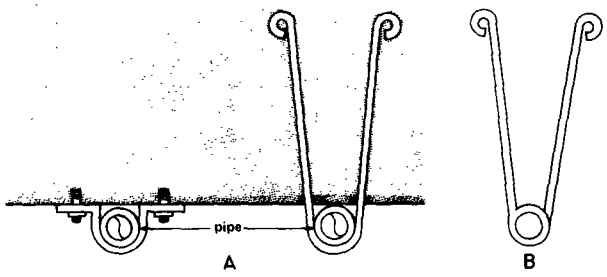


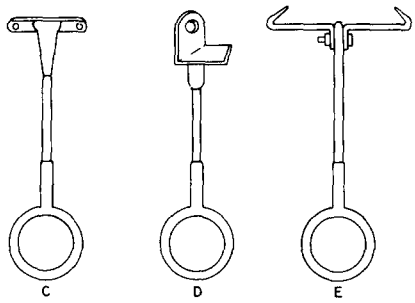
For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3048 m.

Figure A-3-15.5.5 Exception Distance from sprinkler to hanger where maximum pressure exceeds 100 psi and a branch line above a ceiling supplies pendent sprinklers below the ceiling.

NOTE 1: The pendent sprinkler may be installed either directly in the fitting at the end of the line, or in a fitting at the bottom of a drop nipple.

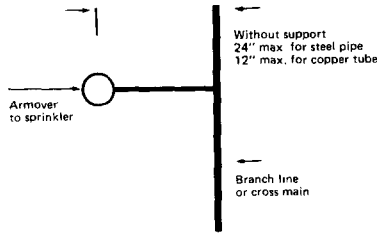
NOTE 2: Hanger closest to sprinkler shall be of a type that clamps to and prevents upward movement of the pipe.





A U-type hangers for branch lines
B Wrap-around U hook
C Adjustable clip for branch lines
D Side beam adjustable hanger
E Adjustable coach screw clip for branch lines

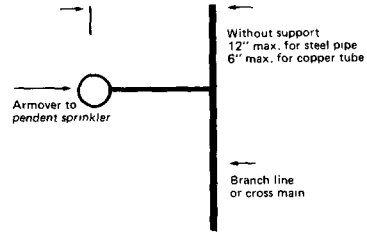
Figure A-3-15.5.5(a) Examples of Acceptable Hangers for End of Line (or Armover) Pendent Sprinklers.



For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3048 m.

Figure A-3-15.5.6 Maximum Length for Unsupported Armover.

NOTE: For a pendent sprinkler below a ceiling and exposed to maximum pressure greater than 100 psi, see Figure A-3-15.5.6 Exception.



For SI Units: 1 in. = 2.54 cm; 1 ft = 0.3048 m.

Figure A-3-15.5.6 Exception Maximum length of unsupported armover when the maximum pressure exceeds 100 psi and a branch line above a ceiling supplies pendent sprinklers below the ceiling.

NOTE: The pendent sprinkler may be installed either directly in the fitting at the end of the armover or in a fitting at the bottom of a drop nipple.

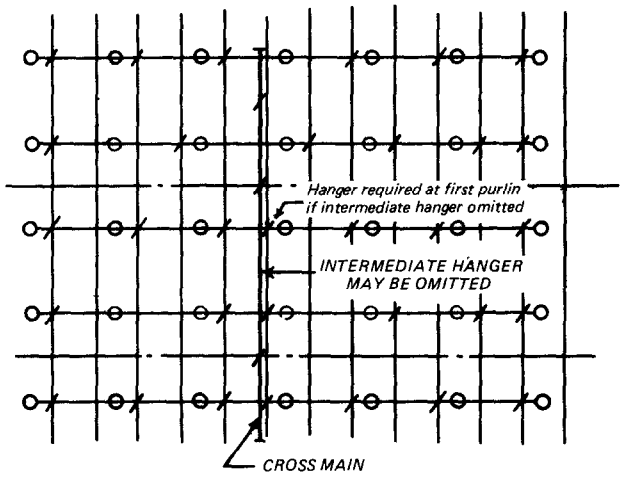


Figure A-3-15.6.1(a) Hangers on Cross Main.

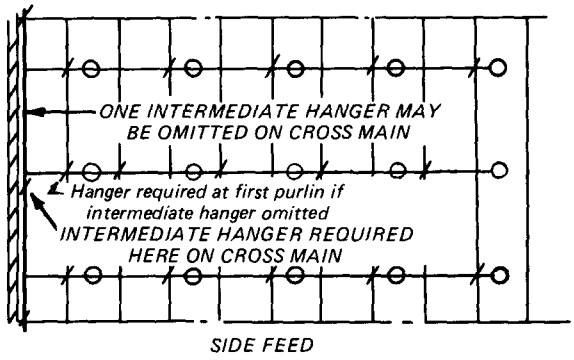


Figure A-3-15.6.1(b) Hanger Omission on Side Feed System.

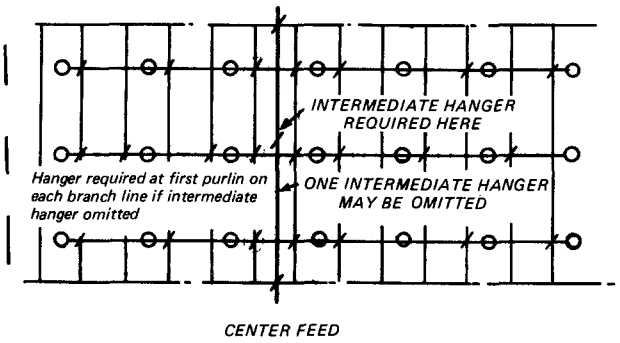


Figure A-3-15.6.1(c) Hangers on Cross Main — Center Feed System.

A-3-16.2.1(a) Upright sprinklers should be installed with the frame parallel to the branch line pipe to reduce to minimum the obstruction of the discharge pattern.

A-3-16.2.1(b) Large or small orifice sprinklers should not be used with pipe schedule systems unless their use is acceptable to the authority having jurisdiction and supported by hydraulic calculations or where installed for outside exposure protection in accordance with Chapter 6.

