NFPA

13

ANSI / NFPA 13
An American
National
Standard
November 20, 1980

INSTALLATION OF SPRINKLER SYSTEMS 1980

NATIONAL FIRE PROTECTION ASSOCIATION, INC.
Batterymarch Park, Quincy, MA 02269

20M-1-81-FP-BC
Printed in U.S.A.

NOTICE

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 obtaining Formal Interpretations of the document, 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.

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.

NFPA has no power or authority to police or enforce compliance with the contents of this document and any certification of products stating compliance with requirements of this document is made at the peril of the certifier.

Standard for the Installation of Sprinkler Systems

NFPA 13-1980

1980 Edition of NFPA 13

This 1980 edition of NFPA 13, *Standard for the Installation of Sprinkler Systems*, was prepared by the Technical Committee on Automatic Sprinklers and was adopted by the National Fire Protection Association, Inc. at its 1980 Fall Meeting in San Diego, California on November 20, 1980. It was released by the Standards Council on December 10, 1980. It supersedes the 1978 edition.

Changes other than editorial are denoted by a vertical line in the margin of the pages in which they appear.

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 so-called 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, and 1980.

The 1978 edition of this standard was approved by the American National Standards Institute as an American National Standard. The 1980 edition will be submitted for similar approval.

Committee on Water Extinguishing Systems and Related Equipment

Correlating Committee

Paul D. Smith, *Chairman*
Gage-Babcock & Associates, Inc.

Robert M. Hodnett, *Secretary*
National Fire Protection Association
(Nonvoting)

Wayne E. Ault, Rolf Jensen & Assoc., Inc.

Thomas J. Brown, Jr., Factory Mutual Research Corp.

John D. Cook, Catalytic Inc.

Robert H. Merz, Moorestown, NJ

James W. Nolan, James W. Nolan Co.

Chester W. Schirmer, Schirmer Engineering Corp.

J. Samuel Slicer, W. Chatham, MA

Nonvoting

Stephen Gilbert, Scandia Industries
Rep. NFPA Fire Hose Comm.

Technical Committee on Automatic Sprinklers

Chester W. Schirmer, *Chairman*
Schirmer Engineering Corp.

Richard F. Edington, *Secretary*
American Risk Management

Frank E. Cann, Jr., Standard Fire Protection Equipment Co.

Ronald M. Cote, Factory Mutual Research Corp.

John L. DeRoo, Union Carbide Corp.
Rep. NFPA Industrial Fire Protection Section

Lee J. Dosedlo, Underwriters Laboratories Inc.

Denison H. Featherstonhaugh, Vipond Automatic Sprinkler Company, Ltd.
Rep. Canadian Automatic Sprinkler Assn.

D. B. Grant, Insurers Advisory Organization

David M. Hammerman, Office of the Fire Marshal, MD
Rep. Fire Marshals Assn. of North America

W. L. Henry, Dow Chemical Co.
Rep. Manufacturing Chemists Assn.

Richard E. Hughey, Insurance Services Office

Rolf H. Jensen, Rolf Jensen & Assoc., Inc.

Marshall A. Klein, Elderburg, MD
Rep. Fire Marshals Assn. of North America

Richard P. Kuchnicki, National Assn. of Home Builders
(Vote limited to NFPA 13D)

W. N. Lawton, Grinnell Fire Protection Systems Co., Inc.
Rep. National Auto Sprinkler & Fire Control Assn.

Murvan M. Maxwell, Maxwell & LeBreton Architects
Rep. American Institute of Architects

Donald I. McGillivray, Underwriters Labs of Canada

Edward J. O'Donoghue, Industrial Risk Insurers

John G. O'Neill, U.S. NBS/Center for Fire Research

Robert L. Retelle, Insurance Services Office

E. J. Schiffhauer, Eastman Kodak Co.

Harry Shaw, U.S. Fire Administration, FEMA
(Vote limited to NFPA 13D)

John J. Walsh, United Assn. of Journeymen and Apprentices of the Plumbing and Pipe Fitting Industry of the United States and Canada

Harry R. Winchell, Liberty Mutual Insurance Co.
Rep. Alliance of American Insurers

Jack A. Wood, Viking Corp.
Rep. National Auto Sprinkler & Fire Control Assn.

D. M. Yarlas, ICI American Inc.
Rep. NFPA Industrial Fire Protection Section

Alternates

Thomas J. Brown Jr., Factory Mutual Research Corp.
(Alternate to Ronald M. Cote)

Barry L. Clark, Insurance Services Office
(Alternate to R. E. Hughey)

Richard Custer, U.S. NBS/Center for Fire Research
(Alternate to J. G. O'Neill)

Robert E. Duke, Fire Control Inc.
(Alternate to F. E. Cann, Jr.)

Thomas W. Hanna, Road Sprinkler Fitters, Local 669
(Alternate to J. J. Walsh)

Frank C. Hill, Culligan Corp.
(Alternate to National Auto Sprinkler & Fire Control Assn.)

Stephen R. Hoover, Kemper Insurance Cos.
(Alternate to H. Winchell)

Thomas A. Lenton, Libbey-Owens-Ford Co.
(Alternate to J. L. DeRoo)

Joseph T. Merry, Eastman Kodak Co.
(Alternate to E. J. Schiffhauer)

Stanley W. Muller, Sizeler & Muller Architects
(Alternate to M. M. Maxwell)

Morley E. Naylor, Insurance Services Office
(Alternate to R. L. Retelle)

Gerald W. O'Rourke, Schirmer Engineering Corp.
(Alternate to C. W. Schirmer)

Edward Reilly, National Auto Sprinkler & Fire Control Assn.
(Alternate to National Auto Sprinkler & Fire Control Assn.)

J. Kenneth Richardson, Rolf Jensen & Assoc., Inc.
(Alternate to R. Jensen)

Allen J. Stevens, U. S. Fire Administration FEMA
(Alternate to Harry Shaw)

W. L. Stuart, Dow Chemical Co.
(Alternate to W. L. Henry)

Miles Suchomel, Underwriters Laboratories Inc.
(Alternate to L. J. Dosedlo)

William Testa, Grinnell Fire Protection Systems Co., Inc.
(Alternate to National Auto Sprinkler & Fire Control Assn.)

D. B. Tucker, Industrial Risk Insurers
(Alternate to Edward J. O'Donoghue)

Nonvoting

Barry M. Lee, Wormald Brothers, Ltd.

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

Chapter 1 General Information 13- 7
1-1 Scope 13- 7
1-2 Purpose 13- 7
1-3 Definitions 13- 7
1-4 Other Publications 13- 9
1-5 Maintenance 13- 9
1-6 Classification of Sprinkler Systems 13- 9
1-7 Classification of Occupancies 13- 9
1-8 Design and Installation 13- 10
1-9 Working Plans 13- 10
1-10 Approval of Sprinkler Systems 13- 12
1-11 Acceptance Tests 13- 12
1-12 Contractor's Material and Test Certificate 13- 14
1-13 Operation of Sprinkler System Control Valves by Contractors 13- 19
1-14 Units 13- 19

Chapter 2 Water Supplies 13- 20
2-1 General Provisions 13- 20
2-2 Water Supply Requirements for Sprinkler Systems .. 13- 20
2-3 Connections to Water Works Systems 13- 21
2-4 Gravity Tanks 13- 24
2-5 Pumps 13- 24
2-6 Pressure Tanks 13- 24
2-7 Fire Department Connections 13- 25
2-8 Arrangment of Water Supply Connections 13- 27
2-9 Water Supply Test Pipes and Gages 13- 27

Chapter 3 System Components 13- 28
3-1 Piping 13- 28
3-2 Definitions 13- 29
3-3 Area Limitation 13- 30
3-4 Pipe Schedules 13- 30
3-5 Schedule for Light Hazard Occupancies 13- 30
3-6 Schedule for Ordinary Hazard Occupancies 13- 32
3-7 Schedule for Extra Hazard Occupancies 13- 34
3-8 Special Provisions Applicable to Piping 13- 34
3-9 System Test Pipes 13- 36
3-10 Protection of Piping 13- 36

3-11 Drainage 13- 39
3-12 Joining of Pipe and Fittings 13- 42
3-13 Fittings 13- 45
3-14 Valves 13- 45
3-15 Hangers 13- 48
3-16 Sprinklers 13- 55
3-17 Sprinkler Alarms 13- 63

Chapter 4 Spacing, Location and Position of Sprinklers 13- 66
4-1 General Information 13- 66
4-2 Spacing and Location of Sprinklers 13- 68
4-3 Position of Sprinklers 13- 73
4-4 Locations or Conditions Involving Special Consideration 13- 83
4-5 Sidewall Sprinklers 13- 83

Chapter 5 Types of Systems 13- 85
5-1 Wet-Pipe Systems 13- 85
5-2 Dry-Pipe Systems 13- 85
5-3 Pre-Action and Deluge Systems 13- 90
5-4 Combined Dry-Pipe and Pre-Action Systems 13- 92
5-5 Antifreeze Systems 13- 95
5-6 Automatic Sprinkler Systems with Nonfire Protection Connections 13- 98

Chapter 6 Outside Sprinklers for Protection Against Exposure Fires 13-102
6-1 Water Supply and Control 13-102
6-2 System Components 13-102
6-3 Sprinklers 13-104
6-4 Piping System 13-104
6-5 Testing and Flushing 13-105

Chapter 7 Hydraulically Designed Sprinkler Systems .. 13-106
7-1 General 13-106
7-2 Information Required 13-106
7-3 Data Sheets and Abbreviations 13-107
7-4 Calculation 13-110

Chapter 8 High-Rise Buildings 13-115
8-1 Application and Scope 13-115
8-2 Definition 13-115
8-3 Design Criteria 13-115
8-4 Water Supplies 13-115
8-5 Alarms 13-116

Appendix A 13-117

Appendix B 13-185

Appendix C Summary of Spacing Rules 13-195

Appendix D Referenced Publications 13-196

Index 13-199

Standard for the Installation of Sprinkler Systems

NFPA 13-1980

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

Information on referenced publications can be found in Appendix D.

Chapter 1 General Information

1-1 Scope. This standard is the minimum for the installation of sprinkler systems for fire protection in buildings and for the character and adequacy of water supplies to sprinkler systems.

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 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.

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

1-3 Definitions.

Approved. Means "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."

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 a water supply, such as a gravity tank, fire pump, reservoir or pressure tank and/or connection by underground piping to a city main. The portion of the sprinkler system above ground is a network of specially sized or hydraulically designed piping installed in a building, structure or area, generally overhead, and to which sprinklers are connected in a systematic pattern. The system includes a controlling valve and 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, *Outside Protection*.

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 his 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, *Care 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, also 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.*)

Pre-Action Systems (*See Section 5-3.*)

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

Combined Dry-Pipe and Pre-Action 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.

1-8 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 blind spaces and closets (*see 4-4.3 to 4-4.17 inclusive, except 4-4.5 and 4-4.6*)

(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 pre-action or deluge valve

(s) Kind and location of alarm bells

(t) Total number of sprinklers on each dry-pipe system, pre-action system, combined dry-pipe/pre-action 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 and sleeves

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

(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)NFor 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. Before asking final approval of automatic sprinkler equipment by the authority having jurisdiction the installing company shall furnish a written statement to the effect that the work covered by its contract has been completed and tested in accordance with the approved specifications and plans. (*See Section 1-12.*)

1-11 Acceptance Tests.

1-11.1 Performance. All tests required by this standard for new work shall be performed by the installer. When the authority having jurisdiction desires to be present during the conduct of tests, the installer shall give the authority having jurisdiction advance notification of time test will be performed. When the representative of the authority having jurisdiction is not available and permission is granted by that authority, the test may be witnessed by the owner or his representative and the Contractor's Material and Test Certificate (*see Section 1-12*) shall be completed and forwarded to the authority having jurisdiction.

1-11.2* Flushing of Underground Connections.

1-11.2.1 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 which may have entered the underground during the course of the installation. For all systems, the flushing operation shall be continued until water is clear.

1-11.2.2* Underground mains and lead-in connections shall be flushed at a flow rate not less than indicated in Table 1-11.2.2 or at the hydraulically calculated water demand rate of the system, whichever is greater.

Table 1-11.2.2

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

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.

1-11.2.3 Provision shall be made for the disposal of water issuing from test outlets to avoid property damage.

1-11.3 Hydrostatic Tests.

1-11.3.1* Test Pressure. All new systems including yard piping shall be tested hydrostatically at not less than 200 lbs per sq in. (13.8 bars) pressure for 2 hrs, or at 50 lbs per sq in. (3.4 bars) in excess of the maximum static pressure when the maximum static pressure is in excess of 150 lbs per sq in. (10.3 bars).

1-11.3.2 The hydrostatic test pressure shall be measured at the low point of the individual system or zone being tested.

1-11.3.3* 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 Outside Protection*, for permissible leakage in underground piping. The amount of leakage shall be measured by pumping from a calibrated container.

1-11.3.4 Fire Department Connection. Piping between the check valve in the fire department inlet pipe and the outside connection shall be tested the same as the balance of the system.

1-11.3.5 Corrosive Chemicals. Brine or other corrosive chemicals shall not be used for testing systems.

1-11.3.6 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.

1-11.4 Test of Dry-Pipe Systems.

1-11.4.1 Hydrostatic Test. New dry-pipe systems shall be tested hydrostatically as specified in 1-11.3 except that, at seasons of the year which will not permit testing with water, an interim test shall be conducted with air pressure of at least 40 lbs per sq in. (2.8 bars) allowed to stand 24 hrs. The standard hydrostatic test shall be conducted when weather permits. The clapper of a differential-type dry-pipe valve shall be held off its seat during any test at a pressure in excess of 50 lbs per sq in. (3.4 bars) to prevent damaging the valve.

1-11.4.2 Air Test. In dry-pipe systems an air pressure of 40 lbs per sq in. (2.8 bars) shall be pumped up, allowed to stand 24 hrs, and all leaks which allow a loss of pressure over 1½ lbs per sq in. (0.1 bars) for the 24 hrs shall be stopped.

1-11.4.3 Operating Test of Dry-Pipe Valve. A working test of the dry-pipe valve alone and with quick opening device, if installed, shall be made before acceptance.

1-11.5 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.

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 APPROPRIATE INSTRUCTIONS AND CARE AND MAINTENANCE CHARTS AND NFPA 13A BEEN LEFT ON PREMISES ☐YES ☐NO
IF NO, EXPLAIN

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 PIPE	
TYPE	MAKE	MODEL	MIN.	SEC.

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

DRY PIPE OPERATING TEST

	TIME TO TRIP THRU TEST PIPE		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

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 PIPE: STATIC PRESSURE. _____ PSI | RESIDUAL PRESSURE WITH VALVE IN TEST PIPE 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

FLUSHED BY INSTALLER OF UNDERGROUND SPRINKLER PIPING ☐ YES ☐ NO

OTHER EXPLAIN

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

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

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 ☐ YES ☐ NO

ACCORDANCE WITH _____ STANDARD

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 90 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

HYDROSTATIC TEST	ALL NEW UNDERGROUND PIPING HYDROSTATICALLY TESTED AT _____ PSI FOR _____ HOURS
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 ☐ YES ☐ NO IF NO, STATE REASON 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

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 his 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

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.

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 water supply requirement for sprinklers only shall be calculated from the density curves in Table 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.

2-2.1.2.2 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 station installation] shall be added to the sprinkler requirement at the base of the riser at the residual pressure required by the sprinkler system design.

2-2.1.2.3 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.

2-2.1.2.4 The lower duration figure is ordinarily acceptable where remote station water flow alarm service or equivalent is provided.

2-2.1.2.5 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.

2-2.1.2.6 The water supply requirement for sprinklers only shall be based upon the area of the sprinkler operation 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: 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.

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

2-2.1.2.7 For areas of sprinkler operation less than 1500 sq ft (139 m^2), the density for 1500 sq ft (139 m^2) shall be used.

2-2.1.2.8 For dry-pipe systems increase area of sprinkler operation by 30 percent without revising density.

2-2.1.2.9* 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 m^2).

2-2.1.2.10 For hazard classifications other than those indicated see appropriate NFPA standards for design criteria.

2-2.1.3* Water demand for hydraulically designed systems for protecting extra hazard occupancies or extra hazard portions of other occupancies shall be determined by the authority having jurisdiction.

Exception: 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* 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 water flow 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 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
Warehouses	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 bars; 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.

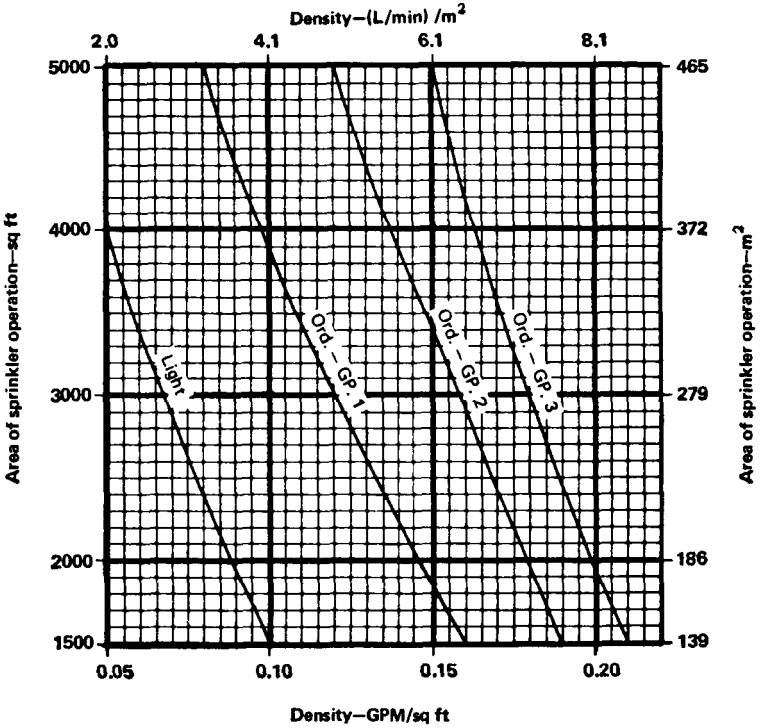
Table 2-2.1(B) Table and Design Curves for Determining Density, Area of Sprinkler Operation and Water Supply Requirements for Hydraulically Designed Sprinkler Systems

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

For SI Units: 1 gpm = 3.785 L/min.

Density Curves



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.

Exception: Unlined cast or ductile iron shall not be less than 4 in. 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, Water Tanks for Private Fire Protection.*)

2-4.2 Capacity and Elevation. The capacity and elevation of the tank and the arangement of the underground supply piping shall provide the volume and pressure required by Table 2-2.1(A) or 2-1.1(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, 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, 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.

2-6.2.1 The size of the pressure tank required shall be in accordance with Table 2-2.1(A) or 2-2.1(B) and shall include the extra capacity needed to fill dry-pipe systems when installed. Minimum requirements when pressure tanks are not the sole water supply source shall be as indicated in 2-6.2.2, 2-6.2.3, and 2-6.2.4.

2-6.2.2 Light Hazard Occupancy. Amount of available water, not less than 2,000 gal (7570 L).

2-6.2.3 Ordinary Hazard Occupancy. Amount of available water, not less than 3,000 gal (11 355 L) for Groups 1 and 2. For Group 3, refer to authority having jurisdiction.

