NFPA No.

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INSTALLATION OF SPRINKLER SYSTEMS 1972

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Official NFPA Definitions

Adopted Jan. 23, 1964: Revised Dec. 9, 1969. Where variances to these definitions are found, efforts to eliminate such conflicts are in process.

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SHOULD is intended to indicate recommendations or that which is advised but not required.

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Statement on NFPA Procedures

This material has been developed in the interest of safety to life and property under the published procedures of the National Fire Protection Association. These procedures are designed to assure the appointment of technically competent Committees having balanced representation from those vitally interested and active in the areas with which the Committees are concerned. These procedures provide that all Committee recommendations shall be published prior to action on them by the Association itself and that following this publication these recommendations shall be presented for adoption to the Annual Meeting of the Association where anyone in attendance, member or not, may present his views. 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.

Standard for the Installation of Sprinkler Systems

NFPA No. 13 — 1972

This edition, adopted by the National Fire Protection Association on May 18, 1972, on recommendation of the Committee on Automatic Sprinklers, supersedes all previous editions.

This edition of the Standard includes amendments and editorial revisions to the 1971 edition. Changes in text, including new and revised text, are indicated in the standard by vertical black lines in the margins. Editorial changes with no change in intent and deleted portions of the 1971 edition of the text are not indicated.

Origin and Development of No. 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 and 1972.

Committee on Automatic Sprinklers

I. L. Lamar, *Chairman,*
Insurance Services Office — Southeastern Region, P.O. Box 29972, Atlanta, Ga. 30329

J. C. Thomson, Jr.,† *Secretary,*
North Carolina Fire Insurance Rating Bureau, Box 2021, Raleigh, N. C. 27602

Stanley Auck, Underwriters' Laboratories, Inc.

Wayne E. Ault, National Automatic Sprinkler & Fire Control Assn.

John A. Baker, Canadian Underwriters Assn.

J. R. Birdwell, Manufacturing Chemists' Assn.

J. D. Coons, Factory Mutual Engineering Corp.

John L. Deroo, Union Carbide Corp.

Robert E. Duke, National Automatic Sprinkler & Fire Control Assn.

Frank J. Fee, Jr., National Automatic Sprinkler & Fire Control Assn.

D. M. Hammerman, Fire Marshals Assn. of North America

Richard E. Hughey, Insurance Services Office — Midwestern Region

Rolf H. Jensen, Illinois Institute of Technology

W. N. Lawton, National Automatic Sprinkler & Fire Control Assn.

Donald I. McGillivary, Underwriters' Laboratories of Canada.

H. K. Meyers, Insurance Services Office — Pacific Region

Robert L. Retelle, Insurance Services Office — New England Region

E. J. Schiffhauer, Eastman Kodak Co.

Chester W. Schirmer, Schirmer Engineering Corp.

W. J. Swingler, Factory Insurance Assn.

Harry Winchell, American Mutual Insurance Alliance

J. A. Wood, National Automatic Sprinkler & Fire Control Assn.

D. M. Yarlas, Industrial Fire Protection Section, NFPA

Alternates.

Donald H. Adickes, American Mutual Insurance Alliance (Alternate to Harry Winchell)

John O. Eubank, Insurance Services Office of Tennessee (Alternate to Richard E. Hughey)

D. B. Grant, Canadian Underwriters' Assn. (Alternate to J. A. Baker)

W. L. Henry, Manufacturing Chemists' Assn. (Alternate to R. J. Birdwell)

John L. Jablonski, American Insurance Association (Alternate to I. L. Lamar)

A. J. Mercurio, Factory Insurance Assn. (Alternate to W. J. Swingler)

J. L. Norcliffe, (Alternate representative: National Automatic Sprinkler & Fire Control Assn.)

F. A. Willits, Jr., (Alternate representative: National Automatic Sprinkler & Fire Control Assn.)

Nonvoting Members

G. C. Ackroyd, Fire Offices' Committee, Aldermary House, London, England.

H. W. Marryatt, Australian Fire Protection Assn., Melbourne, Australia.

SCOPE: The design, installation, inspection, and maintenance of automatic and of open sprinkler systems, including the character and adequacy of water supplies, and the selection of sprinkler heads, piping, valves and all materials and accessories; but not including the installation and operation of fire pumps, nor the construction and installation of gravity and pressure tanks and towers, nor the installation, maintenance and use of Central Station, Proprietary, Auxiliary and Local Signaling Systems for Watchmen, Fire Alarm and Supervisory Service, nor the Supervision and Care of Valves Controlling Water Supplies, nor the design of fire department hose connections.