A-3-16.2.6 Multiple extended coverage sidewall sprinklers may be used in a single room or space not exceeding 9 ft (2.7 m) in height unless otherwise indicated in the listing. Where such sprinklers are placed back to back, a baffle should be employed so that the operation of one sprinkler will not prevent the other from operating.

A-3-16.4.1 Examples of such locations are paper mills, packing houses, tanneries, alkali plants, organic fertilizer plants, foundries, forge shops, fumigation, pickle and vinegar works, stables, storage battery rooms, electroplating rooms, galvanizing rooms, steam rooms of all descriptions, including moist vapor dry kilns, salt storage rooms, locomotive sheds or houses, driveways, areas exposed to outside weather such as piers and wharves exposed to salt air, areas under sidewalks, around bleaching equipment in flour mills, all portions of cold storage buildings where a direct ammonia expansion system is used, and portions of any plant where corrosive vapors prevail.

A-3-16.5 The following Table A-3-16.5 shows the nominal discharge capacities of approved sprinklers having a nominal ½-in. (12.7-mm) orifice at various pressures up to 100 psi (6.9 bars).

Table A-3-16.5 Nominal Discharge Capacities

Pressure at Sprinkler lb per sq in.	Discharge gal per min	Pressure at Sprinkler lb per sq in.	Discharge gal per min
10	18	35	34
15	22	50	41
20	25	75	50
25	28	100	58

For SI Units: 1 gpm = 3.785 L/min; 1 psi = 0.0689 bar.

A-3-16.5.2 Small orifice sprinklers should not be used as a substitute for standard ½ in. and large orifice sprinklers to take advantage of available high water pressure.

A-3-16.6 Information regarding the highest temperature that may be encountered in any location in a particular installation may be obtained by use of a thermometer that will register the highest temperature encountered, which should be hung for several days in the questionable location with the plant in operation.

When an occupancy hazard normally may be expected to produce a fast-developing fire or a rapid rate of heat release, the use of sprinklers of high temperature classification, as a means of limiting the total number of sprinklers which might open in a fire, is recommended. Since the number of sprinklers which might be expected to open will be reduced where the water pressure effective in first operating sprinklers is at least 75 psi (5.2 bars) without the disadvantage of a potential increase in fire damage, this alternative should be given first consideration.

NOTE: Fire tests have shown that the number of sprinklers that might be expected to open, particularly under conditions where fast-developing fires may be expected, can be limited by the use of sprinklers of High Temperature Classification. This may be of advantage in reducing the number of sprinklers that would otherwise open outside the area directly involved in a fire and decrease the overall water demand. However, some increase in fire damage and fire temperatures may be expected when sprinklers of Intermediate or High Temperature Classification are used.

Some occupancies employ high-temperature fumigation processes requiring consideration in the selection of sprinkler temperature ratings.

A-3-16.7 For equipment aboard vessels or in isolated locations, a greater number of sprinklers should be provided to permit equipment to be put back into service promptly after a fire. When a great number of sprinklers are likely to be opened by a flash fire, a greater number of sprinklers should be provided.

A-3-16.8 Sprinklers under open gratings should be provided with shields. Shields over automatic sprinklers should not be less, in least dimension, than four times the distance between the shield and fusible element, except special sprinklers incorporating a built-in shield need not comply with this recommendation if listed for the particular application.

A-3-16.9.1 When painting sprinkler piping or painting in areas near sprinklers, the sprinklers may be protected by covering with a bag that should be removed immediately after the painting has been finished.

A-3-16.9.2 Painting of sprinklers may retard the thermal response of the heat responsive element, may interfere with the free movement of parts, and may render the sprinkler inoperative. Moreover, painting may invite the application of subsequent coatings, thus increasing the possibility of a malfunction of the sprinkler.

A-3-17.2 Central station, auxiliary, remote station, or proprietary protective signaling systems are a highly desirable supplement to local alarms, especially from a safety to life standpoint. (*See 3-17.6.*)

Identification Signs. Approved identification signs should be provided for outside alarm devices. The sign should be located near the device in a conspicuous position and should be worded as follows:

SPRINKLER FIRE ALARM — WHEN BELL RINGS CALL FIRE DEPARTMENT OR POLICE. (*See Figure A-3-17.2.*)

Figure A-3-17.2 Identification Sign.

A-3-17.3.3 A mechanical alarm (water motor gong) may also be required.

A-3-17.3.4 The surge of water when valve trips may seriously damage the device.

A-3-17.4.1 Audible alarms are normally located on the outside of the building. Listed electric gongs, bells, horns, or sirens inside the building or a combination inside and outside are sometimes advisable.

A-3-17.4.2 All alarm apparatus should be so located and installed that all parts are accessible for inspection, removal, and repair, and should be substantially supported.

A-3-17.5 Water-motor-operated devices should be located as near as practicable to the alarm valve, dry-pipe valve, or other waterflow detecting device. The total length of the pipe to these devices should not exceed 75 ft (22.9 m) nor should the water-motor-operated device be located over 20 ft (6.1 m) above the alarm device or dry-pipe valve.

A-3-17.7.2 Switches that will silence electric alarm sounding devices by interruption of electrical current are not desirable; however, if such means are provided, then the electrical alarm sounding device circuit should be arranged so that when the sounding device is electrically silenced, that fact shall be indicated by means of a conspicuous light located in the vicinity of the riser or alarm control panel. This light shall remain in operation during the entire period of the electrical circuit interruption.

A-4-1.1 The installation requirements are specific for the normal arrangement of structural members. There will be arrangements of structural members not specifically detailed by the requirements. By applying the basic principles, layouts for such construction can vary from specific illustrations, provided the maximum specified for the Spacing of Sprinklers (Section 4-2) and Position of Sprinklers (Section 4-3) are not exceeded.

All needless ceiling sheathing, hollow siding, tops of high shelving, partitions, or decks should be removed. Sheathing of paper and similar light flammable materials is particularly objectionable.