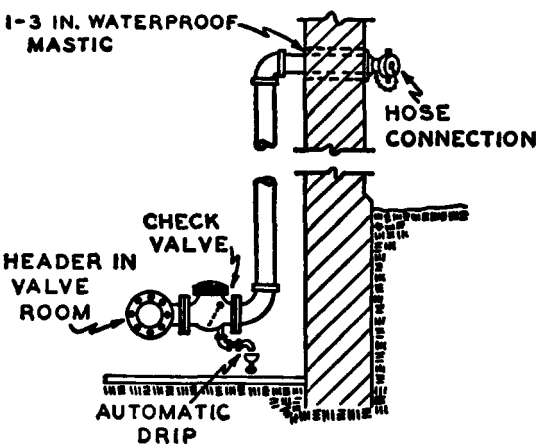
2-6.2.4 Extra Hazard and Woodworker Occupancies. Refer to authority having jurisdiction.

2-6.2.5 For high-rise buildings, see Chapter 8.

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 lbs per sq in. (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 lbs per sq in. (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 When Required. A connection through which a fire department can pump water into the sprinkler system makes a desirable auxiliary supply. For this purpose, a fire department connection shall be provided in all cases except when permission of the authority having jurisdiction is obtained for its omission.



For SI Units: 1 in. = 25.4 mm.

Figure 2-7.1 Fire Department Connection.

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

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 one inch (25 mm) in size cast on plate or fitting reading for service designated: Viz. — "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.

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 Hose coupling threads shall conform to the American National Fire Hose Connection Screw Thread, as specified in NFPA 1963, *Standard for Screw Threads and Gaskets for Fire Hose Connections.*

Exception No. 1: Where local hose coupling threads do not conform to the American National Fire Hose Connection Screw Thread the authority having jurisdiction shall designate the threads to be used.

Exception No. 2: Where local hose couplings are of a type without threads, the authority having jurisdiction shall designate the type of coupling to be used.

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

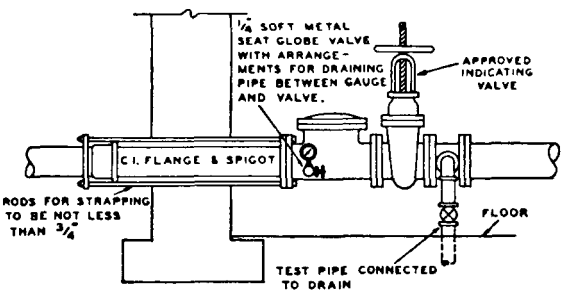
2-8 Arrangment of Water Supply Connections.

2-8.1 Connection Between Underground and System 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. A cast-iron flanged piece is a suitable transition piece.

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 Pipes and Gages.

2-9.1* Test Pipes. Test pipes, 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 pipes 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.*)



For SI Units: 1 in. = 25.4 mm.

Figure 2-9.1 Water Supply Connection with Test Pipe.

2-9.2 Gages.

2-9.2.1 A pressure gage shall be installed on the riser or feed main at or near each test pipe, with a connection not smaller than ¼ in. 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 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).

Table 3-1.1.1

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 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 tube suitable for bending. *(See 3-1.1.7.)*

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.; 0.134 in. (3.40 mm) for 6 in.: and 0.188 in. (4.78 mm) for 8- and 10-in. pipe; or as modified in 3-1.1.5 or as defined in 3-1.1.6.

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. and larger) or Schedule 40 (in sizes less than 8 in.) pipe in Table A2 of ASTM A53 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 fire protection 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, but only those investigated and listed for this service by a testing and inspection agency laboratory.

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 (Type 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. and smaller, and 5 pipe diameters for pipe sizes 2½ in. and larger.

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

Risers. The vertical pipes in a sprinkler system.

System Riser. The abovegound 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 to be protected by sprinklers supplied on each system riser on any one floor shall be as follows:

Light Hazard — 52,000 sq ft (4831 m²)

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

Solid piled storage in excess of 15 ft (4.6 m) in height or palletized or rack storage in excess of 12 ft (3.7 m) in height — 40,000 sq ft (3716 m²)

Extra Hazard — 25,000 sq ft (2323 m²)

Exception: When single systems serve both solid piled storage in excess of 15 ft (4.6 m) or palletized or rack storage in excees of 12 ft (3.7 m) in height and ordinary hazard areas, storage area coverage shall not exceed 40,000 sq ft (3716 m²) and total area coverage shall not exceed 52,000 sq ft (4831 m²).

See NFPA standards, NFPA 231A, *Indoor General Storage*, and NFPA 231C, *Rack Storage of Materials*, for definitions of solid piled, palletized or rack storage.

3-4* Pipe Schedules.

3-4.1 The pipe schedule sizing provisions shall not apply to hydraulically designed systems.

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 pipes 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 occupancy is classified as light hazard and when more than 8 sprinklers on a branch line are necessary, lines may be increased to 9 sprinklers by making the 2 end lengths 1 in. and 1¼ in. respectively, and the sizes thereafter standard. Ten sprinklers may be placed on a branch line making the 2 end lengths 1 in. and 1¼ in. respectively, and feeding the tenth sprinkler by a 2½ in. pipe.

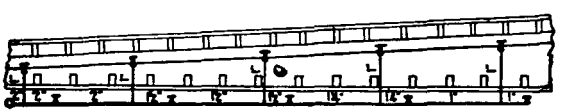
3-5.2 Pipe sizes shall be in accordance with Table 3-5.2.

Table 3-5.2

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

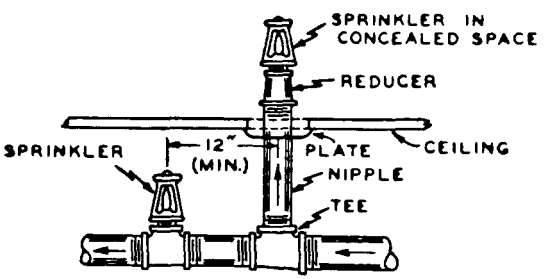
Exception: Each area requiring more than 100 sprinklers and without subdividing partitions (not necessarily fire walls) shall be supplied by feed mains or risers sized for ordinary hazard occupancies.

3-5.3 When sprinklers are installed above and below a ceiling [see Figure 3-5-3(A) and Figure 3-5.3(B)] and such sprinklers are supplied from a common set of branch lines, such branch lines shall not exeeed 8 sprinklers above and 8 sprinklers below the ceiling on either side of the cross main. Pipe sizing, up to and including 2½-in., 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.

Table 3-5.3 Number of Sprinklers Above and Below

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

3-5.3.1* When the total number of sprinklers above and below the ceiling exceeds 50 the pipe supplying more than 50 sprinklers shall be increased to 5 in., and sized thereafter according to the schedule shown in Table 3-5.2 for the number of sprinklers above or below the ceiling, whichever is larger.

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 occupancy is classified as ordinary hazard and when more than 8 sprinklers on a branch line are necessary, lines may be increased to 9 sprinklers by making the 2 end lengths 1 in. and 1¼ in., respectively, and the sizes thereafter standard. Ten sprinklers may be placed on a branch line making the 2 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)

Steel		Copper	
1 in. pipe	2 sprinklers	1 in. tube	2 sprinklers
1¼ in. pipe	3 sprinklers	1¼ in. tube	3 sprinklers
1½ in. pipe	5 sprinklers	1½ in. tube	5 sprinklers
2 in. pipe	10 sprinklers	2 in. tube	12 sprinklers
2½ in. pipe	20 sprinklers	2½ in. tube	25 sprinklers
3 in. pipe	40 sprinklers	3 in. tube	45 sprinklers
3½ in. pipe	65 sprinklers	3½ in. tube	75 sprinklers
4 in. pipe	100 sprinklers	4 in. tube	115 sprinklers
5 in. pipe	160 sprinklers	5 in. tube	180 sprinklers
6 in. pipe	275 sprinklers	6 in. tube	300 sprinklers
8 in. pipe	See Exception No. 1 and 3-3.1	8 in. tube	See Exception No. 1 and 3-3.1

Exception No. 1: For solid piled storage in excess of 15 ft (4.6 m) in height or palletized or racked storage in excess of 12 ft (3.7 m), the area served by any one 8-inch pipe or tube size shall not exceed 40,000 sq ft (3716 m²). Where single systems serve both such storage and ordinary hazard areas, storage area coverage shall not exceed 40,000 sq ft (3716 m²) and total area coverage shall not exceed 52,000 sq ft (4831 m²).

Exception No. 2: 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)

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

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

3-6.3 When sprinklers are installed above and below a ceiling 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 the ceiling on either side of the cross main. Pipe sizing up to and including 3 in. shall be as shown in Table 3-6.3.

Table 3-6.3 Number of Sprinklers Above and Below

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 the ceiling exceeds 60, the pipes supplying more than 60 sprinklers shall be increased to 3½-in. and sized thereafter according to the schedule shown in Table 3-6.2(a) for the number of sprinklers above or below the ceiling, whichever is larger.

3-7 Schedule for Extra Hazard Occupancies.

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

Table 3-7.1

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

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. When piping on wet systems is concealed, with sprinklers installed in pendent position below a ceiling, return bends shall be used when the water supply to the sprinkler system is from a raw water source, millpond, or from open top reservoirs. Return bends shall be connected to the tops of branch lines in order to avoid accumulation of sediment in the drop nipples. In new systems the return bend pipe and fittings shall be one in. in size. In revamping existing systems, where it is not necessary to retain sprinklers in the concealed space, ½-in. or ¾-in. close nipples inserted in the existing sprinkler fittings may be used with one-in. pipe and fittings for the other portions of the return bend. When water supply is potable, return bends are not required on wet systems. *(See Figure 3-8.4.)*

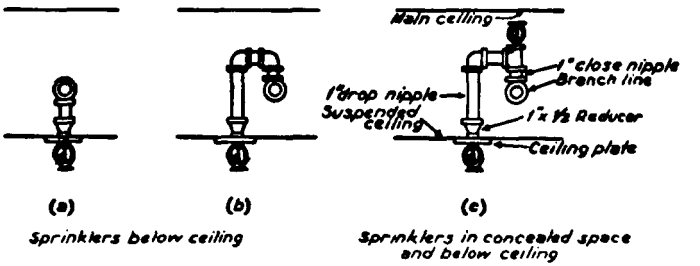


Figure 3-8.4 Pendent Sprinklers at Suspended Ceiling.

3-8.5 Dry Pipe Underground. When necessary to place pipe which will be under air pressure undergound, the pipe shall be protected against corrosion (*see 3-10.2*), or unprotected gasketed joint cast-iron pipe may be used.

3-8.6 One and One-Half-Inch Hose Connections. One and one-half-inch (1½ in.) 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) Piping shall be 1 in. for horizontal runs up to 20 ft (6.1 m), 1¼ in. for runs between 20 and 80 ft (6.1 and 24.4 m), and 1½ in. 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 lbs/psi (6.9 bars), an approved device shall be installed at the outlet to reduce the pressure at the outlet to 100 lbs/psi (6.9 bars).

3-8.7 Hose Connections for Fire Department Use. In buildings of light or ordinary hazard occupancy, 2½-in. hose valves for fire department use may be attached to wet-pipe sprinkler systems 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. unless hydraulic calculations indicate smaller size riser will satisfy sprinkler and hose stream demand.

(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, 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.

(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 refer to Section 2-7.

3-9 System Test Pipes.

3-9.1 Wet Systems.

3-9.1.1* A test pipe of not less than 1-in. diameter terminating in a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler shall be provided for each system.

3-9.1.2* In multi-story buildings where waterflow alarm devices are provided at each riser on each floor or where more than one alarm device is provided in one sprinkler system, a test pipe shall be provided for testing each alarm device.

3-9.2* Dry-Pipe Systems. A 1-in. inspector's test with 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 line in the upper story and be equipped with a 1-in. shutoff valve and cast-iron or brass plug.

3-10* Protection of Piping.

3-10.1 Protection of Piping Against Freezing.

3-10.1.1 When portions of systems 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 in such areas. Preaction systems subject to freezing shall be provided with all drainage facilities required for dry-pipe systems.

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

3-10.1.2 When 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 40°F (4°C).

3-10.2* Protection of Piping Against Corrosion.

3-10.2.1 Where corrosive conditions exist, such as at bleacheries, dye-houses, metalplating processes, animal pens, certain chemical plants and at other locations, where corrosive fumes or moisture may be present, types of pipe tube, fittings and hangers, and protective coatings that resist corrosion shall be used.

3-10.2.2 Steel pipe in overhead feed mains running from one building to another, where exposed to the weather, shall be galvanized, or otherwise protected against corrosion.

3-10.2.3* 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* The basic criteria for protecting piping from earthquake damage is as follows:

(a) Piping shall be made flexible where necessary.

(b) Piping shall be tied to the structure for minimum relative movement, but allowing for expansion, and differential movement within and between structures.

To minimize or prevent pipe breakage where subject to earthquakes, sprinkler systems shall be protected as follows:

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 buildings 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 intermediate floor in multi-story buildings.

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

(d)* On one side of building expansion joints.

3-10.3.3 Fittings. Additional fittings and devices with flexible joints shall be installed where necessary.

3-10.3.3.1 Fittings with flexible joints shall be installed at the top of drops to hose lines regardless of piping size.

3-10.3.3.2 Drops to sprinklers in racks shall be equipped with swing joints assembled with flexible fittings between the rack and the overhead sprinkler system.

Exception: Flexible fittings are not required in the swing joints on drops 3 in. or less in size.

3-10.3.4* Clearance. Sleeves 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 between the pipe and sleeve 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.

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

Exception: When piping enters a building through a basement wall and ground water conditions make providing clearance a problem, the end of the pipe may be attached firmly to the wall, with provisions to allow flexing to take place outside the building. The pipe shall be connected to the riser with fittings with flexible joints.

(c) Floor sleeves shall extend at least 3 in. (76 mm) above the top of the wearing surface.

3-10.3.5* Sway Bracing of Piping Where Subject to Earthquakes.

3-10.3.5.1 Feed and cross mains shall be braced with a two-way sway brace. Tops of risers shall be secured against drifting in any direction, utilizing a four-way sway brace. 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.

3-10.3.5.2 Where "U" hook hangers are used on branch lines, the pipe shall be secured to the end hanger by a wrap-around-type "U" hook. (*See Figure A-3-15.1.*)

3-10.3.5.3 U-type hangers used to support a system will satisfy most of the requirements for sway bracing except that, in general, the longitudinal brace referred to as No. 1 in Figure A-3-10.3.5(b) shall also be required for 2½ in. and larger diameter piping. U-type hangers used as lateral braces shall have legs bent out 10 degrees from the vertical.

3-10.3.5.4 When feed and cross mains are hung with single rods sway bracing shall be provided.

Exception: Sway bracing may be omitted when hanger rods less than 6 in. (152 mm) long are used.

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

3-10.3.5.6 A length of pipe shall not be fastened to sections which will move differently, such as a wall and a roof.

3-10.3.5.7 The last length of pipe at the end of a feed or cross main shall be provided with a transverse brace. Transverse 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.

3-11 Drainage.

3-11.1 Pitching of Piping for Drainage.

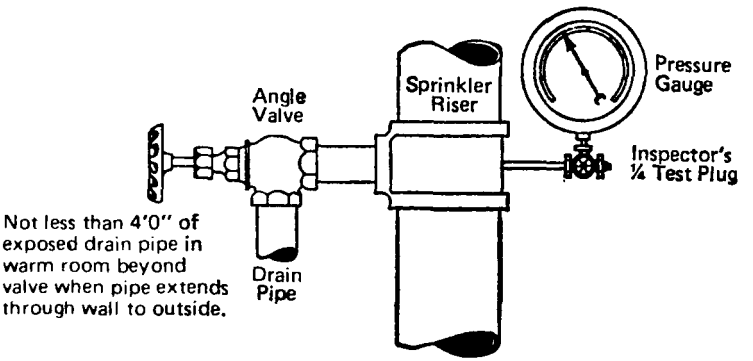
3-11.1.1* All sprinkler pipe and fittings shall be so installed that the system may be drained.

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 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-in. to 1-in. (19 mm 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 where floor may settle under heavy loads.

3-11.2 System or Main Drain Connections and Drain Valves. (*See Figure 3-11.2.*)

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 Sprinkler Riser.

3-11.2.2 On all risers 4 in. or larger, 2-in. drain pipes and valves shall be provided.

3-11.2.3 On risers 2½ in. to 3½ in. inclusive, drain pipes and valves not smaller than 1¼ in. shall be provided.

3-11.2.4 On smaller risers, drain pipe and valves not smaller than ¾ in. shall be provided.

3-11.2.5 All interior sectional control valves shall be provided with an auxiliary drain valve so located as to drain that portion of the system controlled by the sectional valve. These drains shall discharge either outside or to a drain connection.

3-11.2.6 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 capacity of trapped sections of pipe is 5 gal (18.9 L) or less, the auxiliary drain shall consist of a 1 in. nipple and cap or brass plug.

Exception No. 1: Auxiliary drains are not required for piping to a single sprinkler.

Exception No. 2: Existing systems having ¾-in. auxiliary drains from 2 in. and smaller pipe do not require change.

3-11.3.2.2 When capacity of trapped sections of pipe is more than 5 gal (18.9 L), the auxiliary drain shall consist of a 1-in. valve complete with nipple and cap or brass plug.

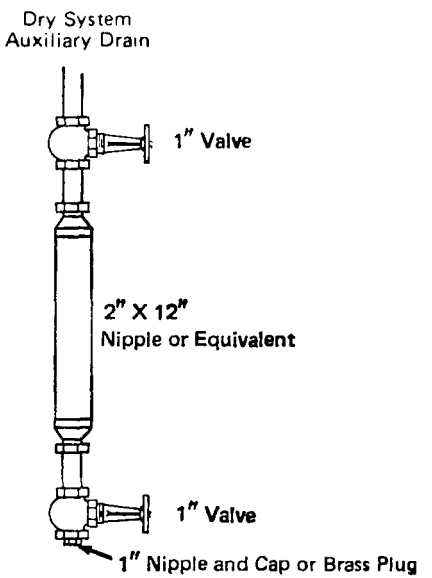
3-11.3.2.3 Tie-in drains are not required on wet-pipe systems.

3-11.3.3 Auxiliary Drains for Dry-Pipe and Pre-Action Systems.

3-11.3.3.1 When capacity of isolated trapped sections of pipe is 5 gal (18.9 L) or less, the auxiliary drain shall consist of a ½-in. valve complete with nipple and cap or brass plug.

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. (*See Figure 3-11.3.3.*)



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

Figure 3-11.3.3

3-11.3.3.3 Tie-in drains shall be provided for multiple adjacent trapped branch lines on dry-pipe or pre-action systems and shall be a minimum of 1-in. in size.

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 corrosive-resistant pipe shall be used.

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

3-11.4.4 Drain pipes when exposed shall be fitted with a turned down elbow.

3-11.4.5* Drain pipes shall be arranged 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 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.

3-12.1.2 All threaded fittings and pipe shall have threads cut to ANSI Standard B2.1. Care shall be taken that the pipe does not extend into the fitting sufficiently to reduce the waterway.

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 which 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. (*See Appendix E.*)

3-12.2.2* Welding sections of sprinkler piping in place inside the building shall not be permitted. Sections of branchlines, 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 Welded fittings and welded formations manufactured, fabricated, or joined in conformance with a qualified welding procedure as set forth herein are an acceptable product under this standard, provided that materials and wall thickness are compatible with other sections of this standard.

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 welded outlets are formed:

(a) Holes in piping shall be cut to full inside diameter of fitting or shaped, contoured nipple.

(b) Discs shall be retrieved.

(c) Openings in piping shall be smooth.

(d) All slag and other welding residue shall be removed.