†Nonvoting.

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Standard for the Installation of

Sprinkler Systems

NFPA No. 13 — 1972

CHAPTER 1. GENERAL INFORMATION

1000. Foreword.

1010. Definition of a Sprinkler System.

1011. 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 system includes a suitable 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 NFPA Standards No. 22, Water Tanks For Private Fire Protection; No. 20, Installation of Centrifugal Fire Pumps and No. 24, Outside Protection.

1020. Scope.

1021. This Standard is in general the minimum for the installation of sprinkler systems for fire protection in buildings housing one or more of the following or similar Light, Ordinary or Extra Hazard Occupancies, except where additional rules are amendatory to this standard for Extra Hazard Occupancies as covered by separate standards.

1030. Other Pamphlets.

1031. Separately published standards referred to herein deal with fire pumps, tanks, and various other related features. A selected list of other publications related to the installation of sprinkler systems is published at the end of this Standard.

1040. Maintenance.

1041. A sprinkler system installed under this Standard must be properly maintained for efficient service. The owner is

responsible for the condition of his sprinkler system and must use due diligence in keeping the system in good operating condition.

1042. The installing contractor shall provide the owner with:

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

(b) Published pamphlet on Care and Maintenance of Sprinkler Systems. (NFPA No. 13A.)

1050. Impairments.

1051. 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.

1052. 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.

1100. Preparation of Building.

1110. General.

1111. 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.

1112. Necessary "stops" to check draft, necessary new partitions, closets, decks, etc., should be put in place, or provided for, so that the sprinkler equipment may conform to same.

1113. Frequently, additional sprinkler equipment can be avoided by cutting down the width of decks or galleries and providing proper clearances. (See Paragraphs 4313, 4315 and 4318.) Slatting of decks or walkways or the use of open grating as a substitute for automatic sprinklers thereunder is not acceptable. The use of cloth or paper dust tops for rooms forms

obstruction to water distribution. If employed, the area below should be sprinklered.

1114. Cutting holes through partitions, either solid or slatted, to allow sprinklers on one side thereof to distribute water to the other side is not effectual.

1115. Where wood cornices on masonry buildings face an exposure they should be replaced with a parapet, or the projecting woodwork should be cut away and metal flashing extended to cover the exposed edge of planking, or suitable sprinkler protection should be provided.

1120. Separation of Sprinklered and Nonsprinklered Areas.

1121. The installation of sprinklers throughout premises is necessary for the protection of life and property, however, when buildings or portions of buildings are of combustible construction or contain combustible material, standard cutoff shall be provided to separate the areas which are sprinkler protected from adjoining unsprinklered areas. All openings shall 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 Sprinkler Standard.

1130. Vertical and Horizontal Drafts.

1131. Floor or wall openings tending to create vertical or horizontal drafts, or other structural conditions that would delay the prompt operation of automatic sprinklers by preventing the banking up of the heated air from the fire, should be properly "stopped" in order to permit control of fire at any point by local sprinklers.

1132. Where moving stairways, large monumental staircases, or similar floor openings are unenclosed, the floor openings involved shall be protected by draft stops in combination with close spaced sprinklers. The draft stops should be located immediately adjacent to the opening, should be 18 inches deep and should be of substantially noncombustible material. Sprinklers, spaced not more than 6 feet apart, should be placed 6 inches to 12 inches from the draft stop on the side away from the opening to form a water curtain. Sprinklers in this water curtain should be hydraulically designed to provide a discharge of 3 gallons per minute per lineal foot of water curtain, measured horizontally around the opening, with no sprinkler discharging less than 15 gpm. Normal ½-inch orifice closed head systems using sprinklers of Ordinary Temperature Classification are adequate for this pur-

pose. Where sprinklers are closer than 6 feet, cross baffles should be provided per Paragraph 4329. Where sprinklers in the normal ceiling pattern are closer than 6 feet from the water curtain, it may be preferable to locate the water curtain sprinklers in recessed baffle pockets. (See Fig. 1132.)