A-4-1.1.1 This standard contemplates full sprinkler protection for all areas. Other NFPA standards that mandate sprinkler installation may not require sprinklers in certain areas. The requirements of this standard should be used insofar as they are applicable. The authority having jurisdiction should be consulted in each case.

A-4-1.2 Installation of sprinklers throughout the premises is necessary for protection of life and property. In some cases partial sprinkler installations covering hazardous sections and other areas are specified in codes or standards or are required by authorities having jurisdiction, for minimum protection to property or to provide opportunity for safe exit from the building.

When buildings or portions of buildings are of combustible construction or contain combustible material, standard fire barriers should be provided to separate the areas that are sprinkler protected from adjoining unsprinklered areas. All openings should be protected in accordance with applicable standards and no sprinkler piping should be placed in an unsprinklered area unless the area is permitted to be unsprinklered by this standard.

Water supplies for partial systems should be adequate and designed with due consideration to the fact that in a partial system more sprinklers may be opened in a fire that originates in an unprotected area and spreads to the sprinklered area than would be the case in a completely protected building. Fire originating in a nonsprinklered area may overpower the partial sprinkler system.

When sprinklers are installed in corridors only, sprinklers should be spaced up to the maximum of 15 ft (4.5 m) along the corridor, with one sprinkler opposite the center of any door or pair of adjacent doors opening onto the corridor, and with an additional sprinkler spaced inside each adjacent room above the door opening. When the sprinkler in the adjacent room provides full protection for that space, an additional sprinkler is not required in the corridor adjacent to the door.

A-4-2.1.2 For examples of sprinkler layouts under smooth ceiling construction, refer to Figures A-4-2.1.2(a) and A-4-2.1.2(b).

A-4-2.3 The arrangement of branch lines depends upon such construction features as the distance between girders or trusses, columns of mushroom-type reinforced concrete, and beams of standard mill construction. Each space or bay should usually be treated as a unit, installing

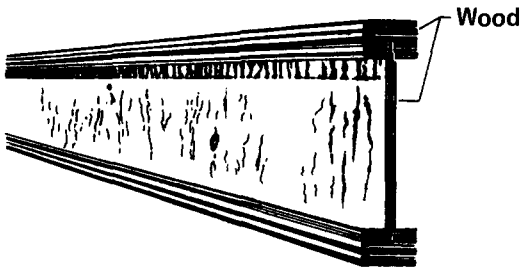


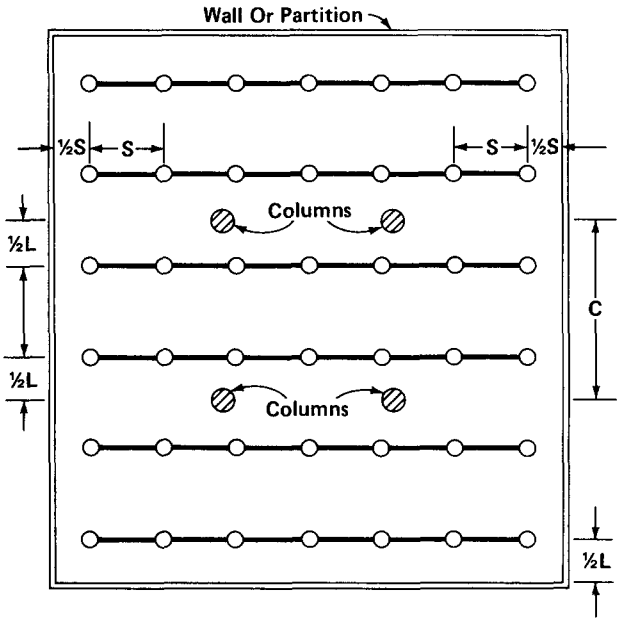
Figure A-4-1.3.8 Typical Composite Wood Joist Construction.

the same number of branch lines uniformly in each space. When single branch lines will suffice, they should be placed midway in each bay or space. The arrangement of branch lines also depends upon the structural members available and suitable for the attachment of hangers, and upon the need for properly locating sprinkler deflectors in accordance with 4-2.4 and Section 4-3.

The direction in which branch lines are usually run in common types of ceiling construction and framing is shown in Table A-4-2.3.

Flat Slab or Pan-Type Reinforced Concrete

Maximum Spacing: 130 Sq Ft per Sprinkler
L X S = 130 or less



KEY

C = Column spacing.
L = Distance between branch lines, limit 15 ft.
S = Distance between sprinklers on branch lines, limit 15 ft.

Examples

C	L	S (Max)	C	L	S (Max)
21 ft 8 in. 24 ft 2 in.	10 ft 10 in. 12 ft 1 in.	12 ft 0 in. 10 ft 9 in.	21 ft 6 in.	10 ft 9 in.	12 ft 1 in.

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m; 1 ft^2 = 0.0929 m^2

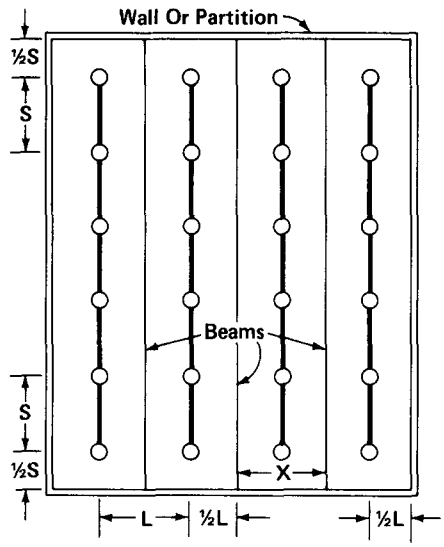
Figure A-4-2.1.2(a) Layout of Sprinklers under Smooth Ceiling Construction — Ordinary Hazard Occupancy.

A-4-2.4.7 On sprinkler lines larger than 2 in. (51 mm), consideration should be given to the distribution interference caused by the pipe, which can be minimized by installing sprinklers on riser nipples or installing sprinklers in the pendent position.

A-4-2.5.2 The distances given in Table 4-2.5.2 were determined through tests in which privacy curtains with either a solid fabric or close mesh ¼ in. (6.4 mm) top panel were installed. For broader-mesh top panels [e.g., ½ in. (12.7 mm)] the obstruction of the sprinkler spray is not likely to be severe and the authority having jurisdiction may not need to apply the requirements in 4-2.5.2.