(e) Fittings or shaped, contoured nipples of any length shall not penetrate beyond the internal diameter of the piping.

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

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

3-12.2.9 When welding is planned, 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 installed by him. 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 he intends to have used by personnel of his 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 in compliance with the requirements of AWS D10.9, Level AR-3.

3-12.2.12 Qualifications Records. 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. 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 couplings shall be joined by a listed combination of couplings, gaskets and grooves. When grooves are cut or rolled on the pipe they shall be dimensionally compatible with the coupling.

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 couplings used with pipe having cut grooves.

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 classfication 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 tyes 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 instruction and the listing.

3-13 Fittings.

3-13.1 Type 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

Material and Dimensions	Standard
Cast Iron	
Cast Iron Screwed Fittings, 125 and 250 lb	ANSI B16.4
Cast Iron Pipe Flanges and Flanged Fittings	ANSI B16.1
Malleable Iron	
Malleable Iron Screwed Fittings, 150 and 300 lb	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.

Exception: Welded fittings or formations as permitted in 3-12.2.

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. 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. 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 Where water pressures are 175 to 300 psi (12.1 to 20.7 bars), the ANSI standards permit the use of standard wall pipe and extra heavy valves. Until pressure ratings for valves are standardized, the manufacturers' ratings shall be observed.

3-13.1.5* When risers are 3 in. in size or larger, a flanged joint or mechanical coupling shall be used at the riser at each floor.

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 sec 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) An underground gate valve of listed type equipped with a listed indicator post,

(b) A listed water control valve assembly which is normally open and requires constant energy application to close and keep closed,

(c) A listed water control valve assembly which has a reliable position indication connected to a remote supervisory station.

3-14.1.2 Drain valves and test valves shall be of listed 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 shall be 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 when arranged as specified in 2-7.3.

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 controlling sprinkler systems, except underground gate valves with roadway boxes, 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,

(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.

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.)*

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

3-15 Hangers.

3-15.1* General.

3-15.1.1 The components of hanger assemblies which directly attach to the pipe or to the building structure shall be listed.

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

3-15.1.2 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 lbs (114 kg) applied at the point of hanging.

3-15.1.3 Types of hangers and installation methods shall be in accordance with the requirements of Section 3-15, unless they are certified by a registered professional engineer for the following:

(a) Designed to support five times the weight of the water-filled pipe plus 250 lbs (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.

3-15.1.4 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.

3-15.1.5 When sprinkler piping is installed below ductwork, piping shall be substantially supported from the building structure or from the steel angles supporting the duct work provided the angles conform to Table 3-15.1.6.

3-15.1.6* For trapeze hangers, the minimum size of steel angle or pipe span between purlins or joists shall be as shown in Table 3-15.1.6, all angles to be used with longer leg vertical. Any other sizes or shapes giving equal or greater section modulus will be acceptable. The trapeze member shall be secured to prevent slippage.

Table 3-15.1.6 Trapeze Members — One foot, six inches to 10 foot spans.

Span of Trapeze Bars	Pipe Size	2½" or Less	3"	3½"	4"	5"	6"	8"	10"
	1' 6"	1½" x 1½" x 5/16" 1" Pipe	1½" x 1½" x 5/16" 1" Pipe	1½" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1¼" Pipe	3" x 2" x 5/16" 1½" Pipe	3" x 2" x ¼" 2" Pipe
	2' 0"	1½" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1½" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2" Pipe
	2' 6"	2" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1½" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2" Pipe	3" x 2" x ¼" 2" Pipe
	3' 0"	2" x 1½" x 5/16" 1" Pipe	2" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1¼" Pipe	3" x 2" x 5/16" 1½" Pipe	3" x 2" x 5/16" 2" Pipe	3½" x 2½" x ¼" 2½" Pipe	3½" x 2½" x 5/16" 2½" Pipe
	4' 0"	2½" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1½" Pipe	3" x 2" x 5/16" 1½" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2" Pipe	3½" x 2½" x 5/16" 2½" Pipe	4" x 3" x 5/16" 3½" Pipe
	5' 0"	2½" x 1½" x 5/16" 1¼" Pipe	2½" x 1½" x 5/16" 1½" Pipe	3" x 2" x 5/16" 1½" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2" Pipe	3½" x 2½" x 5/16" 2½" Pipe	4" x 3" x 5/16" 2½" Pipe	5" x 3½" x 5/16" 4" Pipe
	6' 0"	2½" x 1½" x 5/16" 1½" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2" Pipe	3½" x 2½" x 5/16" 2½" Pipe	4" x 3" x 5/16" 2½" Pipe	4" x 3" x 5/16" 3" Pipe	5" x 3½" x 5/16" 4" Pipe
	7' 0"	3" x 2" x 5/16" 2" Pipe	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2" Pipe	3" x 2" x ¼" 2½" Pipe	3½" x 2½" x 5/16" 2½" Pipe	4" x 3" x 5/16" 3" Pipe	5" x 3½" x 5/16" 3" Pipe	6" x 4" x ¼" 4" Pipe
	8' 0"	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2½" Pipe	3" x 2" x ¼" 2½" Pipe	3½" x 2½" x 5/16" 2½" Pipe	3½" x 2½" x 5/16" 3" Pipe	4" x 3" x 5/16" 3" Pipe	5" x 3½" x 5/16" 3½" Pipe	6" x 4" x ¼" 4" Pipe
	9' 0"	3" x 2" x 5/16" 2" Pipe	3" x 2" x ¼" 2½" Pipe	3½" x 2½" x 5/16" 2½" Pipe	3½" x 2½" x 5/16" 3" Pipe	3½" x 2½" x 5/16" 3½" Pipe	4" x 3" x 5/16" 3½" Pipe	5" x 3½" x 5/16" 4" Pipe	6" x 4" x ⅜" 5" Pipe
	10' 0"	3" x 2" x ¼" 2½" Pipe	3" x 2" x ¼" 2½" Pipe	3½" x 2½" x 5/16" 2½" Pipe	3½" x 2½" x 5/16" 3" Pipe	4" x 3" x 5/16" 3½" Pipe	5" x 3½" x 5/16" 3½" Pipe	6" x 4" x ¼" 4" Pipe	6" x 4" x ⅜" 5" Pipe

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

3-15.1.7 The size of hanger rods and fasteners required to support the steel angle iron or pipe indicated in Table 3-15.1.6 shall comply with 3-15.4.

3-15.1.8 Eye rods and ring hangers shall be secured with necessary lock washers to prevent lateral motion at the point of support.

3-15.1.9 Holes through concrete beams may also be considered as a substitute for hangers for the support of pipes.

3-15.1.10* Maximum Distance Between Hangers. With steel pipe or copper tube as specified in 3-1.1.1, the maximum distance between hangers shall not exceed 12 ft (3.7 m) for 1- and 1¼-in. sizes nor 15 ft (4.6 m) for sizes 1½-in. and larger except as provided in 3-15.6. (*See Figure A-3-15.1.10.*)

3-15.1.11 When sprinkler piping is installed in storage racks as defined in NFPA 231C, 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 lbs (341 kg) for 2-in. or smaller pipe, 1000 lbs (454 kg) for 2½-, 3-, or 3½-in. pipe, and 1200 lbs (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

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

3-15.4.2 "U" Hooks. The size of the rod material of "U" hooks shall be not less than that given in Table 3-12.4.2.

Table 3-15.4.2

Pipe Size	Hook Material Diameter in.	mm
Up to 2 in.	5/16	7.9
2½ in. to 8 in.	3/8	9.5

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

Table 3-15.4.3

Pipe Size	Diameter of Rod With Bent Eye in.	mm	With Welded Eye in.	mm
Up to 4 in.	3/8	9.5	3/8	9.5
5-6 in.	1/2	12.7	1/2	12.7
8 in.	3/4	19.1	1/2	12.7

3-15.4.4 Screws. For ceiling flanges and "U" hooks, screw dimensions shall be not less than those given in Table 3-15.4.4.

Exception: When the thickness of planking and thickness of flange does 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 3-15.4.4

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 3/8 in. x 2 in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 2 in.
8 in.	Lag Screw 5/8 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 3/8 in. x 1½ in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 2 in.
8 in.	Lag Screw 5/8 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 3/8 in. x 2½ in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 3 in.
8 in.	Lag Screw 5/8 in. x 3 in.

For SI Units: 1 in. = 25.4 mm.

3-15.4.5 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 3-15.4.5.

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 3-15.4.5

Size of Pipe	Size of Bolt or Lag Screw in.	Size of Bolt or Lag Screw mm	Length of Lag Screw Used with Wood Beams in.	Length of Lag Screw Used with Wood Beams 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

3-15.4.6 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.

3-15.4.7 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.

3-15.4.8 The minimum thickness of plank and the minimum width of lower face of beams or joists in which lag screw rods are used shall be as given in Table 3-15.4.8.

Table 3-15.4.8

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

Lag screw rods shall not be used for support of pipes larger than 6 inches. All holes for lag screw rods shall be pre-drilled 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 3-15.1.10.

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 3-15.5.6 inclusive.

3-15.5.2 The distance between the hanger and centerline of upright sprinkler shall be no less than 3 in. (76 mm).

3-15.5.3* The unsupported length between the end sprinkler and the last hanger shall be not more than 36 in. (914 mm) for 1-in. pipe, or 48 in. (1219 mm) for 1¼-in. pipe. When these limits are exceeded, the pipe shall be extended beyond the end sprinkler and supported by an additional hanger.

3-15.5.4* When sprinklers are less than 6 ft (1.8 m) apart, hangers may be spaced up to, but not exceeding, 12 ft (3.7 m). (*See Figure A-3-15.5.4.*)

3-15.5.5 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.

3-15.5.6* Hangers are not required on 1-in. arms not over 12 in. (305 mm) long for copper tube, nor 24 in. (610 mm) long for steel pipe from branch lines or cross mains.

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 3-15.1.10. 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, Exception Nos. 1 and 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 buildings designed for live floor loads in excess of 125 lbs per sq ft (611 kg/m²), riser supports shall be provided at the ground level and at each fourth level above. In buildings designed for live floor loads less than 125 lbs per sq ft (611 kg/m²), riser supports shall be provided at ground level and at each third level above. Where risers are supported from the ground, the ground support constitutes the first level of 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 Working Pressure for Sprinklers. 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 Types of Sprinklers.

3-16.2.1 Only listed sprinklers shall be used. Sprinklers shall not be altered in any respect, nor have any type of ornamentation or coatings applied after shipment from the place of manufacture.

3-16.2.2* The character of the discharge of sprinklers is such that it is necessary to use two distinct designs — one approved for the upright and the other for the pendent position.

3-16.2.3 Sprinklers used for the special purposes and locations described in 3-16.2.4 to 3-16.4, inclusive, shall be of types specifically approved for such use.

3-16.2.4 Open sprinklers may be used to protect special hazards, for protection against exposures, or in other special locations.

3-16.2.5 For locations or conditions 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 or preaction systems.

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

3-16.2.6* 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. Large orifice sprinklers having ½-in. iron pipe thread shall not be installed in new sprinkler systems.

3-16.2.7 In situations involving special problems of water distribution, sprinklers having a discharge other than that which is characteristic of the ordinary types may be used. These will usually have special deflectors. Sprinklers having special discharge characteristics may be required where either a fine spray or directional discharge of water is needed (e.g., directional discharge may be needed to properly protect substructures of piers and wharves due to the arrangement of structural supporting members. See NFPA 87, *Standard for the Construction and Protection of Piers and Wharves.*

3-16.2.8* Standard sprinklers may be used to replace old-style sprinklers.

Exception: For installation under piers and wharves where construction features require 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 the standard pendent sprinkler installed in an upright position or by the use of the old-style sprinklers.

3-16.2.9 Old-style sprinklers may be used to replace old-style sprinklers.

3-16.2.10 Old-style sprinklers shall not be used to replace standard sprinklers without a complete engineering review of the system which may result in major changes.

3-16.3 Corrosion-Resistant Sprinklers.

3-16.3.1 Listed corrosion-resistant or special coated sprinklers shall be installed in locations where chemicals, moisture or other corrosive vapors exist sufficient to cause corrosion of such devices as in 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, portions of any plant where corrosive vapors prevail.

3-16.3.2 Wax-coated or Similar Sprinklers.

3-16.3.2.1 Care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating.

3-16.3.2.2 The color identification for coated sprinklers may be a dot on the top of the deflector, the color of the coating material or coating frame arms.

3-16.3.2.3 Color identification is not required for plated sprinklers, ceiling sprinklers or similar decorative types.

3-16.3.3 Corrosion-resistant coatings shall not be applied to sprinklers by anyone other than the manufacturer of the sprinklers.

Exception: Any damage to the protective coating occuring 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.

3-16.4 Sidewall Sprinklers. Sidewall sprinklers are special sprinklers and their use shall be confined to light hazard occupancies as defined in 1-7.1.1, unless specifically designed and listed for ordinary hazard occupancies, or unless used in accordance with 3-16.2.7.

3-16.5* Discharge Capacities. Table 3-16.5 shows the K factor, relative discharge and identification for sprinklers having different nominal 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.)	Orifice Type	"K"[1] Factor	Percent of Nominal ½-in. Discharge	Thread Type	Pintle	Nominal Orifice Size Marked On Frame
¼	Small	1.3-1.5	25	½ in. NPT	Yes	Yes
5/16	Small	1.8-2.0	38.3	½ in. NPT	Yes	Yes
⅜	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	No	No
			or	½ in. NPT	Yes	Yes

[1]"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

3-16.6* Temperature Ratings.

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 sprinkler, ceiling sprinklers or similar decorative types.

Table 3-16.6.1

Temperature Ratings, Classifications and Color Codings

Maximum Ceiling Temperature °F	Maximum Ceiling Temperature °C	Temperature Rating °F	Temperature Rating °C	Temperature Classification	Color Code
100	38	135 to 170	57 to 77	Ordinary	Uncolored
150	66	175 to 225	79 to 107	Intermediate	White
225	107	250 to 300	121 to 149	High	Blue
300	149	325 to 375	163 to 191	Extra High	Red
375	191	400 to 475	204 to 246	Very Extra High	Green
475	246	500 to 575	260 to 302	Ultra High	Orange

3-16.6.2 When higher temperature sprinklers are necessary to meet extraordinary conditions, special sprinklers as high as 650°F (343°C) are obtainable and may be used.

3-16.6.3 The use of sprinklers with temperature ratings higher than ordinary shall be in accordance with the maximum ceiling temperature given in Table 3-16.6.1.

Exception: Intermediate or high temperature sprinklers may be used in other than light hazard occupancies. For situations involving high piled or rack storage refer to NFPA 231, Standard on Indoor General Storage, and NFPA 231C, Standard for Rack Storage of Materials.

3-16.6.4 The following practices shall be observed when installing high temperature sprinklers, unless maximum expected temperatures are otherwise determined or unless high temperature sprinklers are used throughout.

(a) Sprinklers near unit heaters. Where steam pressure is not more than 15 lbs per sq in. (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. (505 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 blow-off valve which 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.

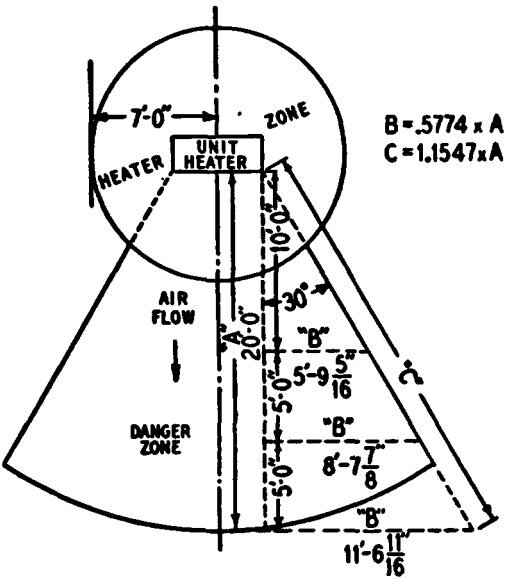
(e) Sprinklers in an unventilated concealed space under an uninsulated roof, or in an unventilated attic, shall be of intermediate temperature classification.

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

(g) Where a locomotive enters a building, sprinklers shall be located not nearer than 5 ft (1.5 m) from the center line of the track.

(h) 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*).

3-16.6.5 In case of change of occupancy involving temperature change, the sprinklers shall be changed accordingly.



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

Figure 3-16.6.4(a) Heater and Danger Zones at Unit Heaters.

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 promptly be replaced. These sprinklers shall correspond as to types and temperature ratings with 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:

For equipments not over 300 sprinklers, not less than 6 sprinklers

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

For equipments above 1,000 sprinklers, not less than 24 sprinklers

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

Table 3-16.6.4(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 3-16.6.4 (a)] extending 7 ft 0 in. above and 2 ft 0 in. below unit 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 3-16.6.4(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. Steam 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) Blow-off Valve	More than 7 ft 0 in.	—	7 ft 0 in. or less

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

Table 3-16.6.4(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.

3-16.8* Guards and Shields. Sprinklers which are so located as to be subject to mechanical injury (in either the upright or the pendent position) shall be protected with approved 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* Sprinkler frames may be factory painted or enameled for the purpose of identifying sprinklers of different temperature ratings in accordance with 3-16.6.1 or as ornamental finish in accordance with 3-16.9.3. Otherwise, sprinklers shall not be painted and any sprinklers which have been painted, except for factory applied coatings, shall be replaced with new listed sprinklers.

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 min after such flow begins. For remote sprinkler water flow alarm transmission see 3-17.6.1.

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

3-17.3 Water Flow Detecting Devices.

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

3-17.3.2 Dry-Pipe Valves. 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 Valves. The alarm apparatus for preaction and deluge systems shall consist of listed alarm attachments, actuated by a detection system independent of flow of water in the system.

3-17.3.4 Waterflow alarm indicators (paddle type) shall not be installed in dry-pipe, preaction or deluge systems. The surge of water when valve trips may seriously damage the device.

3-17.4 Attachments — General.

3-17.4.1* An alarm unit shall include a listed mechanical alarm, horn or siren, or an approved 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 chambers, 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 Dry-pipe, preaction and deluge valves shall be fitted with a test connection for electric alarm switch or water motor gong or both. This pipe connection shall be made on the water 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 to the intermediate chamber of the dry-pipe valve.

3-17.4.5 A control valve shall be installed in connection with pressure-type contactor or water-motor-operated alarm devices and such valves shall be of the type which 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 pararaph.

3-17.5* Attachments — Mechanically Operated. For all types of sprinkler systems employing water-motor-operated alarms, an approved ¾-in. 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 inch.

3-17.6 Attachments — Electrically Operated.

3-17.6.1 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, *Central Station Signaling Systems,*

(b) NFPA 72B, *Auxiliary Protective Signaling Systems,*

(c) NFPA 72C, *Remote Station Protective Signaling Systems,*

(d) NFPA 72D, *Proprietary Protective Signaling Systems.*

3-17.6.2* Electrically operated alarm attachments forming part of a local sprinkler waterflow alarm system shall be installed in accordance with the local alarm system provisions of NFPA 72A, *Standard for Local Protective Signaling Systems,* and in accordance with the provisions of 3-17.6.3, A-3-17.6.2, and 3-17.6.4. This standard permits local electrical waterflow alarms to be of open circuit type.

3-17.6.3 Waterflow detecting devices, including the associated alarm circuits, shall be tested by an actual waterflow through use of a test connection. *(See 3-17.7.)*

3-17.6.4 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 3-17.6.1.

3-17.7 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 Principles.