NOTE: In totally sprinkler protected buildings containing light or ordinary hazard occupancy this method provides some degree of safeguard against the passage of fire through floor openings. It is not, however, equivalent to a proper enclosure. (See also NFPA No. 101, Life Safety Code for requirements for means of egress.)

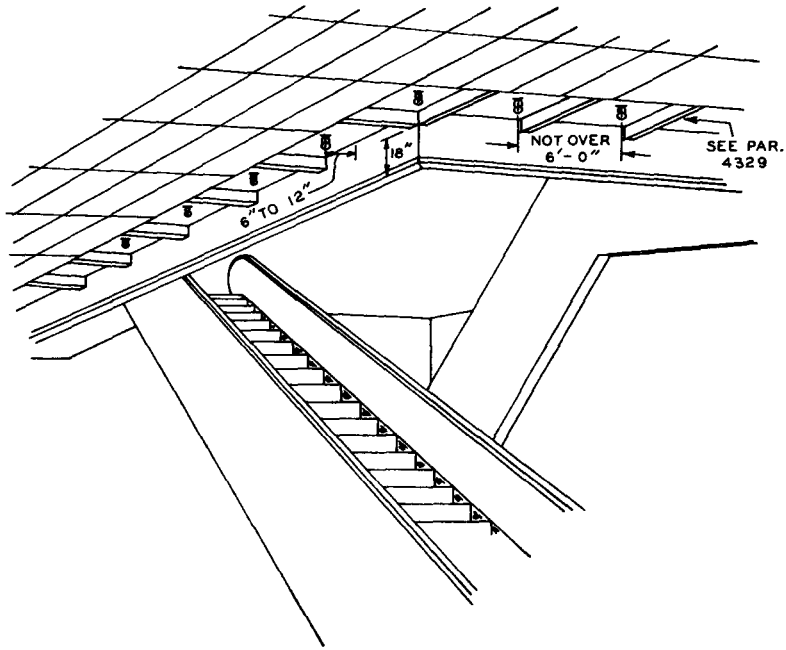


Fig. 1132. Sprinklers Around Escalators

1140. Floors.

1141. Flooring should preferably be made tight and waterproof.

1142. Some of the more common defects, assuming that the floor itself is tight, are cracks at side walls, openings around pipes or conduits, and small unprotected openings cut through floor for various purposes. These can be made tight by flashing, metal plates, etc. Such small openings that cannot be completely stopped off may be curbed to prevent water running through.

1143. Waterproofing of floors is highly desirable, especially if goods or machinery are of considerable value and susceptible to water damage. There are various methods of making floors reasonably watertight, depending on the type of construction.

1144. Scuppers or floor drains are also desirable in many types of buildings or occupancies. It is of importance to get any water off of floors as soon as possible after fire is extinguished and scuppers will facilitate doing this.

1145. The recommendation that floors should be made tight is important; first, to prevent easy spread of fire from one floor to another, and second, to prevent water from sprinklers or hose streams from running through floors and damaging property on floors below.

1150. Accessory Construction.

1151. Sprinkler equipments may require: Dry-pipe valve enclosures (see Section 5258); boxing to prevent freezing of tank risers, etc. (see Figure 3111); ladders; protection of yard hydrants, sprinkler risers and post indicators against mechanical damage, etc. This work should be promptly attended to if not let with the sprinkler contract.

1160. Protection Against Exposure.

1161. Exposure protection should be provided wherever conditions are such that a sprinklered building is exposed to fire from without. (See Chapter 6, Outside Sprinklers for Protection Against Exposure Fires.)

1200. Classification of Sprinkler Systems.

1201. This Standard covers automatic sprinkler systems of the types described 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. The types of automatic sprinkler systems are listed in Sections 1210–1271, inclusive.

1210. Wet-Pipe Systems. (See Section 5100.)

1220. Dry-Pipe Systems. (See Section 5200.)

1230. Pre-action Systems. (See Section 5300.)

1240. Deluge Systems. (See Section 5300.)

1250. Combined Dry-Pipe and Pre-action Systems. (See Section 5400.)

1260. Limited Water Supply Systems. (See Section 5600.)

1270. Sprinkler Systems — Special Types.

1271. 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.