Continuous Smooth Bays with Beams Supported on Columns

Maximum Spacing: 130 Sq Ft per Sprinkler
L X S = 130 or less



KEY

L = Distance between branch lines, limit 15 ft.
S = Distance between sprinklers on branch lines, limit 15 ft.
X = Width of bay.

Examples

X	L	S (Max)	X	L	S (Max)
10 ft 10 in. 12 ft 1 in	10 ft 10 in. 12 ft 1 in.	12 ft 0 in. 10 ft 9 in.	10 ft 9 in.	10 ft 9 in.	12 ft 1 in.

For SI Units: 1 in. = 25.4 mm, 1 ft = 0.3048 m, 1 ft^2 = 0.0929 m^2.

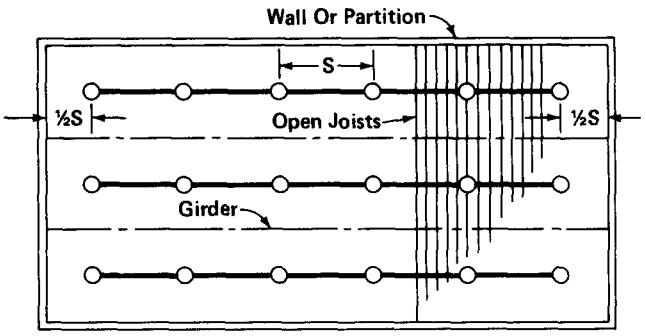
Figure A-4-2.1.2(b) Layout of Sprinklers under Smooth Ceiling Construction — Ordinary Hazard Occupancy.

A-4-4 Special Occupancy Considerations.

(a) Subject to the approval of the authority having jurisdiction, sprinklers may be omitted in rooms or areas where they are considered undesirable because of the nature of the contents, or in rooms or areas of noncombustible construction with wholly noncombustible contents and that are not exposed by other areas. Sprinklers should not be omitted from any room merely because it is damp or of fire-resistive construction.

Joists Above Girders or Framed into Girders; Branch Lines Uniformly Spaced Between Girders

Maximum Spacing, 130 Sq Ft per Sprinkler
L × S = 130 or less



KEY

L = Distance between branch lines, limit 15 ft.
S = Distance between sprinklers on branch lines, limit 15 ft.
Y = Maximum distance between girders.

Examples

Y	L	S (Max)	Y	L	S (Max)
10 ft 9 in	10 ft 9 in.	12 ft 1 in.	10 ft 10 in. 12 ft 1 in.	10 ft 10 in. 12 ft 1 in.	12 ft 0 in. 10 ft 9 in.

For SI Units, 1 in. = 25.4 mm; 1 ft = 0.3048 m, 1 ft^2 = 0.0929 m^2.

Figure A-4-2.2.1.2 Layout of Sprinklers under Open Wood Joist Construction — Light and Ordinary Hazard Occupancies.

Table A-4-2.3 Common Branch-Line Run Directions

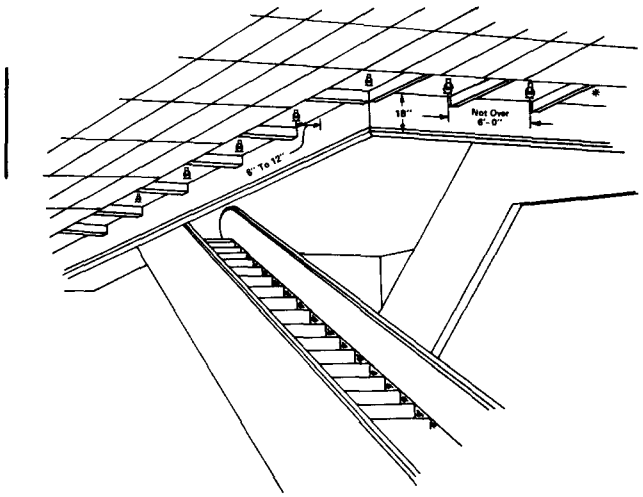
Type of Ceiling	Location of Branch Lines
Smooth Continuous:	
Concrete mushroom	Either direction
Concrete pan-type or flat	Either direction
Sheathed (ceiling attached to bottom of beams, wood joists, or bar joists):	
Girders beneath sheathing	Across the beam or joists
No girders beneath sheathing	Whichever direction facilitates easy and proper hanging
Bays more than 7½ ft (2.3 m) wide:	
Formed by beams supported on columns	Parallel to beams
Formed by beams supported on girders or trusses	Either across beams or parallel to beams in the bays above girders or trusses
Supported directly on girders	Parallel to girders
Supported directly on trusses	Either direction, parallel to or through trusses
Beam and Girder:	
Wood or steel beams spaced 3 to 7 ½ ft (0.9 to 2.3 m) apart	Across beams
Open Bar Joist	Across the joists or trusses (either through or under them)
Open Joist (wood, steel or concrete)	Across joists

(b) It is not advisable to install sprinklers when the application of water, or of flame and water, to a room or area's contents may constitute a serious life or fire hazard, as in the manufacture or storage of quantities of aluminum powder, calcium carbide, calcium phosphide, metallic sodium and potassium, quicklime, magnesium powder, and sodium peroxide. The manufacture and storage of such materials should be confined to specially cut-off, unsprinklered rooms, or buildings of fire-resistive construction.

A-4-4.4.4 When there is a limited amount of combustibles available to burn and a limited prospect of fire propagation, sprinklers may not be required.

A-4-4.8.1.2 When practicable, sprinklers should be staggered at alternate floor levels, particularly when only one sprinkler is installed at each floor level.

A-4-4.8.2 Floor or wall openings tending to create vertical or horizontal drafts, or other structural conditions that would delay the prompt operation of automatic sprinklers by preventing the banking up of the heated air from the fire, should be properly stopped in order to permit control of fire at any point by local sprinklers.