4-1.1.1 The basic principles for providing proper protection are namely: (1) Sprinklers installed throughout the premises, including basements, lofts and all of the locations herein specified. (2) Definite maximum protection area per sprinkler. (3) Minimum interference to discharge pattern by beams, bracing, girders, trusses, piping, lighting fixtures and air conditioning ducts. (4) Correct location of automatic sprinklers with respect to ceilings, or beams and wood joists to obtain suitable sensitivity.

4-1.1.2 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.

4-1.1.3 Special sprinklers may be installed with larger protection areas or distances between sprinklers than are specified in Sections 4-2 and 4-5 when installed in accordance with their listings.

4-1.1.4* Clearance between sprinklers and structural member shall comply with this standard unless tests are performed which show that deviations offer no obstruction to spray discharge.

4-1.2* Partial Installations. When partial sprinkler installations 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 m^2) 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 m^2) 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 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 boards or planks on wooden beams spaced less than 3 ft (0.9 m) on centers. Wooden beams less than 4 in. (102 mm) nominal thickness spaced more than 3 ft (0.9 m) on centers are also considered as wood joist construction.

4-1.3.8 High-Piled Storage. High-piled storage is defined as solid piled storage in excess of 15 ft (4.6 m) in height or palletized or rack storage in excess of 12 ft (3.7 m) in height. See Appendix D for availability of information for sprinkler protection of high-piled storage.

4-2 Spacing and Location of 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, except high-piled stock, the distance between the branch lines and between sprinklers on branch lines shall not exceed 15 ft (4.6 m). In buildings used for high-piled storage (as defined in 4-1.3.8) 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.

4-2.1.3 For extra hazard occupancy, 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 Distance from Walls. 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.

4-2.2 Protection Area Limitations.

4-2.2.1 Light Hazard Occupancy.

4-2.2.1.1 Under smooth ceiling construction and under beam and girder construction [as defined in 4-1.3.1 items (a) through (i), and 4-1.3.2] the protection area per sprinkler shall not exceed 200 sq ft (18.6 m^2). For hydraulically designed sprinkler systems the protected area limit per sprinkler may be increased to 225 sq ft (20.9 m^2).

4-2.2.1.2* Under open wood joist construction (as defined in 4-1-3-7) 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), except that in buildings used for high-piled storage (as defined in 4-1.3.8) the protection area per sprinkler shall not exceed 100 sq ft (9.3 m²).

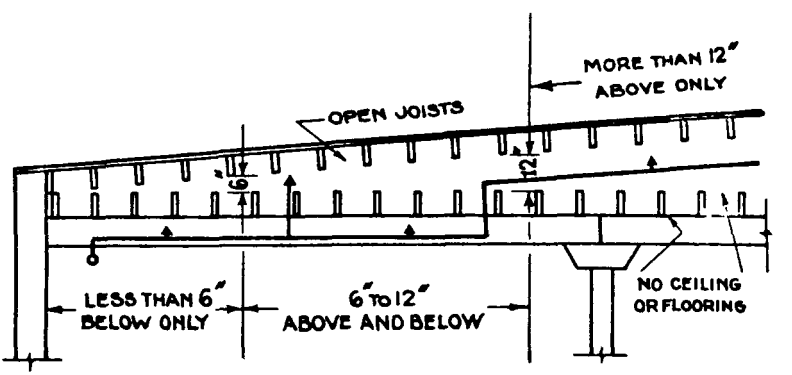
Exception: Sprinkler spacing may exceed 100 sq ft (9.3 m²) but shall not exceed 130 sq ft (12.1 m²) in systems hydraulically designed in accordance with NFPA 231 and 231C for densities below 0.25 gpm per sq ft [(10.2 L/min)/m²)].

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.

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

4-2.3.1 Sprinklers may be located under beams, in bays, or combination of both, 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 from 6 in. to 12 in. (152 mm to 305 mm) between the top of the lower joist and bottom of the upper joist. (*See Figure 4-2.3.2.*)



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 center line of 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,

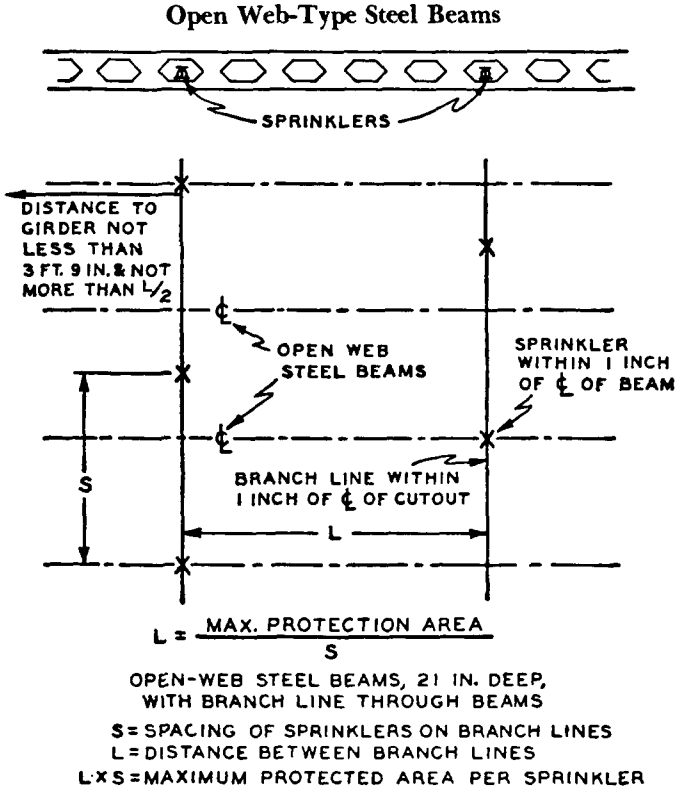
(b) Sprinklers in the beam openings are located within 1 in. (25 mm) horizontally of the opening center line.

(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.

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 beam and the distance shall not exceed ½ of the allowable distance between sprinklers.



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

Figure 4-2.4.4 Location of Branch Lines and 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 not greater than 1 in. per ft (83 mm/m) may be considered as level in the application of this rule and sprinklers may be installed with deflectors horizontal.

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.

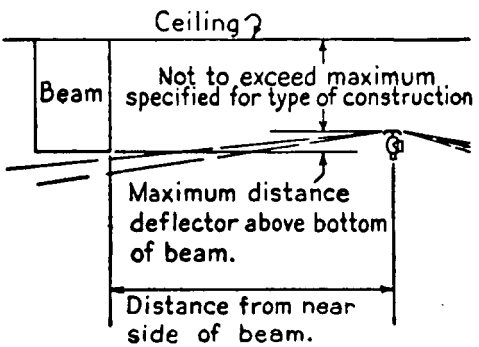


Figure 4-2.4.6 Position of Deflector, Upright or Pendent, When Located Above Bottom of Beam.

4-2.5 Clear Space Below Sprinklers. 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, *Rack Storage of Materials*.

4-3 Position of Sprinklers.

4-3.1 Smooth Ceiling Construction (*as defined in 4-1.3.1*). Deflectors of sprinklers shall be located 1 in. (25 mm) to 10 in. (254 mm) below combustible ceilings or 12 in. (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 in. to 4 in. (25 mm 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 in. (25 mm to 406 mm) below combustible or noncombustible roof or floor decks.

4-3.2.2 Deflectors of sprinklers under beams shall be located 1 in. to 4 in. (25 mm 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 When concrete tee construction is encountered with the stems of the tees spaced less than 7½ ft (2.3 m) on centers but more than 3 ft (0.9 m) on centers, 4-3.2.1 and 4-3.4.1 do not apply when the sprinkler deflectors are located at or above the level of the stems and the deflectors of the sprinklers are located as specified in 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 in. to 10 in. (25 mm to 254 mm) below combustible 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 in. to 18 in. (25 mm 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 in. to 4 in. (25 mm 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 in. to 6 in. (25 mm 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 4-3.1.1 and 4-3.1.3.

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 blind 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 ihe 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 are processed, handled or stored on the floor above.

4-4.4 Concealed Spaces.

4-4.4.1 Sprinklers shall be installed in all concealed spaces enclosed wholly or partly by exposed combustible construction, as in walls, floors and ceilings, except as modified by 4-4.4.2 and 4-4.4.3. In spaces formed by studs or joists, sprinklers shall be provided where there is 6 in. (152 mm) or more clearance between the inside or near edges of the studs or joists which form the opposite sides of the space; the distance from the first sprinkler to the wall, however, need not be less than specified in 4-2.1.4. In partly or wholly combustible bar

joist construction, sprinklers shall be installed wherever the total depth of the space exceeds 6 in. (152 mm) between roof or floor deck and ceiling; the spacing of sprinklers in that case may be on the basis of light hazard classification provided the space is not accessible for storage or other use.

4-4.4.2 Sprinklers may be omitted from combustible concealed spaces when any of the following conditions prevail:

(a) When the ceiling is attached directly to the underside of the supporting beams of a combustible roof or floor deck.

(b) When concealed space is entirely filled with a noncombustible insulation. In solid joisted construction the insulation need fill only the space from the ceiling to the bottom edge of the joist of the roof or floor deck.

(c) When there are small concealed spaces over rooms that do not exceed 50 sq ft (4.6 m^2) in area.

4-4.4.3 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.

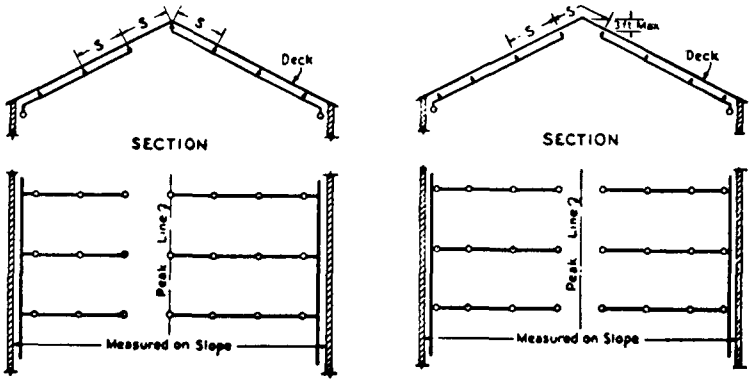
(b) If the exposed combustibles are in the horizontal plane, permission may be given to protect the area of the combustibles on a light hazard spacing and add a row of sprinklers not over 6 ft (1.8 m) outside the outline of the area and not over 12 ft (3.7 m) along the outline. When the outline returns to a wall or other obstruction, the last sprinkler shall not be over 6 ft (1.8 m) from 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 be not 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 Figure 4-4.5.3.*)

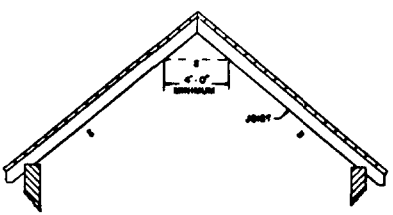


S — spacing of sprinklers on branch slopes

For SI Units: 1 ft = 0.3048 m.

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

4-4.5.4 In a steeply pitched roof, the distance from the peak to deflectors may be increased to maintain a horizontal clearance of not less than 2 ft (0.6 m). (*See Figure 4-4.5.4.*)



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

Figure 4-4.5.4 Desirable Horizontal Clearance for Sprinklers at Peak of Pitched Roof.

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 side wall 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 which 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 Shafts.

4-4.8.1 Vertical Shafts.

4-4.8.1.1 Within vertical shafts having combustible sides, sprinklers shall be provided for each 200 sq ft (18.6 m^2) of combustible surface, in addition to sprinklers at tops of shafts. Such sprinklers shall be installed at each floor level when shaft is trapped.

4-4.8.1.2 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, large monumental staircases, or similar floor openings are unenclosed, the floor openings involved shall be protected by draft stops in combination with closely spaced sprinklers.

4-4.8.3 Noncombustible stair shafts ordinarily will require sprinklers only at the top and lower tiers except when serving two or more separate fire sections when sprinklers will also be required at each floor landing.

4-4.9* Building Service Chutes. Building service chutes (linen, rubbish, etc.) shall be protected internally by automatic sprinklers. This will require a sprinkler at the top of the chute and, in addition, a sprinkler shall be installed within the chute at alternate floor 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 canopies are not used for storage or handling.

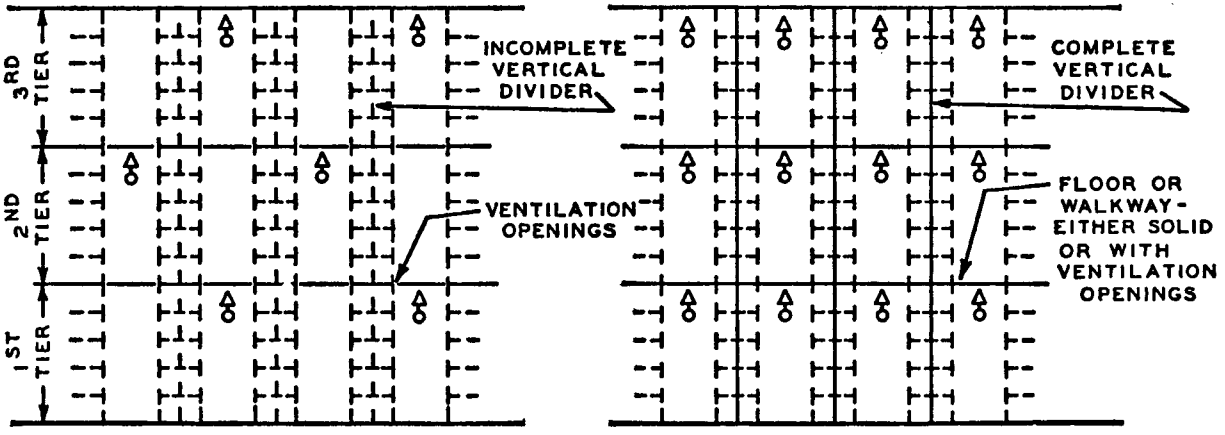
4-4.10.3 Sprinklers shall be installed under exterior docks and platforms of combustible construction unless such space is closed off and protected against accumulation of debris.

4-4.11* Decks. Sprinklers shall be installed under decks and galleries which are 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.

4-4.12 Library Stack Rooms. For single tier stacks where 18-in. (457-mm) clearance can be provided between sprinkler deflectors and top of stacks, sprinklers shall be located without regard to stacks. For multi-tier stacks and for single-tier stacks where 18-in. (457-mm) clearance is not available between sprinkler deflectors and tops of stacks, branch lines shall be located in alternate aisles or in each aisle, depending on the arrangement of vertical shelf dividers. When vertical shelf dividers are incomplete, branch lines should be located in alternate aisles. If there are ventilation openings through floors or walkways, the location of branch lines shall be staggered in a vertical plane. When vertical shelf dividers are complete, so that lateral spread of sprinkler discharge will be prevented, branch lines shall be located in each aisle. (*See Figure 4-4.12.*)

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.



SPRINKLERS IN MULTITIER LIBRARY BOOKSTACKS

Figure 4-4.12

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 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.

(a) In light hazard occupancies when spacing of sprinklers of either standard or old style is not wider than 10 by 10 ft (3 x 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 x 3 m) but not wider than 10 by 12 ft (3 x 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 x 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 x 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 x 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.

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.*)

4-4.17 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. pipe..... 4 sprinklers	2 in. pipe.....20 sprinklers
1¼ in. pipe..... 6 sprinklers	2½ in. pipe.....40 sprinklers
1½ in. pipe.....10 sprinklers	3 in. pipe.....80 sprinklers

4-4.17.3 Sprinklers shall be of approved 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 Systems.

4-4.18.1 In cooking areas protected by automatic sprinklers, sprinklers 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 Vapor Removal from Cooking Equipment.*) Sprinklers shall be so located as to give complete coverage of cooking surfaces, within exhaust ducts, within exhaust hood plenum chamber, and under filters, if any.

4-4.18.2 Sprinklers with temperature classifications of intermediate, high or extra high will be required. Use of a temperature measuring device may be necessary to determine the appropriate temperature classification. Sprinkler systems shall be designed so that a cooking surface fire will operate sprinklers protecting the cooking surface prior to or simultaneously with sprinklers protecting the plenum chamber and ventilation ducts. This may be accomplished by installing sprinklers in the plenum chamber and ducts at least two temperature ratings higher than those protecting the cooking surfaces and not less than 325°F (163°C) or by use of thermal control valves.

4-4.18.3 Distance between sprinklers shall not exceed 10 ft (3 m) within and under exhaust hoods and in horizontal ducts. The first sprinkler in a horizontal duct shall be installed at the duct entrance.

4-4.18.4* A standard one-half in. orifice pendent sprinkler with the frame parallel to the front edge of the deep fat fryer(s) shall be centered over each single or pair of fryers. A single sprinkler shall not protect more than 30 in. (762 mm) of deep fat fryer surface in any dimension. Sprinklers protecting deep fat fryers shall have their deflectors located at least 1 in. (25 mm) below the lower edge of the hood, and not less than 2 ft (0.6 m) nor more than 3 ft, 6 in. (1.1 m) above the deep fat fryer cooking surface.

Exception: Listed automatic spray nozzles may be used for the protection of deep fat fryers. The position, arrangement, location and water supply of individual spray nozzles shall be verified by approved test procedure.

4-4.18.5 Other sprinklers shall be arranged so that their run-off 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.

4-4.18.6 One sprinkler shall be installed at the top of each vertical riser and an additional sprinkler shall be installed under any offset. Subject to the approval of the authority having jurisdiction, sprinklers 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).

4-4.18.7 Sprinklers and piping located at the top of a vertical riser, near the extremity of an exhaust duct, or in other areas subject to freezing, shall be properly protected against freezing by approved means.

4-4.18.8 Automatic sprinklers and spray nozzles used for protecting commercial-type cooking equipment and ventilation systems shall be replaced annually.

4-4.19 Baffles. Baffles (*except for in-rack sprinklers, see NFPA 231C, Standard on 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. When placed on branch line piping, the top of baffles shall extend 2 to 3 in. (51 to 76 mm) above the deflectors. (*See Figure A-3-15.5.4.*)

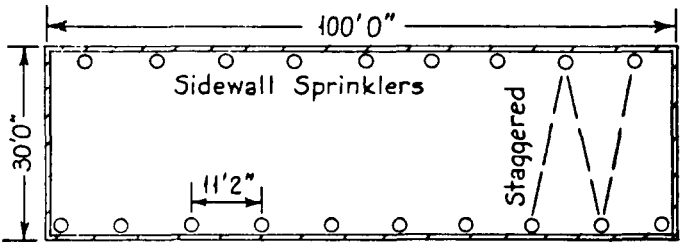
4-4.20 Small Rooms. Small room means a room with a smooth ceiling area not exceeding 800 sq ft (74.3 m²) of light hazard occupancy classification.

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.

4-5* Sidewall Sprinklers. *(See 3-16.4.)*

4-5.1 Distance Between Branch Lines and Sprinklers on Branch Lines.

4-5.1.1 Distance Between Branch Lines. Rooms or bays having widths in excess of 15 ft up to 30 ft (4.6 m to 9.1 m) shall have sprinklers on two opposite walls or two opposite sides of bays with spacing as required in Section 4-5 and sprinklers regularly staggered. Additional branch lines shall be provided in rooms over 30 ft (9.1 m) in width except where special sprinklers are used *(see 4-1.1.3)*.



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

Figure 4-5.1.1 Spacing of Sidewall Sprinklers under Smooth Ceilings, with Light Hazard Occupancy.