1300. Classification of Occupancies.

1310. Light Hazard Occupancies.

1311. LIGHT HAZARD OCCUPANCIES include buildings housing occupancies such as

Apartments
Asylums
Churches
Clubs
Colleges and Universities
Dormitories
Dwellings
Hospitals
Hotels
Institutions
Libraries, except Large Stack Room Areas
Museums
Nursing, Convalescent and Care Homes
Office Buildings
Prisons
Public Buildings
Rooming Houses
Schools
Tenements

1312. The rules for installation of sprinkler systems in Light Hazard Occupancies shall apply to all portions of the occupancies listed above or similar light hazard occupancies, except that in certain sections of the above occupancies such as attics, basements, kitchens, laundries, storage areas, and work rooms, ordinary hazard spacing with light hazard pipe sizing and water supplies shall be required. Finished rooms that may be located in attics or basements such as living quarters, bars, lounges, etc., may be treated as Light Hazard Occupancy.

1313. The rules for installation of sprinkler systems in Light Hazard Occupancies may also apply in small stores and similar occupancies incidental to the properties listed above, provided such occupancies do not individually exceed 3,000 square feet in floor area in any one store in any floor and provided floor openings are properly protected.

1314. It is important that sprinkler systems designed for Light Hazard Occupancies shall not be installed in any building, the occupancy of which is likely to be changed subsequently to a classification not so listed.

1320. Ordinary Hazard Occupancies.

1321. ORDINARY HAZARD OCCUPANCIES include buildings housing occupancies such as

Abrasive Works
Automobile Garages, Sales and Service

Bakeries
Beverage Manufacturing
Bleacheries
Boiler Houses
Bottling Works
Breweries
Brick Tile and Clay Products

Canneries
Cement Plants
Cereal Mills
Chemical Works — Low Hazard
Chemical Works — Ordinary Hazard
Clothing Factories
Cold Storage Warehouses
Confectionery Products Manufacturing
Cotton and Woolen Mills

Dairy Products Mfg. & Processing
Distilleries
Dry Cleaning
Dyeing and Print Works

Electric Generating Stations

Feed Mills
Flour Mills
Foundries
Fur Processing

Glass and Glass Products Factories
Grain Elevators, Tanks and Warehouses

Ice Manufacturing

Laundries
Leather Goods Manufacturing
Libraries, Large Stack Room Areas
Lithographing

Macaroni Factories
Machine Shops
Meat Packing and Curing
Mercantiles
Metal Working
Millinery Manufacturing
Mining Properties

Paper and Pulp Mills
Pharmaceutical Manufacturing
Piers and Wharves
Power Plants
Printing and Publishing

Restaurants
Rope, Cordage and Twine Factories

Shoe Factories
Slaughterhouses
Smelters
Steel Mills
Sugar Refining

Tanneries
Textile Knitting and Weaving Mills
Theatres and Auditoriums
Tire Manufacturing
Tobacco Products Manufacturing

Warehouses and Storage Buildings
- General
- Household Furniture
- Tobacco

Watch and Jewelry Manufacturing
Waterworks and Pumping Stations
Wineries

1322. Where hazards in those buildings or portions of buildings of the above occupancies are severe, the authority having jurisdiction shall be consulted for special rulings regarding water supplies, types of equipment, pipe sizes, types of sprinklers and sprinkler spacing.

1330. Extra Hazard Occupancies.

1331. EXTRA HAZARD OCCUPANCIES include only those buildings or portions of buildings housing occupancies where the hazard is severe as determined by the authority having jurisdiction. These include occupancies such as

Aircraft Hangars
Chemical Works — Extra Hazard
Cotton Picker and Opening Operations
Explosives and Pyrotechnics Manufacturing
Linoleum and Oilcloth Manufacturing
Linseed Oil Mills
Oil Refineries
Paint Shops
Pyroxylin Plastic Manufacturing and Processing
Shade Cloth Manufacturing
Solvent Extracting
Varnish Works
and other occupancies involving processing, mixing, storage and dispensing flammable and/or combustible liquids.

1332. Where severe hazards are not otherwise adequately protected, the authority having jurisdiction should be consulted for special rulings regarding water supplies, types of equipment, supplementary systems if required, pipe sizes, types of sprinklers. and sprinkler spacing.