For SI Units: 1 in. = 25.4 mm, 1 ft = 0.3048 m.
*Baffle (*See 4-4.19**)

Figure A-4-4.8.2.3 Sprinklers Around Escalators.

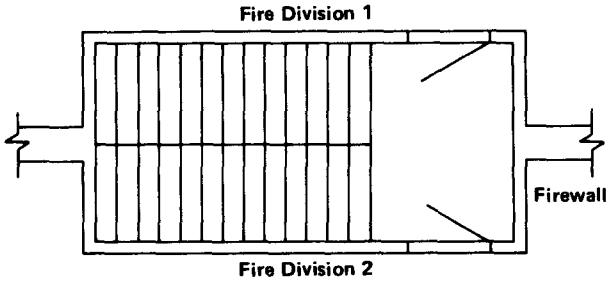


Figure A-4-4.8.2.4(a) Noncombustible Stair Shaft Serving Two Fire Sections.

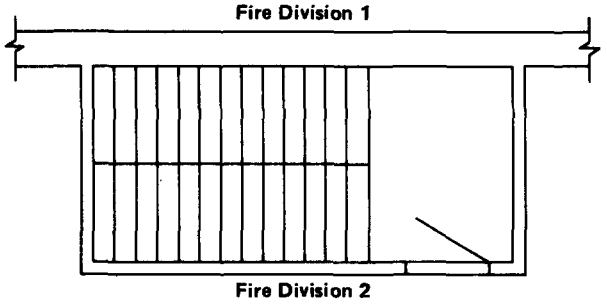


Figure A-4-4.8.2.4(b) Noncombustible Stair Shaft Serving One Fire Section.

A-4-4.9 The installation of sprinklers at floor levels should be so arranged as to protect the sprinklers from mechanical injury, from falling materials, and not cause obstruction within the chute. This can usually be accomplished by recessing the sprinkler in the wall of the chute or by providing a protective deflector canopy over the sprinkler. Sprinklers should be placed so that there will be minimum interference of the discharge therefrom. (*See also 4-1.2.*) Sprinklers with special directional discharge characteristics may be advantageous.

A-4-4.10 Small loading docks, covered platforms, ducts, or similar small unheated areas may be protected by dry pendent sprinklers extending through the wall from wet sprinkler piping in an adjacent heated area, as shown in Figure A-4-4.10.

Where possible, the dry pendent sprinkler should extend down at a 45° angle. The width of the area to be protected should not exceed 7½ ft (2.3 m). Sprinklers should be spaced not over 12 ft (3.7 m) apart.

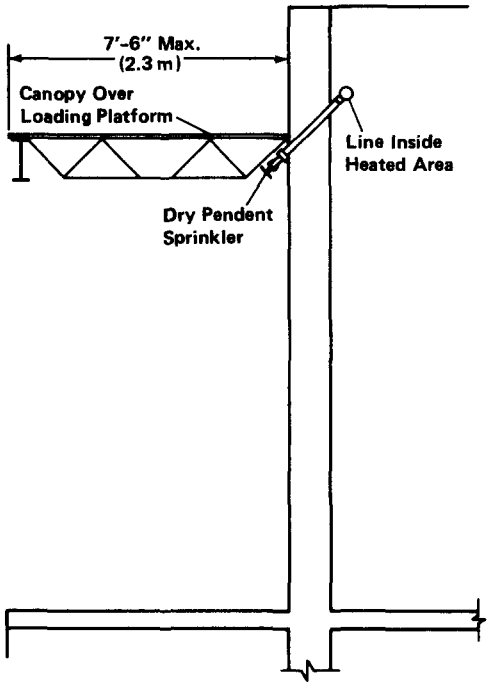


Figure A-4-4.10 Dry Pendent Sprinklers for Protection of Covered Platforms, Shipping Docks, and Similar Areas.

A-4-4.11 Frequently, additional sprinkler equipment can be avoided by reducing the width of decks or galleries and providing proper clearances. Slatting of decks or walkways or the use of open grating as a substitute for automatic sprinklers thereunder is not acceptable. The use of cloth or paper dust tops for rooms forms obstruction to water distribution. If employed, the area below should be sprinklered.

A-4-4.13 For ducts less than 4 ft (1.2 m) wide that obstruct distribution from ceiling sprinklers, see Appendix B-4-2.3.

A-4-4.15 The installation of open-grid egg crate, louver, or honeycomb ceilings beneath sprinklers restricts the sidewise travel of the sprinkler discharge and may change the character of discharge.

A-4-4.16.3 Drop-out ceilings do not provide the required protection for soft-soldered copper joints or other piping that requires protection.

A-4-4.16.4 The ceiling tiles may drop before sprinkler operation. Delayed operation may occur because heat must then bank down from the deck above before sprinklers will operate.

A-4-4.18 Automatic sprinklers protecting commercial-type cooking equipment and ventilation systems should be controlled by separate, readily accessible indicating-type control valves that are properly identified. (*See 3-14.3.*)

A-4-4.20.1 Examples of Sprinkler Spacing within Small Rooms. An example of sprinklers in small rooms for hydraulically designed and pipe schedule systems is shown in Figure A-4-4.20.1(a), and examples for hydraulically designed systems only are shown in Figures A-4-4.20.1(b), (c), and (d).