4-5.1.2 Distance Between Sprinklers on Branch Lines. Sidewall sprinklers shall be located not more than 10 ft (3 m) apart on walls for ordinary hazard occupancies and not more than 14 ft (4.3 m) apart for light hazard occupancies.

4-5.2 Protection Area Limitations for Light Hazard Occupancy.

4-5.2.1 With noncombustible smooth ceiling the protection area allotted per sprinkler shall not exceed 196 sq ft (18.2 m²) with the distance between sprinklers on lines not in excess of 14 ft (4.3 m).

4-5.2.2 With combustible smooth ceiling sheathed with plasterboard, metal, or wood lath and plaster, the protection area allotted per sprinkler shall not exceed 168 sq ft (15.6 m²) with the distance

between sprinklers on lines not in excess of 14 ft (4.3 m). When sheathing is combustible such as wood, fiberboard or other combustible material, the protection area allotted per sprinkler shall not exceed 120 sq ft (11.1 m^2) with the distance between sprinklers on lines not in excess of 14 ft (4.3 m).

4-5.3 Protection Area Limitations for Ordinary Hazard Occupancy.

4-5.3.1 With noncombustible smooth ceiling the protection area allotted per sprinkler shall not exceed 100 sq ft (9.3 m^2) with the distance between sprinklers on lines not in excess of 10 ft (3 m).

4-5.3.2 With combustible smooth ceiling sheathed with plasterboard, metal, wood lath and plaster, wood, fiberboard or other combustible material, the protection area per sprinkler shall not exceed 80 sq ft (7.4 m^2) per sprinkler with the distance between sprinklers on lines not in excess of 10 ft (3 m).

4-5.4* 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: Horizontal-type sidewall sprinklers may be positioned 6 to 12 in. (152 to 305 mm) below noncombustible ceilings when listed for these positions.

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. Approved pressure gages conforming to 2-9.2.2 shall be installed in sprinkler risers, above and below each alarm check valve.

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 approved dry pendent type if installed in an area subject to freezing. The use of standard pendent sprinklers installed on return bends is 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 500-gal (1893-L) system capacity for gridded systems or not more than 750-gal (2839-L) system capacity for nongridded systems shall be controlled by one dry-pipe valve.

Exception No. 1: If check valves are installed in branches of the system to assist in more rapidly reducing the air pressure above the valve seat to the dry-pipe valve trip point, systems may exceed the above volume limitations, but no system branch shall have a capacity exceeding 400 gal (1514 L) for gridded systems nor 600 gal (2271 L) for nongridded systems, nor shall the total of a system branch plus common pipe exceed 500 gal (1893 L) for gridded systems nor 750 gal (2839 L) for nongridded systems. A hole ⅛ in. (3.2 mm) in diameter shall be drilled in the clapper of each check valve to permit equalization of air pressure among the various parts of the system. An approved indicating drain valve, connected by a bypass around each check valve, shall be provided as a means for draining the system. All check valves shall be located in heated enclosures to prevent the formation of ice.*

Check valves shall not be installed in any piping where they may interfere with the hydraulic characteristics of the system, such as in the branch lines or cross mains of a gridded system.

Exception No. 2: Piping volume may exceed 500 gal (1893 L) for gridded systems or exceed 750 gal (2839 L) for nongridded systems if the system design is such that water is delivered to the inspector's test pipe in not more than 60 sec, starting at the normal air pressure on the system.

5-2.4* Quick-Opening Devices.

5-2.4.1 When Required. Dry-pipe valves shall be provided with an approved quick-opening device where system capacity exceeds 350 gal (1325 L) for gridded systems or capacity exceeds 500 gal (1893 L) for nongridded systems.

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 made 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 provided to accelerate operation of dry-pipe valve.

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 which 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.

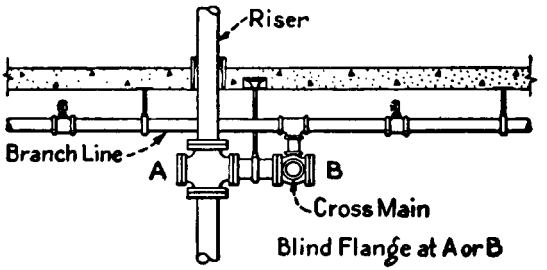
5-2-5.3 The supply for the sprinkler in the dry-pipe valve enclosure shall be from the dry side of the system.

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.

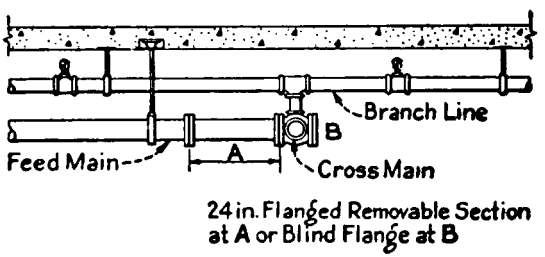
5-2.6* Cold Storage Rooms.

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



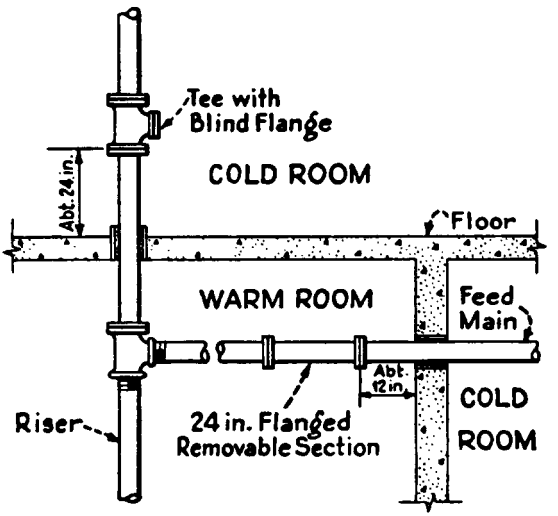
(b) Elevation at Feed Main and Cross Main

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

Figure 5-2.6.1(A) Fittings to Facilitate Examination of Feed Mains, Risers, and Cross Mains in Freezing Areas.

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).



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

Figure 5-2.6.1(B) Fittings in Feed Main or Riser Passing Through Wall or Floor from Warm Room to Cold Room.

5-2.6.2 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 min, 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. 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.

5-2.7.4 Relief Valve. An approved relief valve shall be provided between compressor and controlling valve set to relieve at a pressure 5 psi (0.3 bars) in excess of maximum air pressure which 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 fitting below relief valve.

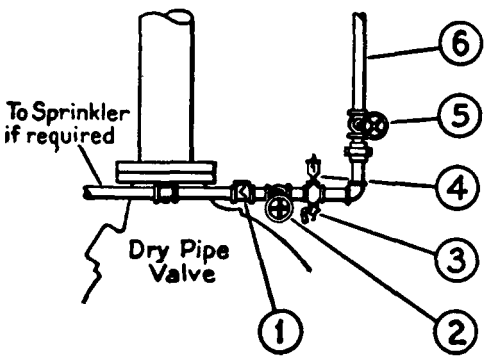


Figure 5-2.7.5 Air Supply from Shop System.

1. Check Valve
2. Control Valve (Renewable Disc Type)
3. Small Air Cock (Normally Open)
4. Relief Valve
5. Same as No. 2
6. Air Supply

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 back flow prevention device shall be installed in the air supply to each system to prevent air or water flow from one system to another.

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 1-11.4.2.

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 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 Pre-Action and Deluge Systems.

5-3.1 Definitions.

Pre-Action System means 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 which permits water to flow into the sprinkler piping system and to be discharged from any sprinklers which may be open.

Deluge System means a system employing open sprinklers attached to a piping system connected to a water supply through a valve which 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. Pre-action and deluge systems are normally without water in the system piping and the water supply is controlled by an automatic valve operated by means of fire detection devices and provided with manual means for operation which are independent of the sprinklers. Systems may have equipment of the types described in (a) through (f) below. (*See 5-3.5.1*)

(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 pre-action or deluge systems shall be tested hydrostatically as specified in 1-11.3.1. 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 test is completed.

5-3.4 Location and Spacing of Fire Detection Devices. Spacing of fire detection devices shall be in accordance with their listing by testing laboratories or in accordance with manufacturer's specification.

5-3.5 Pre-Action Systems.

5-3.5.1 Size of Systems. Not more than 1,000 closed sprinklers shall be controlled by any one pre-action valve.

5-3.5.2 Supervision. Sprinkler piping and fire detection devices shall be automatically supervised when there are more than 20 sprinklers on the system.

5-3.5.3 Pipe Schedule. (*See Sections 3-5, 3-6, 3-7 and Chapter 7.*)

5-3.5.4 Pendent Sprinklers. Automatic sprinklers on pre-action systems installed in the pendent position shall be of the approved dry pendent type if installed in an area subject to freezing.

5-3.6* Deluge Systems. The fire detection devices or systems shall be automatically supervised when there are more than 20 sprinklers on the system.

5-3.7 Devices for Test Purposes and Testing Apparatus.

5-3.7.1 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 which will assure a proper test of the circuit.

5-3.7.2 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.

5-3.7.3 Pressure Gages. Approved pressure gages conforming to 2-9.2.2 shall be installed as follows:

(a) Above and below pre-action valve and below deluge valve.

(b) On air supply to pre-action and deluge valves.

5-4 Combined Dry-Pipe and Pre-Action Systems.

5-4.1 General.

5-4.1.1* Definition. A Combined Dry-Pipe and Pre-Action Sprinkler System. A system 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 which 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 pre-action 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 pre-action 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.

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. 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 same 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 pre-action 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. 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.

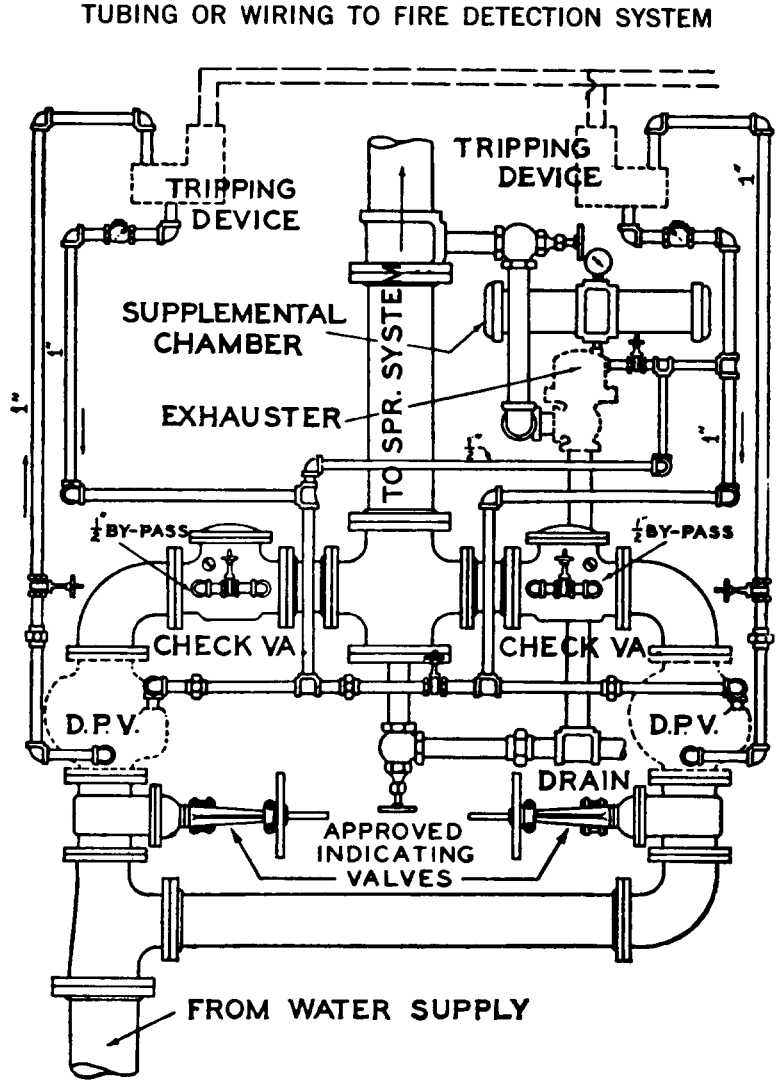


Figure 5-4.2 Header for Combined Dry-Pipe and Pre-Action Sprinkler System Standard Trimmings Not Shown.

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 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. 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 20 sprinklers or less.

5-4.4.3 Air exhaust valves at end of 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 furthest sprinkler within a period of time not exceeding 1 min 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 Inspector's Test Connection. The end section shall have an inspector's test connection as required for dry-pipe systems.

5-5 Antifreeze Systems.

5-5.1 Definition. Antifreeze system means a system 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)	Spec. Grav. at 60°F (15.6°C)	Freezing Point °F	Freezing Point °C
Glycerine C.P. or U.S.P. Grade*	50% Water	1.133	−15	−26.1
	40% Water	1.151	−22	−30.0
	30% Water	1.165	−40	−40.0
	Hydrometer Scale 1.000 to 1.200			
Propylene Glycol	70% Water	1.027	+ 9	−12.8
	60% Water	1.034	− 6	−21.1
	50% Water	1.041	−26	−32.2
	40% Water	1.045	−60	−51.1
	Hydrometer Scale 1.000 to 1.120 (Subdivisions 0.002)			

*C.P. — Chemically Pure.
U.S.P.— United States Pharmacopoeia 96.5%.

Table 5-5.3.2 Antifreeze Solutions

Suitable for Use if Public Water Is Not Connected to Sprinklers

Material	Solution (by Volume)	Spec. Grav. at 60°F (15.6°C)	Freezing Point °F	Freezing Point °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 corrosion inhibitor of sodium bichromate ¼ 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

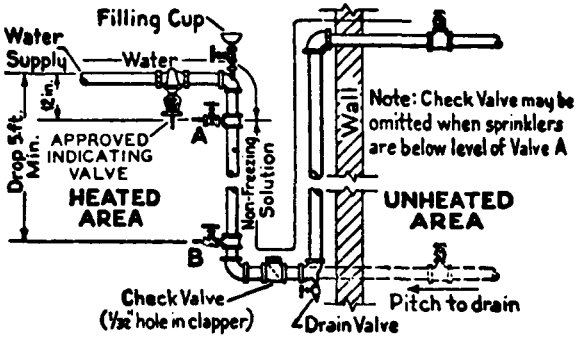
*Free from magnesium chloride and other impurities.

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 $\frac{1}{32}$-in. (3.2-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 filling cup is also shown.



NOTE: The $\frac{1}{32}$-in. (3.2-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 Piping, fittings, valves and pipe hangers shall meet requirements specified in Chapter 3.

5-6.1.2.2 A dielectric fitting shall be installed in junction where dissimilar piping materials are joined, e.g., copper to steel.

Exception: Dielectric fittings are not required at junction where sprinklers are connected to piping.

5-6.1.2.3 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 required rating of sprinkler system components.

5-6.1.2.4 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.

5-6.1.2.5 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) Shut-off 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 shut-off 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 which 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 Sprinkler water flow signal shall not be impaired when water is discharged through opened sprinkler or through Inspector's 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 pipes 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) Water flow tests have been conducted and water flow 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, water flow 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 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 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 together 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.

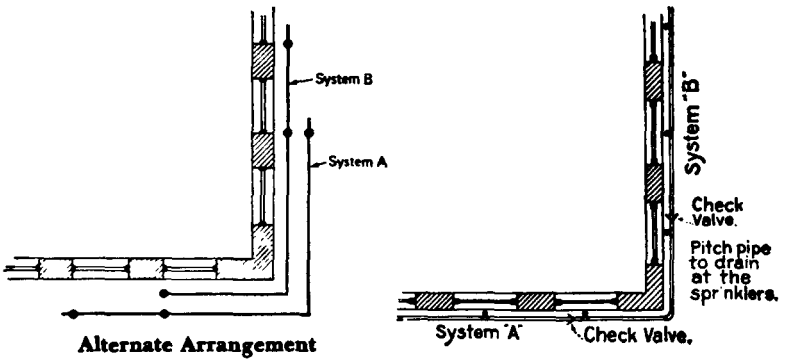


Figure 6-2.1.4 Arrangement of Check Valves.

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. Pressure gage shall be installed just below control valve of each system.

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.

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)	5/16 (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

[1]For additional information on outside sprinklers see Appendix B-6-1.

6-4.3 Risers and feed main sizes on pipe schedule systems shall be as follows for central feed risers:

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

6-5 Testing and Flushing.

6-5.1 Tests.

6-5.1.1 All piping shall be tested hydrostatically as specified in 1-11.3.

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 1-11.2.

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)/m²] 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. nominal for ferrous piping and ¾-in. 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. Unless an alternate means of identification is provided by owner, the installer shall properly identify a hydraulically designed automatic sprinkler system by a permanently attached placard indicating the location, and the basis of design (discharge density over designed area of discharge, including gallons per minute and residual pressure demand at base of riser). Such signs shall be placed at the controlling alarm valve, or dry-pipe valve, for the system containing the hydraulically designed layout.

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 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 Work Sheets. Detailed work sheets (*for sample work sheet, 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) Elevation head in psi between reference points

(k) Required pressure in psi at each reference point

(l) Velocity pressure and normal pressure if included in calculations

(m) Notes to indicate starting points, reference to other sheets or to clarify data shown

(n)* 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(n).]*

7-3.4* Graph Sheet. Water supply curves and system requirements, plus hose demand when applicable, shall be plotted on semi-logarithmic graph paper 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
DPV	Dry-Pipe 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 Hazen and Williams formula.

$$p = \frac{4.52}{C^{1.85}} \frac{Q^{1.85}}{d^{4.87}}$$

where p is the frictional resistance in pounds pressure per square inch per feet 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 functional resistance in bars per metre of pipe, Q_m is the flow in L/min and d_m is the actual internal diameter in mm with C as the function 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 bars.

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 bars). The highest pressure at the junction point shall be carried into the calculations.

7-4.2 Equivalent Pipe Lengths of Valves and Fittings. 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.

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.

Use with Hazen and Williams' C = 120 only. For other values of C, the figures in Table 7-4.2 should be multiplied by the factors indicated below:

Value of C	100	120	130	140	150
Multiplying factor	0.713	1.00	1.16	1.33	1.51

(This is based upon the friction loss through the fitting being independent of the C factor applicable to the piping.)

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.

*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* 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 equal to 1.2 times the square root of the area of sprinkler operation corresponding to the density used. 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.

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.

7-4.3.1.1* For gridded systems, the designer shall verify he is using the hydraulically most demanding area. 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 which show the peaking of the demand area friction loss shall be acceptable based on a single set of calculations.

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.

(b)* When sprinklers are installed above and below a ceiling and such sprinklers are supplied from a common set of branch lines, the branch lines and supply shall be calculated to supply the largest area of operation either above or below.

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 and 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 which 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 thru 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

Pipe or Tube	Hazen-William's "C" Value*
Unlined Cast or Ductile Iron	100
Black Steel (Dry Systems including Pre-action)	100
Black Steel (Wet Systems including Deluge)	120
Galvanized (all)	120
Plastic (listed) – Underground	150
Cement Lined Cast or Ductile Iron	140
Copper Tube	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 requirement shall not apply when areas of application are selected in accordance with 2-2.1.2.6.

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 bars).

Chapter 8 High-Rise Buildings

8-1 Application and Scope. This chapter deals with automatic sprinkler system design for life safety and fire protection in high-rise buildings of noncombustible, protected noncombustible or fire-resistive construction, as defined in NFPA 220, *Standard Types of Building Construction*, which is used predominantly for light hazard occupancies. It is intended to cover totally sprinklered buildings only, and shall not apply to partially sprinklered buildings.

8-2 Definition.