1400. Design and Installation.

1410. Devices and Materials.

1411. The authority having jurisdiction should be consulted as to approved devices and materials.

1412. Normally, only new materials and devices shall be employed in the installation of sprinkler systems. Second-hand sprinklers shall not be used. When special conditions warrant, listed devices such as alarm valves, retarding chambers, circuit closers, water motor alarm devices, dry pipe valves, and quick

opening devices, etc., may be re-used, but if re-used they shall be reconditioned by the original manufacturer. On request of the authority having jurisdiction, the original manufacturer shall furnish a certificate, stating that such specified devices have been reconditioned and tested and are considered satisfactory for re-use.

1413. For the installation of fire pumps, gravity and pressure tanks, valves and other related devices, see separately published Standards or Publications listed in Appendix D of this Sprinkler Standard.

1420. Workmanship.

1421. **Sprinkler system layout and installation should be entrusted to none but fully experienced and responsible parties. Sprinkler system installation is a trade in itself. Inspectors cannot be expected to act as working superintendents or correct errors.**

1430. Preliminary Plans.

1431. Before an equipment is installed or remodeled, in order to avoid error or subsequent misunderstanding, preliminary layouts shall be submitted for approval to the authority having jurisdiction. Any material deviation from approved plans will require special permission. Preliminary layouts should show:

Name of owner and occupant.

Location, including street address.

Point of compass.

Construction and Occupancy of each building.

NOTE: Data on special hazards should be submitted as they may require special rulings.

Building height in feet.

If it is proposed to use a city main as a supply, sketch should show whether the main is dead-end or circulating, size of the main and pressure in pounds; and if dead-end, direction and distance to nearest circulating main.

Distance from nearest pumping station or reservoir should also be indicated.

In cases where reliable up-to-date information is not available, a test of the city main should be conducted by the contractor in accordance with Section 2220. 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

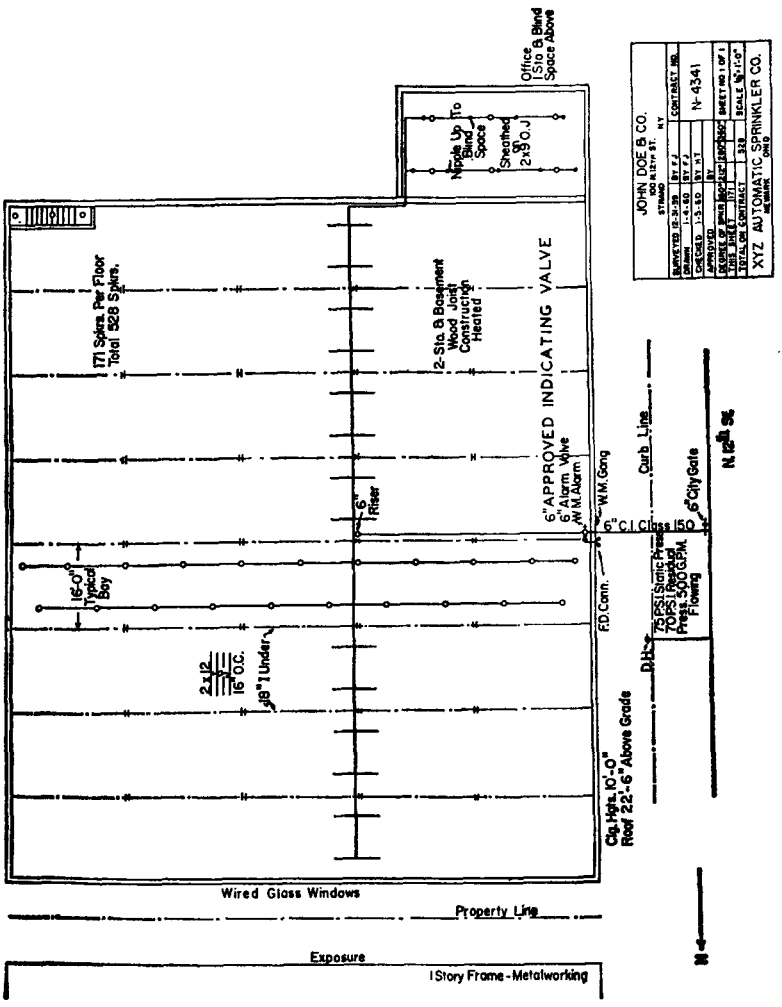


Fig. 1430. Typical Preliminary Plan.

number of open hydrant butts flowed; also data covering minimum pressure in connection with city main should be included.