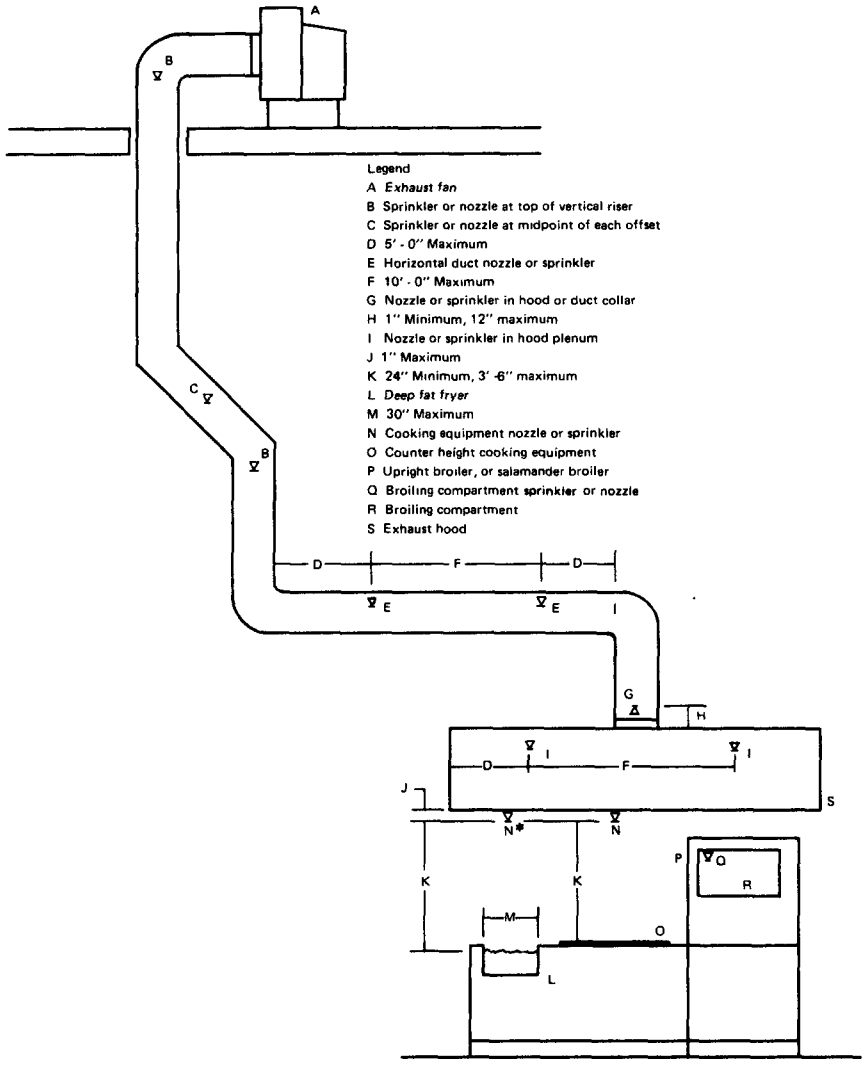
A-4-5 The installation of sidewall sprinklers other than beneath smooth ceilings will require special consideration. Beams or other ceiling obstructions interfere with proper distribution and, when present, sidewall sprinklers should be spaced with regard to such obstructions.

A-4-5.5 Sidewall sprinklers should be placed to receive heat from a fire and at the same time most effectively distribute the water discharged by them. This is likely to be particularly important when heavy decorative molding is encountered near the junction of walls and ceilings.

A-5-1.1 A dry-pipe, preaction, or deluge system may be supplied from a larger wet-pipe system, providing the water supply is adequate.

A-5-2.1 A dry-pipe system should be installed only where heat is not adequate to prevent freezing of water in all or sections of the system. Dry-pipe systems should be converted to wet-pipe systems when they become unnecessary because adequate heat is provided. Sprinklers should not be shut off in cold weather.

When two or more dry-pipe valves are used, systems should preferably be divided horizontally to prevent



*Listed for deep fat fryer protection.

Figure A-4-4.18 Typical Installation Showing Automatic Sprinklers or Automatic Spray Nozzles Being Used for the Protection of Commercial Cooking Equipment and Ventilation Systems.

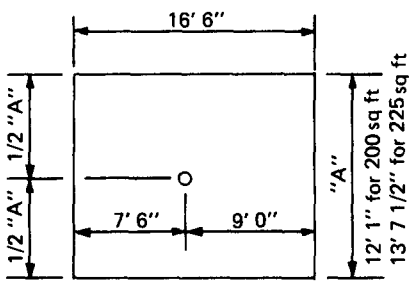


Figure A-4-4.20.1(a).

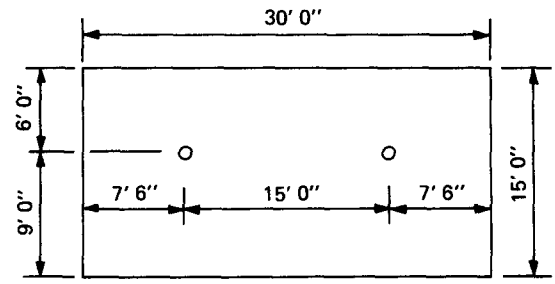


Figure A-4-4.20.1(b).

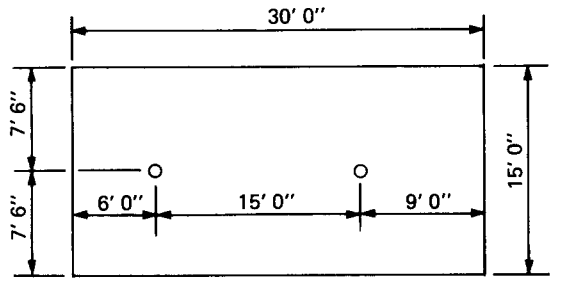


Figure A-4-4.20.1(c).

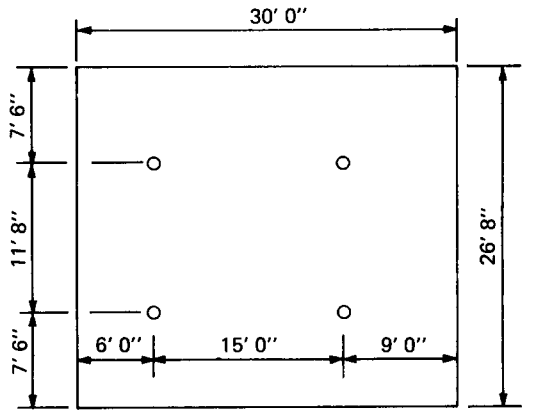


Figure A-4-4.20.1(d).

simultaneous operation of more than one system and resultant increased time delay in filling systems and discharging water, plus receipt of more than one waterflow alarm signal.

When adequate heat is present in sections of the dry-pipe system, consideration should be given to dividing the system into a separate wet-pipe system and dry-pipe system. Minimized use of dry-pipe systems is desirable where speed of operation is of particular concern.