High-Rise Building. One in which fire must be fought internally because of height.

8-3 Design Criteria.

8-3.1 The installation may be either a pipe schedule system or a hydraulically designed system. Pipe schedule systems shall comply with Chapters 1 through 6 of this standard. Hydraulically designed systems shall comply with Chapters 1 through 7 of this standard as modified by 8-3.2 and shall comply with Chapter 8.

8-3.2 In light hazard occupancies, special sprinklers may be installed with larger protection areas than indicated in 4-2.2.1.1 or greater distances between sprinklers or branch lines than indicated in 4-2.1.1 when such installations are made in accordance with approvals or listings of a testing laboratory.

8-4 Water Supplies.

8-4.1 Acceptable water supplies are as follows:

(a) Public water system where pressure and discharge capacity meet the design requirements of the system as calculated.

(b) Automatic fire pumps supplied under head from a water supply source adequate to meet hydraulically designed system requirements, including public mains, reservoirs, and wells.

(c) Pressure tanks.

(d) Gravity tanks.

8-4.2 Each water supply source shall be automatic and of adequate capacity and pressure to supply the sprinkler system calculated demand for a period of not less than 30 minutes.

8-4.3 Hose connections may be supplied from sprinkler risers. *(See 3-8.6 and 3-8.7.)*

8-5 Alarms.

8-5.1 A separate and distinct supervisory signal shall be provided to indicate a condition that will impair the satisfactory operation of the sprinkler system. This shall include, but need not be limited to, monitoring of control valves, fire pump power supplies and running conditions, water tank levels, and temperatures. Pressure supervision shall also be provided on pressure tanks.

8-5.2 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. 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.

8-5.3 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 monitoring station.

8-5.4 Alarm and supervisory systems in connection with the sprinkler system shall be installed in accordance with NFPA 71, *Standard for Central Station Signaling Systems*; NFPA 72C, *Standard for Remote Station Protective Signaling Systems*; or NFPA 72D, *Standard for Proprietary Protective Signaling Systems.*

Appendix A

The following notes, bearing the same number as the text of the *Standard for the Installation of Sprinkler Systems* to which they apply, contain useful explanatory material and references to standards.

This Appendix is not a part of this NFPA Standard for the Installation of Sprinkler Systems but is included for information purposes only.

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 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-1-7.2.1 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
- Machine shops
- Metal working

(cont.)

(A-1-7.3.2 cont.)

Cold Storage warehouses
Confectionery products
Distilleries
Leather goods mfg.
Libraries-large stack room areas
Mercantiles
Printing and publishing
Textile mfg.
Tobacco Products mfg.
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 involve a wide range of variables which may produce severe fires. The following lists conditions which may be used to evaluate the severity of extra hazard occupancies.

Extra Hazard Occupancies (Group 1) include occupancies as described in 1-7.4.1 with little or no flammable or combustible liquids. These 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

[1]For high-piled storage as defined in 4-1.3.8, see Appendix D for separately published NFPA standards relating to water supply requirements, particularly NFPA 231, *Indoor General Storage*, and NFPA 231C, *Rack Storage of Materials*.

Extra Hazard Occupancies (Group 2) include occupancies as described in 1-7.4.1 but with moderate to substantial amounts of flammable or combustible liquids or where shielding of combustibles is extensive. 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-1-8.1 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.

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

(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 connection with 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.

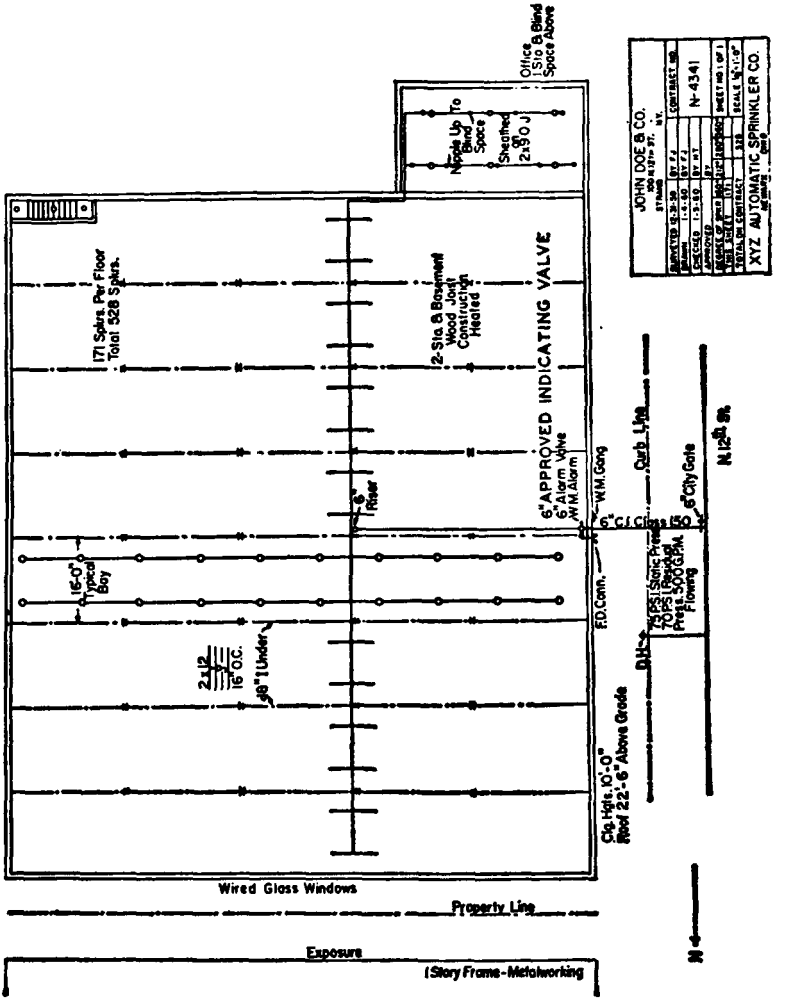
(l) Spacing of sprinklers, number of sprinklers in each story or fire area and total number of sprinklers, number of sprinklers on each riser and on each system by floors, total area protected by each system on each floor, total number of sprinklers on each dry-pipe system or pre-action or deluge system 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, and size and material of any proposed underground pipe

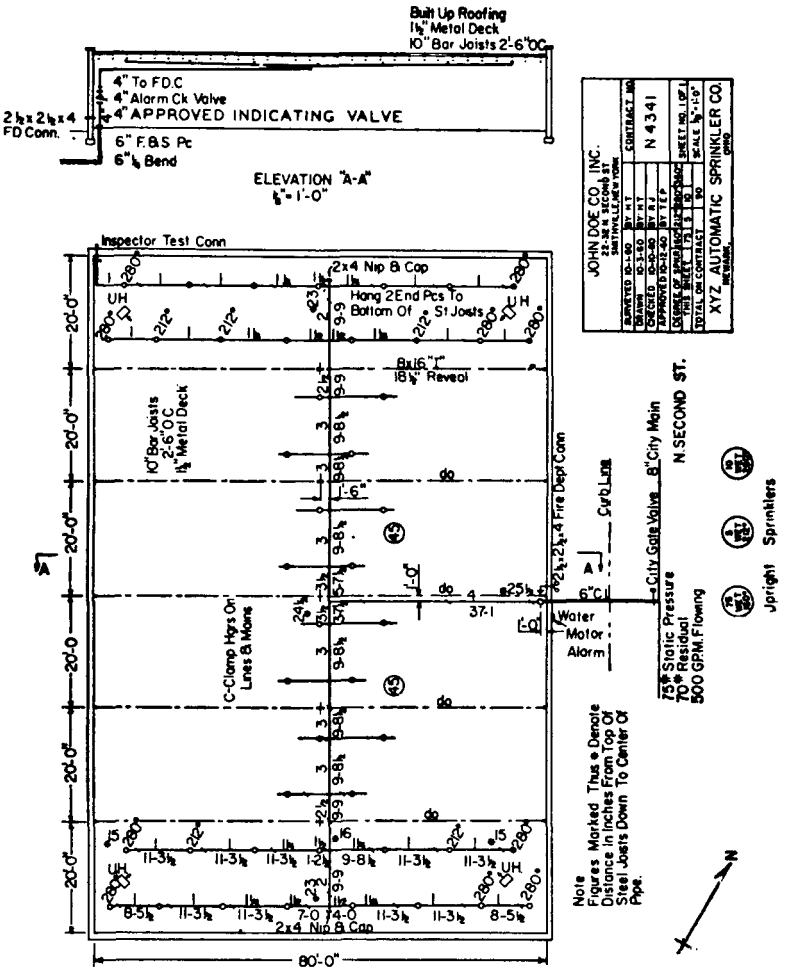
(o) Whether property is located in a flood area requiring consideration in the design of sprinkler system

(p) Name and address of party submitting the layout.



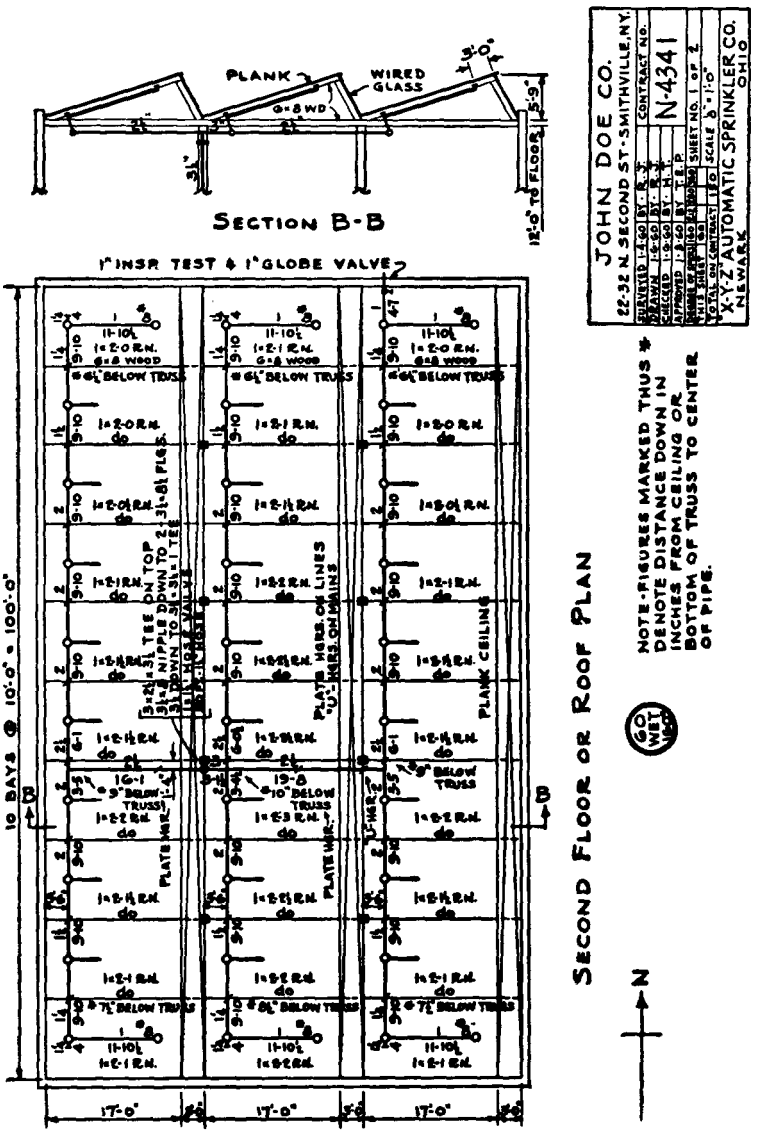
For SI Units: 1 ft = 0.3048 m; 1 psi = 0.0689 bars.

Figure A-1-9 Typical Preliminary Plan.



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

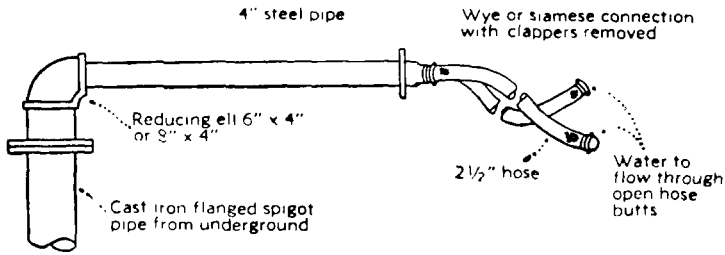
Figure A-1-9.2(A) Typical Working Plans.



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

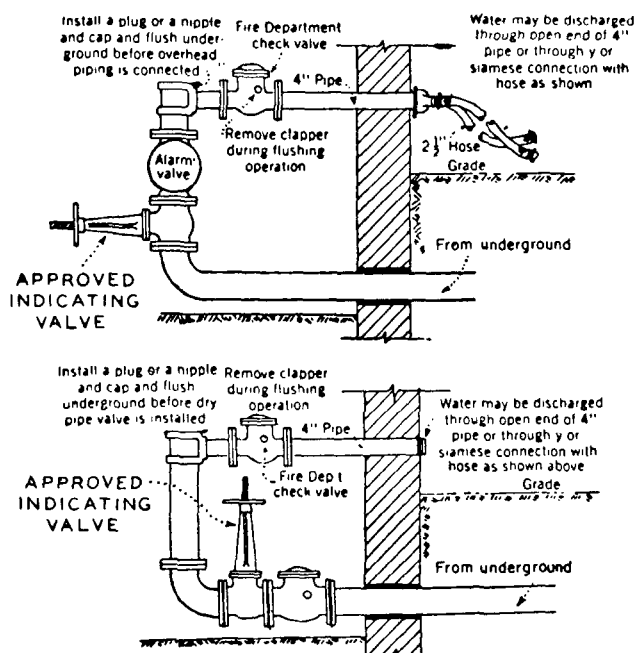
Figure A-1-9.2(B) Typical Working Plans (cont.)

A-1-11.2



For SI Units: 1 in. = 25.4 mm.

Employing horizontal run of 4-inch pipe and reducing fitting near base of riser.



Employing fire department connections.

Figure A-1-11.2 Methods of Flushing Water Supply Connections.

A-1-11.2.2 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 1-11.2.2 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-1-11.3.1 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 test.

A-1-11.3.3 Valves isolating the section to be tested may not be "drop tight." When such leakage is suspected, test blanks of the type recommended in 1-11.3.6 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 which 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 the 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 Appendix D 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 event of fire. The primary factors affecting the number of sprinklers which 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 which have 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-2-2.1.2.9 This section is included to compensate for possible delay in operation of sprinklers from fires in concealed spaces found in wood frame, brick veneer, and ordinary construction.

Table A-2-2.1.3 Minimum Water Supply Requirements for Hydraulically Designed Extra Hazard Sprinkler Systems

Hazard Classification	Sprinklers Only-gpm	Inside Hose-gpm	Total Combined Inside and Outside Hose-gpm	Duration in Minutes
Ex. Haz – Gp.1	See A-2-2.1.3.	0,50 or 100	500	90-120
Ex. Haz – Gp.2	See A-2-2.1.3.	0,50 or 100	1000	120

For SI Units: 1 gpm = 3.785 L/min.

NOTE 1: The lower duration figure is ordinarily acceptable where remote station water flow alarm service or equivalent is provided.

NOTE 2: 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.

NOTE 3: Calculations should be based upon the area of sprinkler operation selected from Figure A-2-2.1.3 or upon the area of the largest room. Such a room should be enclosed with construction having a fire resistance rating equal to the water supply duration indicated in Table A-2-2.1.3 with minimum protection of openings by automatic or self-closing doors with appropriate fire resistance ratings for the enclosure.

NOTE 4: For areas of sprinkler operation less than 2,500 sq ft (232 m^2), the density for 2,500 sq ft (232 m^2) should be used.

NOTE 5: For dry systems, increase area of sprinkler operation by 30 percent without revising density.

NOTE 6: For construction having unsprinklered combustible concealed spaces, as described in 4-4.4, the minimum area of sprinkler operation should be 3,000 sq ft (278 m^2).

NOTE 7: When high temperature sprinklers are used for extra hazard occupancies (Groups 1 and 2), the area of sprinkler operation may be reduced by 25 percent without revising the density but not less than 2,000 sq ft (185.8 m^2).

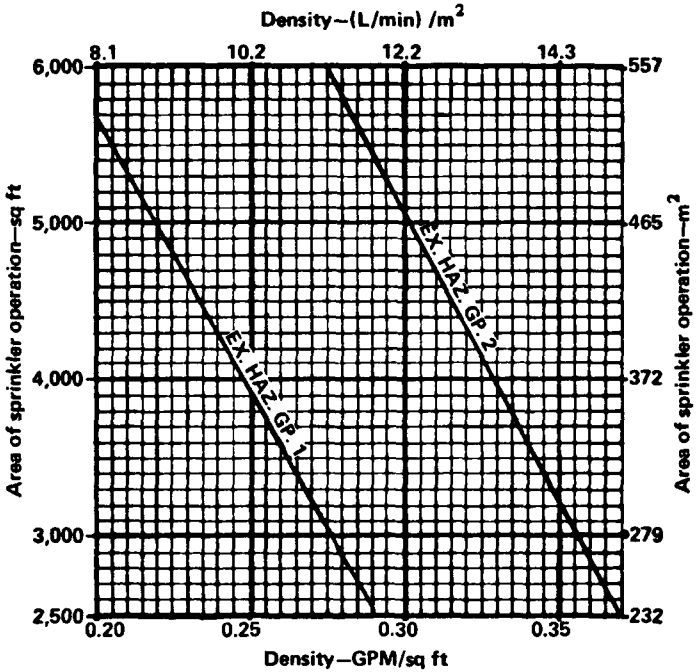


Figure A-2-2.1.3

A-2-2.1.3 Table A-2-2.1.3 and Figure A-2-2.1.3 are guides to determine density, area of sprinkler operation and water supply requirements for hydraulically designed sprinkler systems for extra hazard occupancies. Systems should be calculated to satisfy a single point on the appropriate design curve and interior piping should be sized for this design point. It is not necessary to meet all points on the selected curve. Total water supply available to the sprinkler system at the riser design reference point should be the sum of the sprinkler and interior hose stream demand shown in Table A-2-2.1.3.

A-2-3.1.1 Reliability of public water supply should take into account probable minimum pressure condition prevailing during such periods as at night, or during summer months when heavy usage may occur, also possibility of interruption by flood, or ice conditions in winter.

Pressure Regulating Valves. Pressure regulating valves should not be used except with permission of the authority having jurisdiction.

A-2-3.2 In private underground piping systems for buildings of other than light hazard occupancy, any dead-end pipe which supplies both sprinklers and hydrants should be not less than 8 in. in size.

A-2-5 See sections dealing with sprinkler equipment supervisory and water flow alarm services in NFPA 71, *Standard for Central Station Signaling Systems*, NFPA 72A, *Standard for Local Protective Signaling Systems*, NFPA 72B, *Standard for Auxiliary Protective Signaling Systems*, NFPA 72C, *Standard for Remote Station Protective Signaling Systems for Fire Alarm and Supervisory Service*, or NFPA 72D, *Standard for Proprietary Protective Signaling Systems*. See also NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps* and NFPA 24, *Standard for Outside Protection*.

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-2-6.3 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 the 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 lbs per sq in. 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 anticipated in the previous pararaph. 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 bars.

In this case the tank would be filled with 50 percent air and 50 percent water and the tank pressure would be 165 psi. 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-2-7.2 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 hose connections should be located on the street side of the building and arranged so that hose lines can be readily and conveniently attached to the inlet without interference from any nearby objects including buildings, fences, posts, or other fire department connections.

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-3-2.*)

A-2-9.1

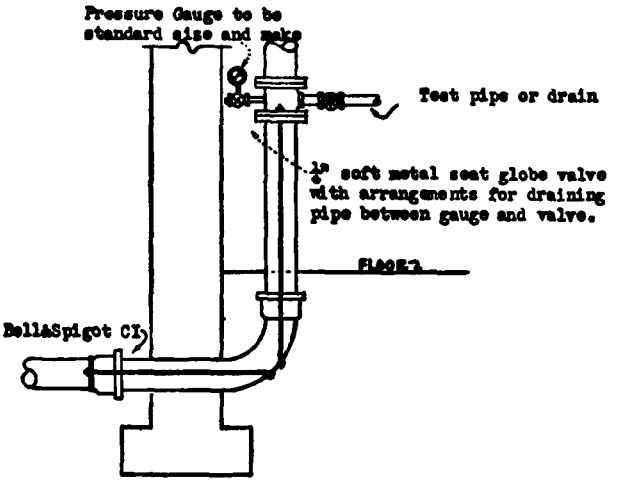


Figure A-2-9.1 Test Pipe on Water Supply with Outside Control. Also applicable to an interior riser.

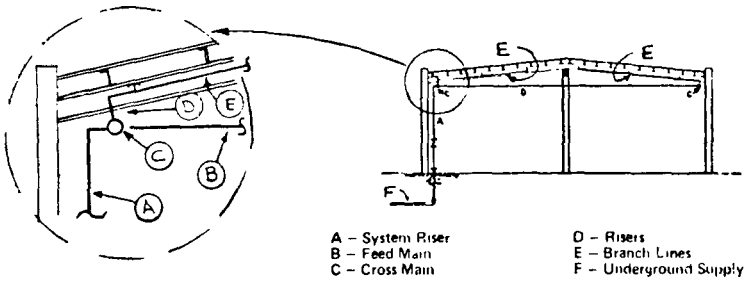


Figure A-3-2 Building Elevation Showing Parts of Sprinkler Piping System.

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. 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 the ceiling.

A-3-6.3.1 For example, a 3-in. steel pipe, which is permitted to supply 40 sprinklers, may supply a total of 60 sprinklers where not more than 40 sprinklers are above or below the ceiling.

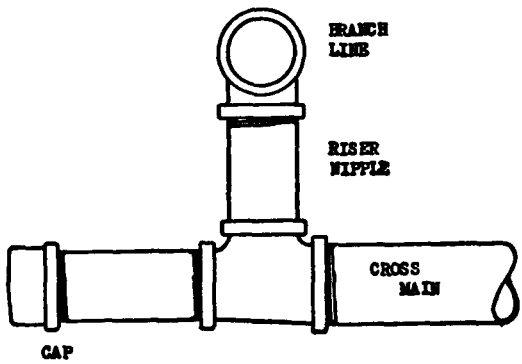


Figure A-3-8.2(a) Screw-type Cap.

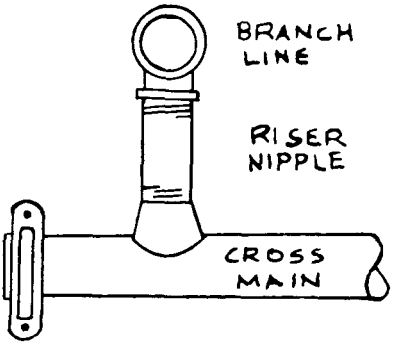
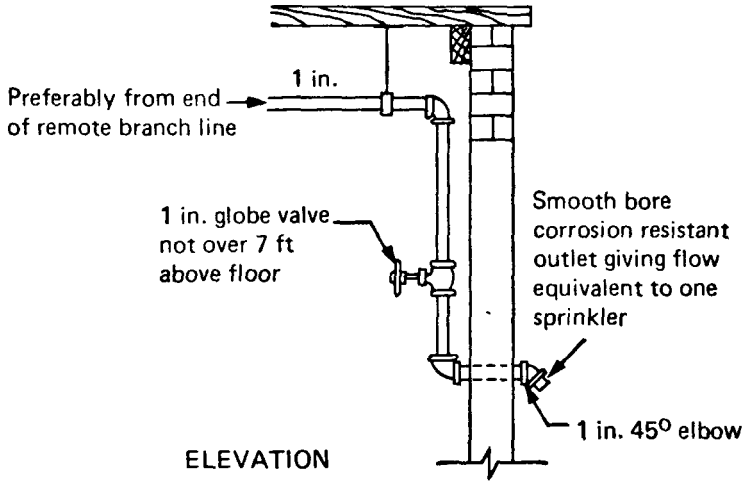


Figure A-3-8.2(b) Groove-type Cap

A-3-9.1.1 This test pipe 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 pipe outside the building, the test pipe 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 and A-3-9.1.2.)* 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.



For SI Units: 1 ft = 0.3048 m.

NOTE: Not less than 4 ft (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-3-9.1.2

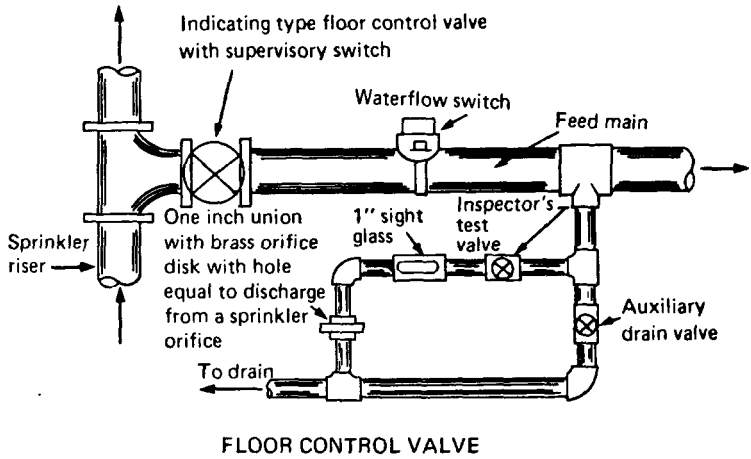


Figure A-3-9.1.2 Floor Control Valve

A-3-9.2

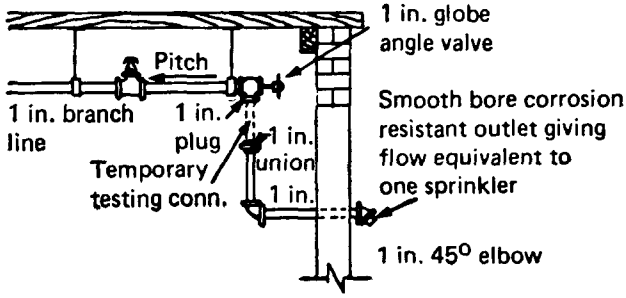


Figure A-3-9.2 One-Inch System Test Pipes on Dry-Pipe Systems.

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 mobil material handling equipment and other vehicles. 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 heat structural members such as girders.

A-3-10.2 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 resort may be made to the use of some form of corrosion resisting material.

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 which 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 Most earthquake-related strains are imparted to the sprinkler piping by the building. If the piping could be isolated from the building, earthquake strains could only enter through the riser. It is differential building movement between parts with different natural frequencies that damages sprinkler systems. Any method designed to protect sprinkler systems from earthquake-induced strains should combine flexibility and dampening as appropriate.

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. or smaller in size is pliable enough so that flexible couplings are not usually necessary.

A-3-10.3.2(d) Sprinkler piping above the first floor 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-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 which pass horizontally through walls or foundations should not be cemented solidly or strains will accumulate at such points.

When risers or lengths of pipe up to 6 ft (1.8 m) extend through suspended ceilings, they should not be fastened to the ceiling framing members.

A-3-10.3.5 Sway Bracing.

Location of Bracing. [*See Figure A-3-10.3.5(a).*]
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-3-10.3.5(g)*]. 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.

Details of Bracing.

In the design of sway braces, the slenderness ratio l/r should approximately be 200 where "l" is the distance between the center lines of support and "r" is the least radius of gyration, both in inches (mm). Suggested lengths of shapes used for sway bracing are shown in Table A-3-10.3.5.

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(e).*]

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.

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(f)*]. 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.

In wood joisted buildings, U-hangers with legs bent out 10 degrees from the vertical satisfy the purpose of two-way braces. When piping is hung from C-clamps, positive bracing is needed because the clamp can slip under seismic shaking.

A four-way brace is usually provided at the riser. It may provide longitudinal and lateral bracing for the adjacent mains. [*See Figures A-3-10.3.5(a) and (g).*]

When four-way braces are needed on mains, such as at right angle turns in a looped system, a two-way brace may be used on each leg of the loop. U-hangers or short hanger rods less than 6 in. (152 mm) in length may accomplish the bracing.

For risers, a U-bolt and flat bent at 45 degree angles can be used [*see Figure A-3-10.3.5(h)*].

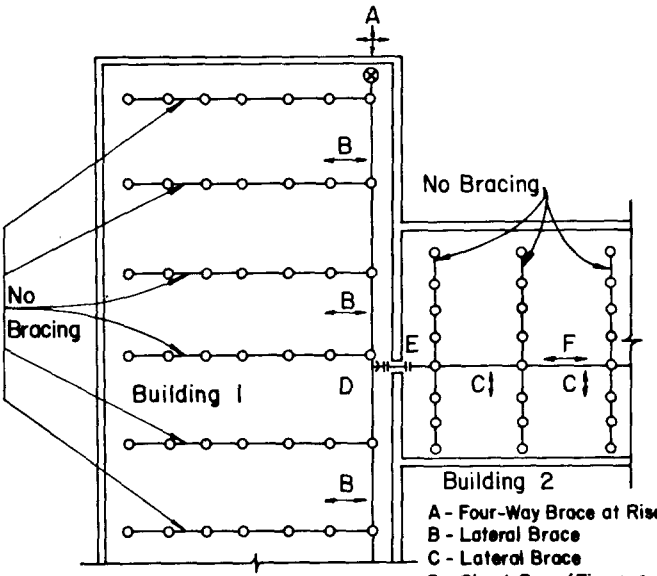


Figure A-3-10.3.5(a) Earthquake Protection for Sprinkler Piping

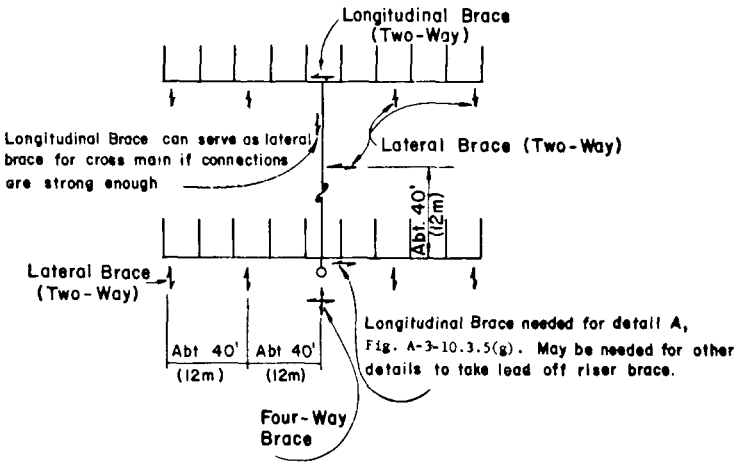


Figure A-3-10.3.5(b) Typical Location of Bracing on a Pipe Schedule System.

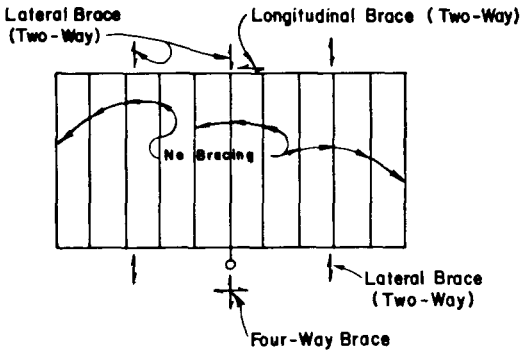


Figure A-3-10.3.5(c) Typical Location of Bracing on a Gridded System.

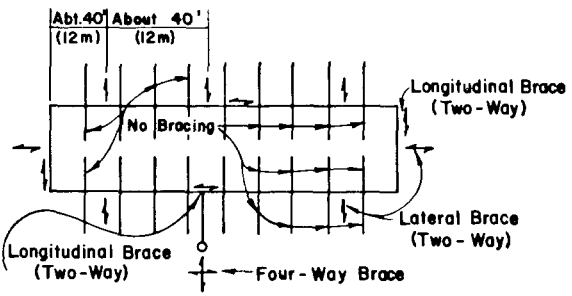


Figure A-3-10.3.5(d) Typical Location of Bracing on a Looped System.

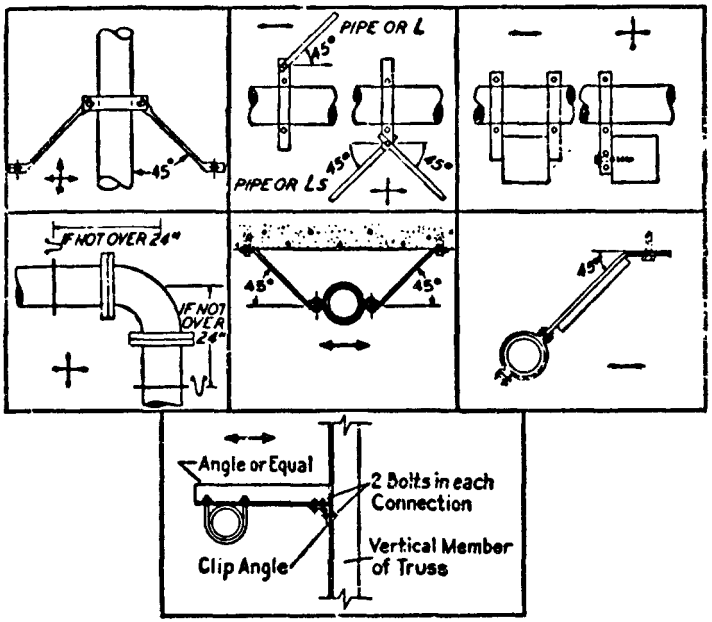


Figure A-3-10.3.5(e) Acceptable Types of Sway Bracing.

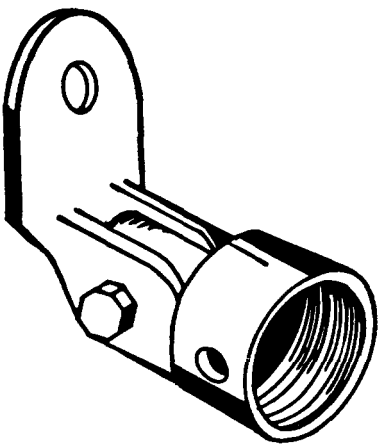


Figure A-3-10.3.5(f) Special Fitting.

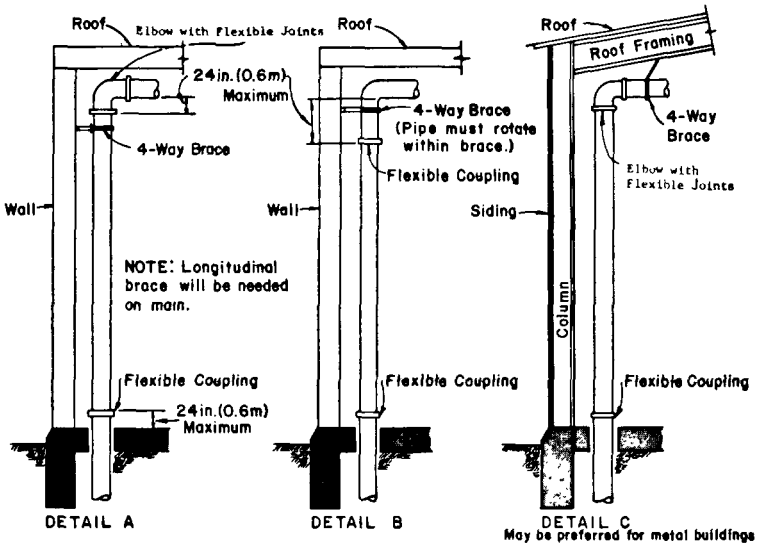


Figure A-3-10.3.5(g) Riser details

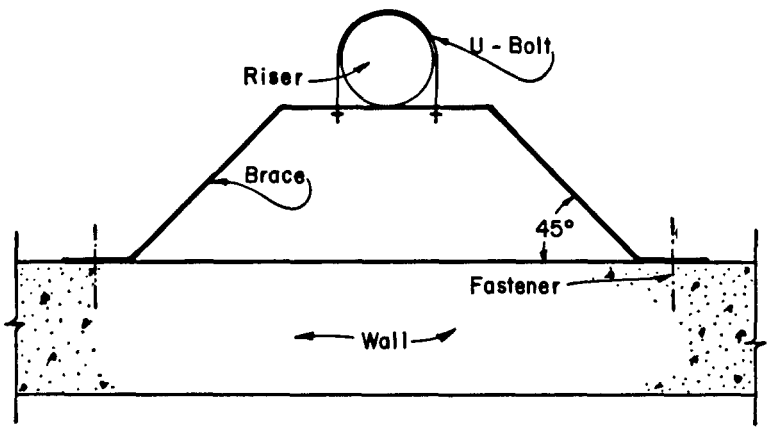


Figure A-3-10.3.5(h) Detail of Four-Way Brace at Riser

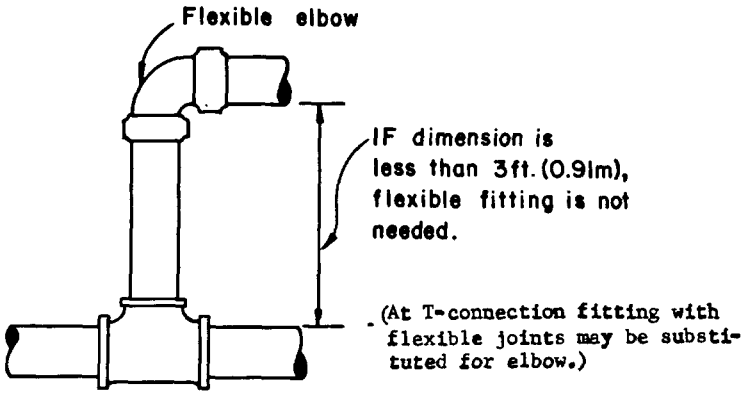


Figure A-3-10.3.5(i) Detail at Short Riser.

Table A-3-10.3.5 Typical Brace Sizes

Item	l/r = 200	Item	l/r = 200
Angles		Flats	
1½ × 1½ × ¼ in.	4 ft 10 in.	1½ × ¼ in.	1 ft 2 in.
2 × 2 × ¼ in.	6 ft 6 in.	2 × ¼ in.	1 ft 2 in.
2½ × 2 × ¼ in.	7 ft 0 in.	2 × ⅜ in.	1 ft 9 in.
2½ × 2½ × ¼ in.	8 ft 2 in.	Pipe	
3 × 2½ × ¼ in.	8 ft 10 in.	1 in.	7 ft 0 in.
3 × 3 × ¼ in.	9 ft 10 in.	1¼ in.	9 ft 0 in.
Rods		1½ in.	10 ft 4 in.
¾ in.	3 ft 1 in.	2 in.	13 ft 1 in.
⅞ in.	3 ft 7 in.		

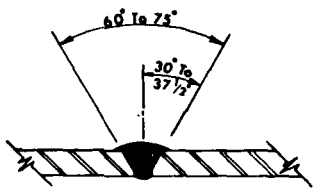
For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m.