A-5-2.3 The capacities of the various sizes of pipe given in Table A-5-2.3 are for convenience in calculating the capacity of a system.

Table A-5-2.3 Capacity of One Foot of Pipe (Based on actual internal pipe diameters)

Nominal Diameter	Gal Sch 40	Gal Sch 10	Nominal Diameter	Gal Sch 40	Gal Sch 10
¾ in.	0.028	—	3 in.	0.383	0.433
1 in	0.045	0.049	3½ in.	0.513	0.576
1¼ in.	0.078	0.085	4 in.	0.660	0.740
1½ in.	0.106	0.115	5 in.	1.040	1.144
2 in.	0.174	0.190	6 in.	1.501	1.649[1]
2½ in.	0.248	0.283	8 in.	2.66[3]	2.776[2]

For SI Units: 1 ft = 0.3048 m; 1 gal = 3.785 L; 1 in. = 25.4 mm.

[1]0.134 Wall Pipe
[2]0.188 Wall Pipe
[3]Schedule 30

A-5-2.4.2 In the case of dry-pipe valves having relatively small priming chambers and in which the normal quantity of priming water fills, or nearly fills, the entire priming chamber, the objective contemplated by this rule will be met by requiring connection of the quick-opening device at a point on the riser above the dry-pipe valve, which will provide a capacity measure between the normal priming level of the air chamber and the connection of 1½, 2, and 3 gal (5.7, 7.6, and 11.4 L) for 4-, 5-, and 6-in. risers, respectively. Making the connection 24 in. (610 mm) above the normal priming water level will ordinarily provide this capacity.

A-5-2.5 The dry-pipe valve should be located in an accessible place near the sprinkler system it controls.

When exposed to cold, the dry-pipe valve should be located in an approved valve room or enclosure and, where this is not possible, in an underground pit acceptable to the authority having jurisdiction. The room should be of sufficient size to give at least 2½ ft (0.8 m) of free space at the sides and in front of, above and below, the dry-pipe valve or valves, and this room, if feasible, should not be built until the valve is in position.

Size of enclosure should be governed by the number and arrangement of dry-pipe valves, so as to give ready access to these devices.

A-5-2.6 Careful installation and maintenance, and some special arrangements of piping and devices as outlined in this section, are needed to avoid the formation of ice and frost inside piping in cold storage rooms that will be maintained at or below 32°F (0°C). Conditions are particularly favorable to condensation where pipes enter cold rooms from rooms having temperatures above freezing.

Whenever the opportunity offers, fittings such as specified in 5-2.6.1 and illustrated in Figures 5-2.6.1(a) and 5-2.6.1(b), as well as flushing connections specified in 3-8.2, should be provided in existing systems.

When possible, risers should be located in stair towers or other locations outside of refrigerated areas. This would reduce the probabilities of ice or frost formation within the riser (supply) pipe.

Cross mains should be connected to risers or feed mains with flanges. In general, flanged fittings should be installed at points that would allow easy dismantling of the system. Split ring or other easily removable types of hangers will facilitate the dismantling.

A-5-2.7.2 The compressor should draw its air supply from a place where the air is dry and not too warm. Moisture from condensation may cause trouble in the system.

A-5-3.2 Preaction and deluge systems may also have outside sprinklers for protection against exposure fire.

A-5-3.3 Conditions of occupancy or special hazards may require quick application of large quantities of water and in such cases deluge systems may be needed.

Fire detection devices should be selected to assure operation, yet guard against premature operation of sprinklers, based on normal room temperatures and draft conditions.

In locations where ambient temperature at the ceiling is high, from heat sources other than fire conditions, heat-responsive devices that operate at higher than ordinary temperature and are capable of withstanding the normal high temperature for long periods of time should be selected.

When corrosive conditions exist, materials or protective coatings that resist corrosion should be used.

To help avoid ice formation in piping due to accidental tripping of dry-pipe valves in cold storage rooms, a deluge automatic water control valve may be used on the supply side of the dry-pipe valve. When this combination is employed

(a) Dry systems may be manifolded to a deluge valve, the protected area not exceeding 40,000 sq ft (3716 m²). The distance between valves should be as short as possible to minimize water hammer.

(b) The dry-pipe valves should be pressurized to 50 psi (3.4 bars) to reduce the possibility of dry-pipe valve operation from water hammer.

A-5-3.7 Deluge systems are usually applied to severe conditions of occupancy. In designing piping systems the pipe sizes should be calculated in accordance with the standard for hydraulically designed sprinkler systems as given in Chapter 7.

When 8-in. piping is employed to reduce friction losses in a system operated by fire detection devices, a 6-in. preaction or deluge valve and 6-in. gate valve between taper reducers may be used.

A-5-4.1.1 When Installed. Combined dry-pipe and preaction systems may be installed when wet-pipe systems are impractical. They are intended for use in but not limited to structures where a number of dry-pipe valves would be required if a dry-pipe system were installed.

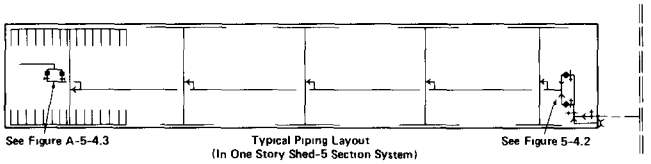


Figure A-5-4.1.1 Typical Piping Layout for Combined Dry-Pipe and Preaction Sprinkler System.

A-5-5.2 Antifreeze solutions may be used for maintaining automatic sprinkler protection in small unheated areas. Antifreeze solutions are recommended only for systems not exceeding 40 gallons (151 L).

Because of the cost of refilling the system or replenishing small leaks, it is advisable to use small dry valves where more than 40 gallons (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.

A-5-5.3.3 Beyond certain limits, increased proportion of antifreeze does not lower the freezing point of solution. (*See Figure A-5-5.3.3.*) Glycerine, diethylene glycol,

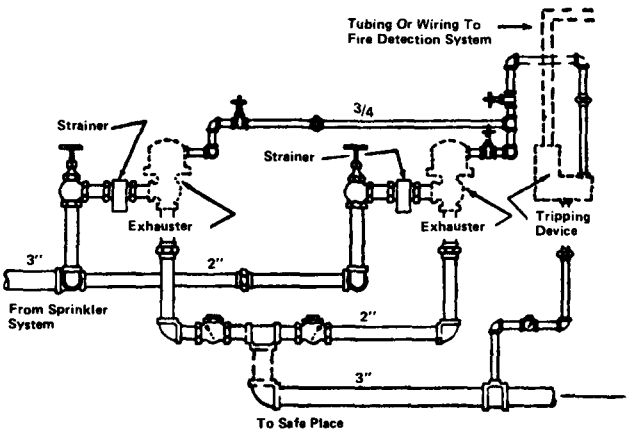


Figure A-5-4.3 Arrangement of Air Exhaust Valves for Combined Dry-Pipe and Preaction Sprinkler System.

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).

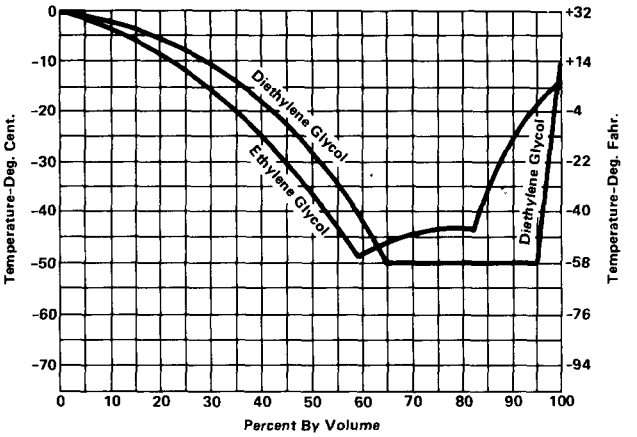


Figure A-5-5.3.3 Freezing Points of Water Solutions of Ethylene Glycol and Diethylene Glycol.

A-5-5.4 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-5-5.5 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-5-6.1.3(a) Outlets should be provided at critical points on sprinkler system piping to accommodate attachment of pressure gages for test purposes.

A-6-1.1.1 The water supply should be capable of furnishing total demand for all exposure sprinklers

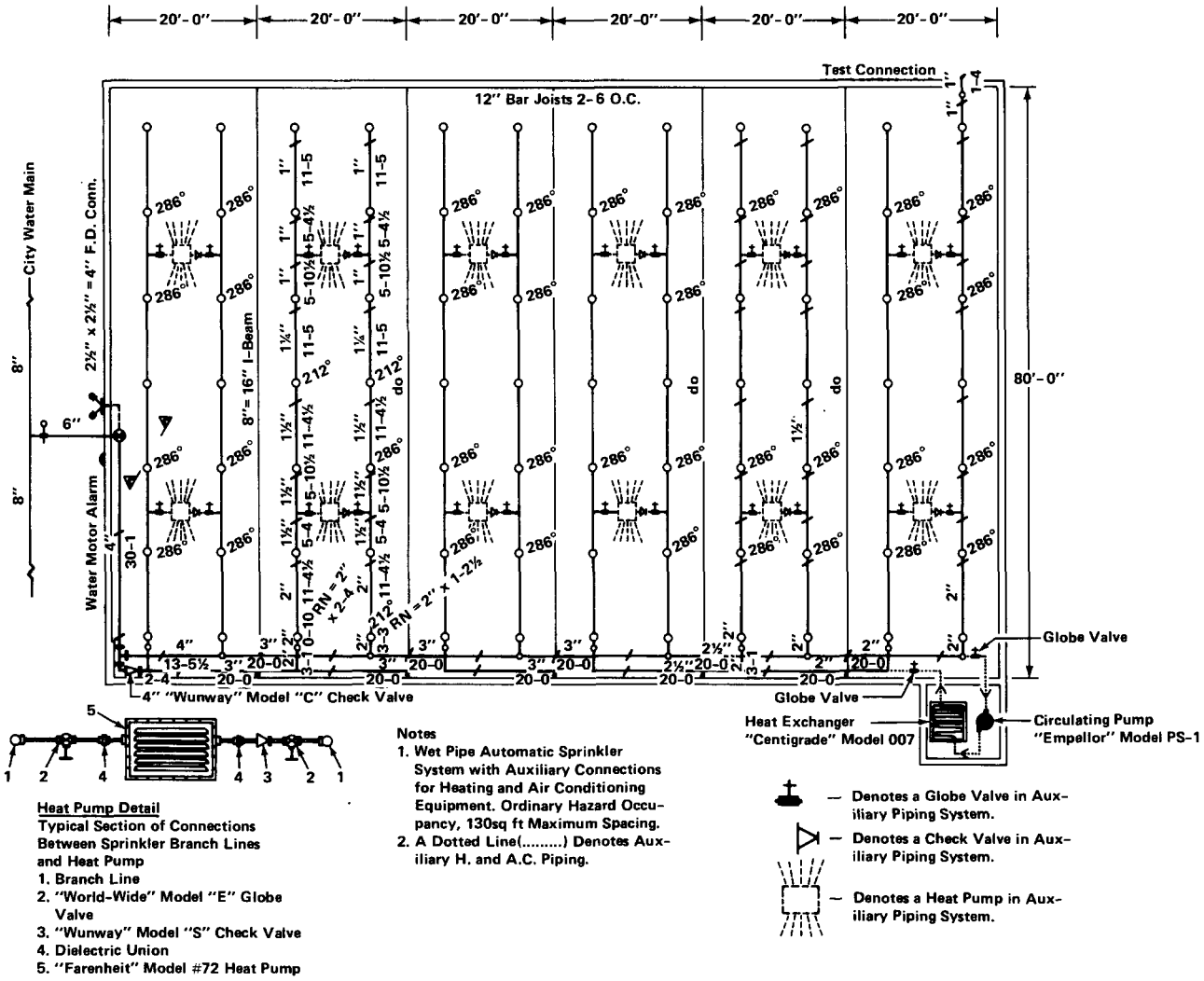


Figure A-5-6.1.10(a) Working Plans for Circulating Closed-Loop Systems