Pipe sizes are ANSI B36.10 Schedule 40.

A-3-11.1.1 All piping should be arranged where practicable to drain to the main drain valve.

A-3-11.4.1 When possible, the main sprinkler riser drain should discharge outide 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.

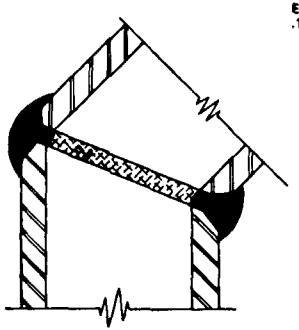
A-3-11.4.5 When exterior ambient temperatures are subject to freezing, 32°F (0°C) or less, at least 4 ft (1.2 m) of pipe should be installed beyond the valve, in a warm room.



STANDARD "VEE"

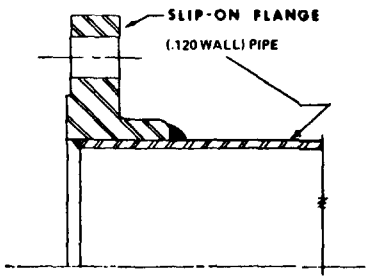
Scale: 2:1

Examples Ref.:
.120 Wall Pipe



45° BUTT-WELD

Scale: 2:1



FLANGE CONNECTION

Scale: ½ Size

Figure A-3-12.2(a) Butt-Weld Joints and Flange Connection.

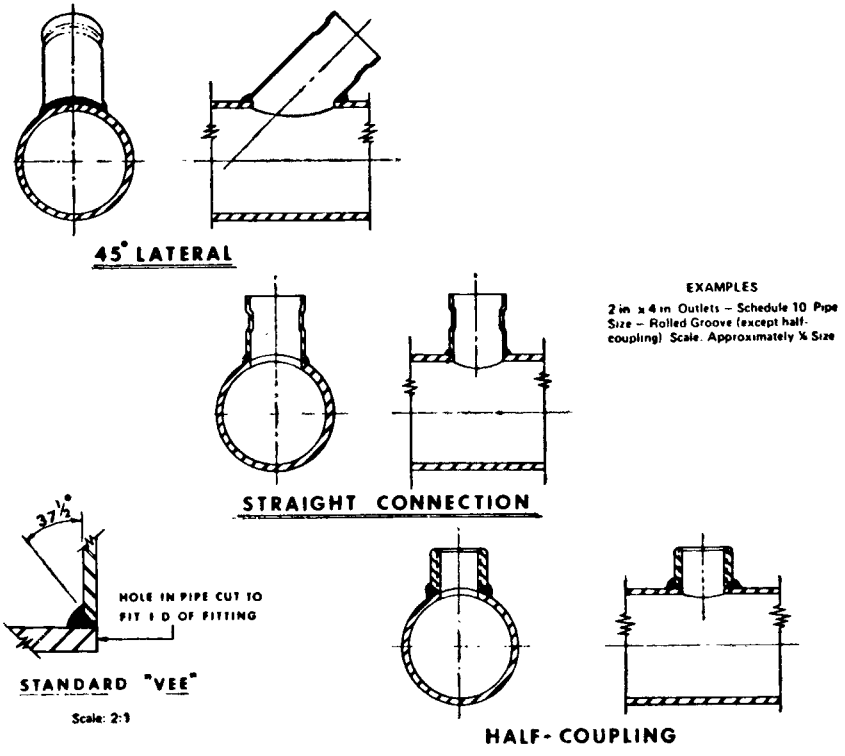


Figure A-3-12.2(b) Welded Branch Connections.

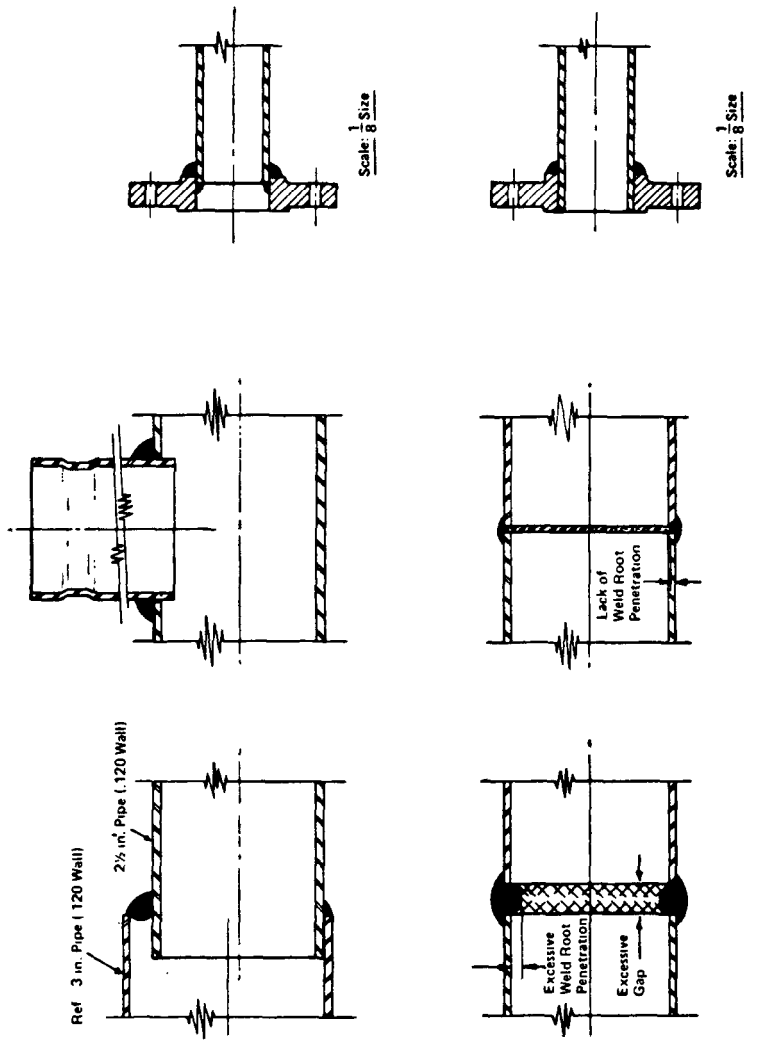


Figure A-3-12.2(c) Unacceptable Weld Joints.

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-3-12.4 The fire hazard of the brazing process should be suitably safeguarded.

A-3-13.1.5

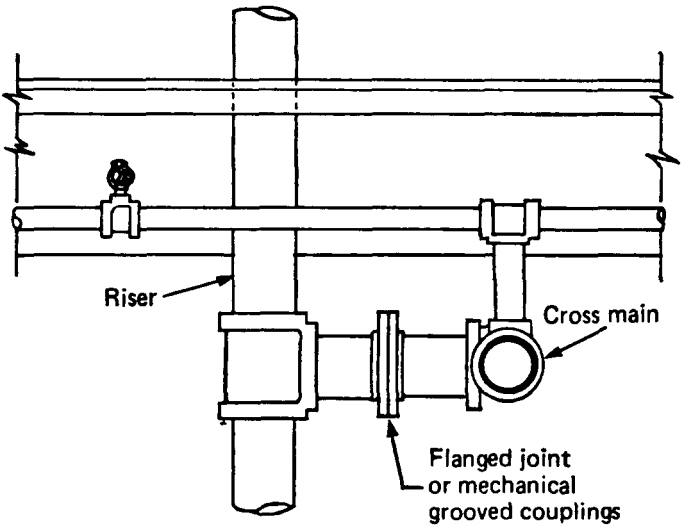


Figure A-3-13.1.5 One Arrangement of Flanged Joint at Sprinkler Riser.

A-3-13.2 Approved flexible connections are permissible and encouraged for sprinkler installations in racks to reduce possibility of physical damage. When flexible tubing is used it should be located so that it will be protected against mechanical injury.

A-3-14.2 Valves Controlling Water Supplies.

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 outside wall of the building.

All valves controlling water supplies for sprinkler system 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 cut-off 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 Outside Protection*. For pits protecting valves located at the base of a tank riser, refer to NFPA 22, *Standard for Water Tanks for Private Fire Protection*.

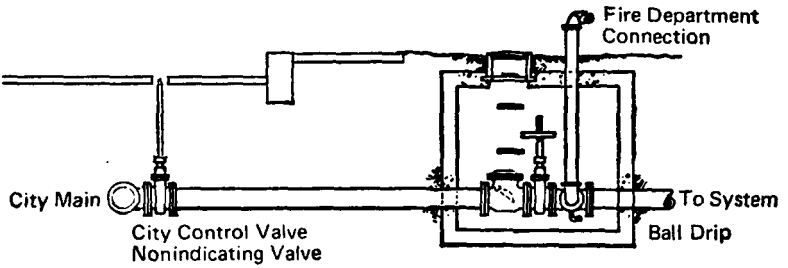


Figure A-3-14.2.5 Pit for Gate Valve, Check Valve and Fire Department Connection.

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 valves 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 ⅜ in. (9.5 mm).

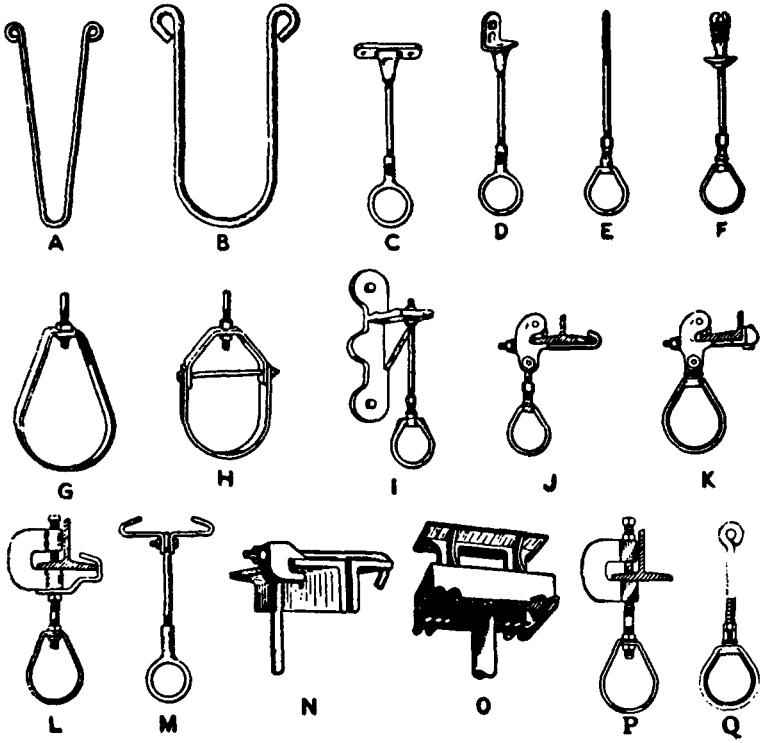
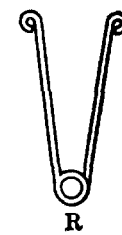


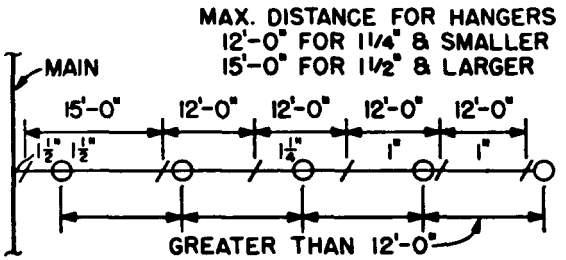
Figure A-3-15.1 Common Types of Acceptable Hangers.

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 — Center 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.



A-3-15.1.6 Table 3-15.1.6 assumes that the load is located at the midpoint of the span of the trapeze member. 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

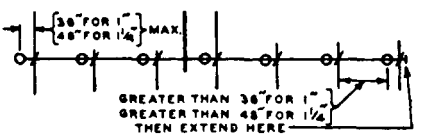
$L = \frac{4ab}{a+b}$ where "L" is the equivalent length, "a" is the distance from one support to the load and "b" is the distance from the other support to the load.



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

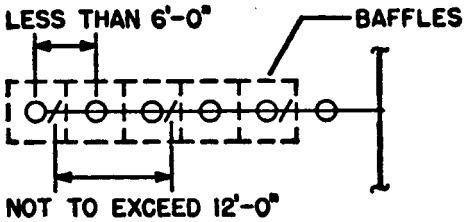
Figure A-3-15.1.10 Distance Between Hangers.

A-3-15.3.1 Power-driven studs should not be used in steel less than $\frac{5}{16}$ in. total thickness.



For SI Units: 1 in. = 25.4 mm.

Figure A-3-15.5.3 Distance Sprinkler to Hanger.



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

Figure A-3-15.5.4 Distance Between Hangers. *(See 3-15.5.4.)*

A-3-15.5.6 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.

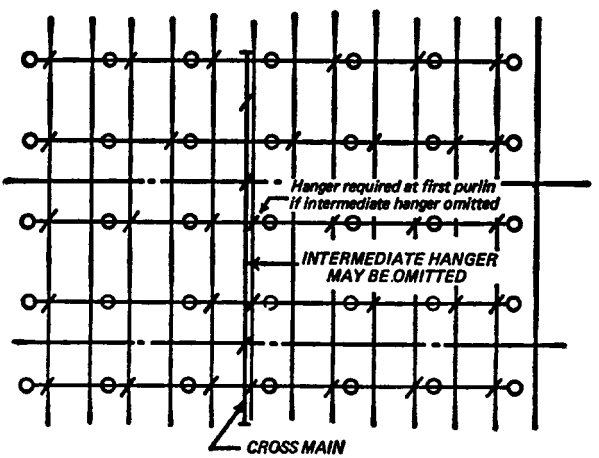


Figure A-3-15.6.1(A) Hangers on Cross Main.

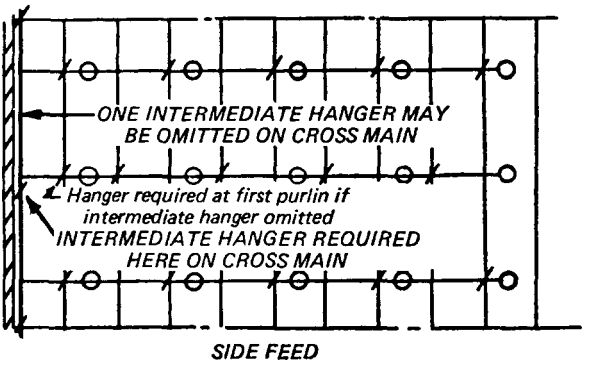


Figure A-3-15.6.1(B) Hanger Omission on Side Feed System.

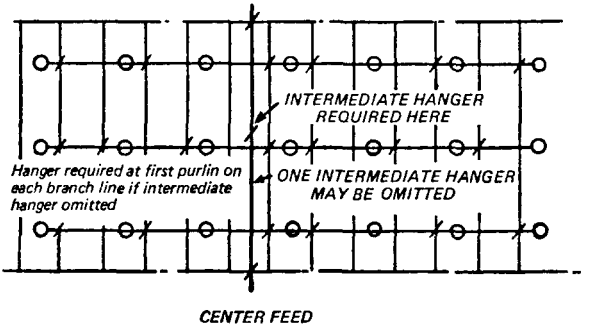


Figure A-3-15.6.1(C) Hangers on Cross Main — Center Feed System.

A-3-16.2.2 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-3-16.2.6 Large 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.

A-3-16.2.8 The standard sprinkler is the type commonly manufactured since 1953, incorporating a uniform, hemispherical discharge pattern. Water is discharged in all directions below the plane of the deflector. Little or no water is discharged upward to wet the ceiling. Sprinkler deflectors are stamped as follows:

Upright Sprinkler Marked SSU

Pendent Sprinkler Marked SSP

The old style sprinkler is the type commonly manufactured before 1955. It discharged approximately 50 percent of the water upward to the ceiling.

A-3-16.5 The following Table A-5-16.5 shows the nominal discharge capacities of approved sprinklers having a nominal ½-in. (12.7-mm) orifice at various pressures up io 100 psi (6.9 bars).

Table A-3-16.5

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-3-16.6 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 which 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 which 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 ratings 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 requirement if approved 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 which 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 fusible element, may interfere with the free movement of arts, 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 Section 8-5.*)

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-3-17.4.1 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. If absolutely necessary to exceed 75 ft (22.9 m), the pipe line to the water-motor-operated device should be increased one or more sizes to compensate for loss of pressure due to hydraulic friction.

A-3-17.6.2 Switches which 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 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-4-1.1.4 New partitions, closets, decks, etc., should be put in place, or provided for, so that the sprinkler equipment may conform to same.

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.

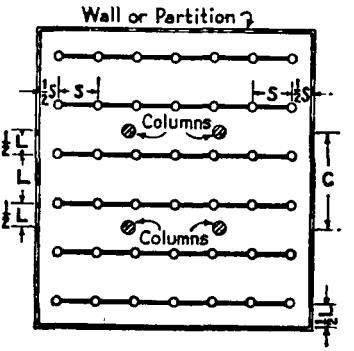
When buildings or portions of buildings are of combustible construction or contain combustible material, standard fire barriers should be provided to separate the areas which are sprinkler protected from adjoining unsprinklered areas. All openings should be protected in accordance with applicable standards 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 which originates in an unprotected area and spreads to the sprinklered area than would be the case in a completely protected building. Fire originating in nonsprinklered area may overpower the partial sprinkler system.

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).

Flat Slab or Pan Type Reinforced Concrete

Maximum Spacing: 130 Sq Ft per Sprinkler
LXS = 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.

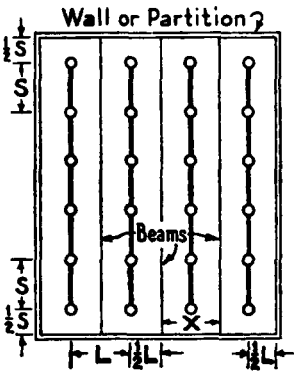
Examples

C	L	S (Max)	C	L	S (Max)
21 ft 8 in.	10 ft 10 in.	12 ft 0 in.	21 ft 6 in.	10 ft 9 in.	12 ft 1 in.
24 ft 2 in.	12 ft 1 in.	10 ft 9 in.			

Figure A-4-2.1.2(A) Layout of Sprinklers Under Smooth Ceiling Construction — Ordinary Hazard Occupancy.

Continuous Smooth Bays with Beams Supported on Columns

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.
X = Width of bay.

Examples

X	L	S (Max)	X	L	S (Max)
10 ft 10 in.	10 ft 10 in.	12 ft 0 in.	10 ft 9 in.	10 ft 9 in.	12 ft 1 in.
12 ft 1 in.	12 ft 1 in.	10 ft 9 in.			

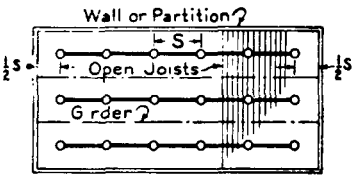
For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m; 1 ft² = 0.0929 m²

Figure A-4-2.1.2(B) Layout of Sprinklers Under Smooth Ceiling Construction — Ordinary Hazard Occupancy.

A-4-2.2.1.2

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.	10 ft 10 in.	12 ft 0 in.
			12 ft 1 in.	12 ft 1 in.	10 ft 9 in.

For SI Units: 1 in. = 25.4 mm; 1 ft = 0.3048 m; 1 ft² = 0.0929 m².

Figure A-4-2.2.1.2 Layout of Sprinklers Under Open Wood Joist Construction — Light and Ordinary Hazard Occupancies.

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 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 the common types of ceiling construction and framing is shown in Table A-4-2.3.