Data covering waterworks systems in small towns would expedite the review of plans.

Fire walls, fire doors, unprotected window openings. Large unprotected floor openings, blind spaces.

Distance to and construction and occupancy of exposing buildings — *e.g.*, lumber yards, brick mercantiles, fire-resistive office buildings, etc.

Spacing of Sprinklers. Number of sprinklers in each story or fire area and total number of sprinklers. Number of sprinklers on each riser and on each system by floors. Total area protected by each system on each floor. Total number of sprinklers on each dry pipe system or preaction or deluge system. If extension to present equipment, number of sprinklers on riser per floor, and if dry-pipe system total number of sprinklers already installed.

Capacities of dry pipe systems should be indicated, with the bulk pipe included. See Table 5232. If an extension is made to an existing dry pipe system, indicate the total capacity of the existing and also extended portion of the system.

Weight or class and size of any proposed underground pipe.

Indicate if property is located in a flood area requiring consideration in the design of sprinkler system.

Name and address of party submitting the layout.

1440. Working Plans.

1441. Before an equipment is installed or remodeled, complete working plans shall be submitted for approval to the authority having jurisdiction. Any material deviation from approved plans will require special permission.

1442. Submission of working plans for approval before starting installation will avoid subsequent expensive changes, and give owners and contractors the benefit of the latest fire protection engineering experience.

1443. Working plans should 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 show the following data:

Name of owner and occupant.
Location, including street address.
Point of compass.
Ceiling construction.
Full height cross section.
Location of fire walls.
Location of partitions.
Occupancy of each area or room

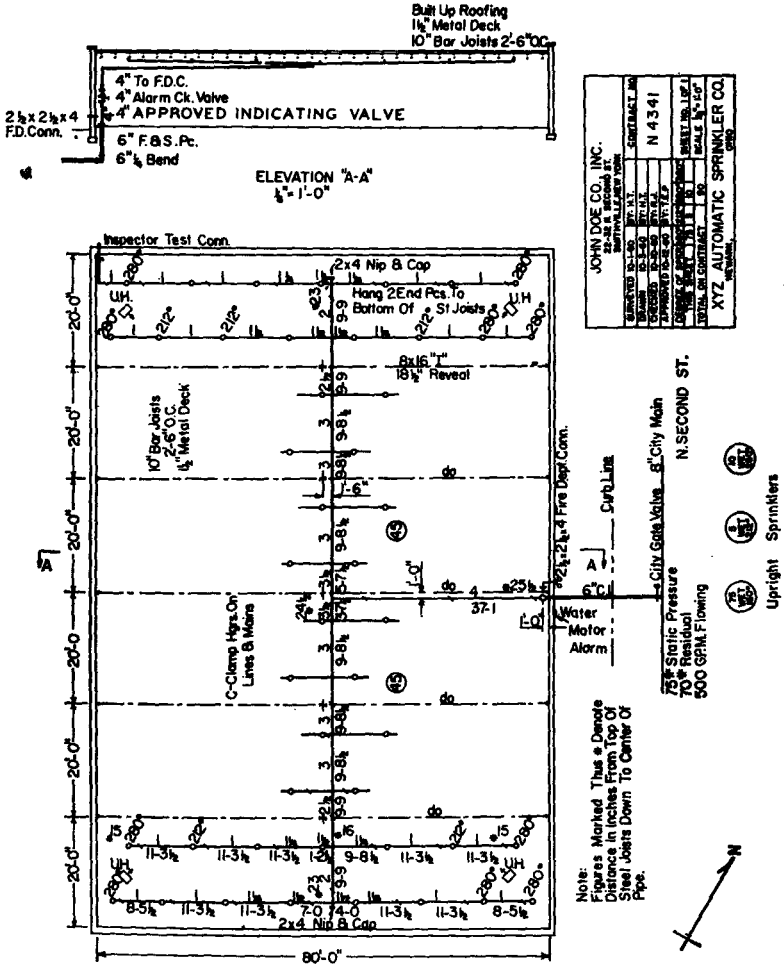


Fig. 1440-1. Typical Working Plans.

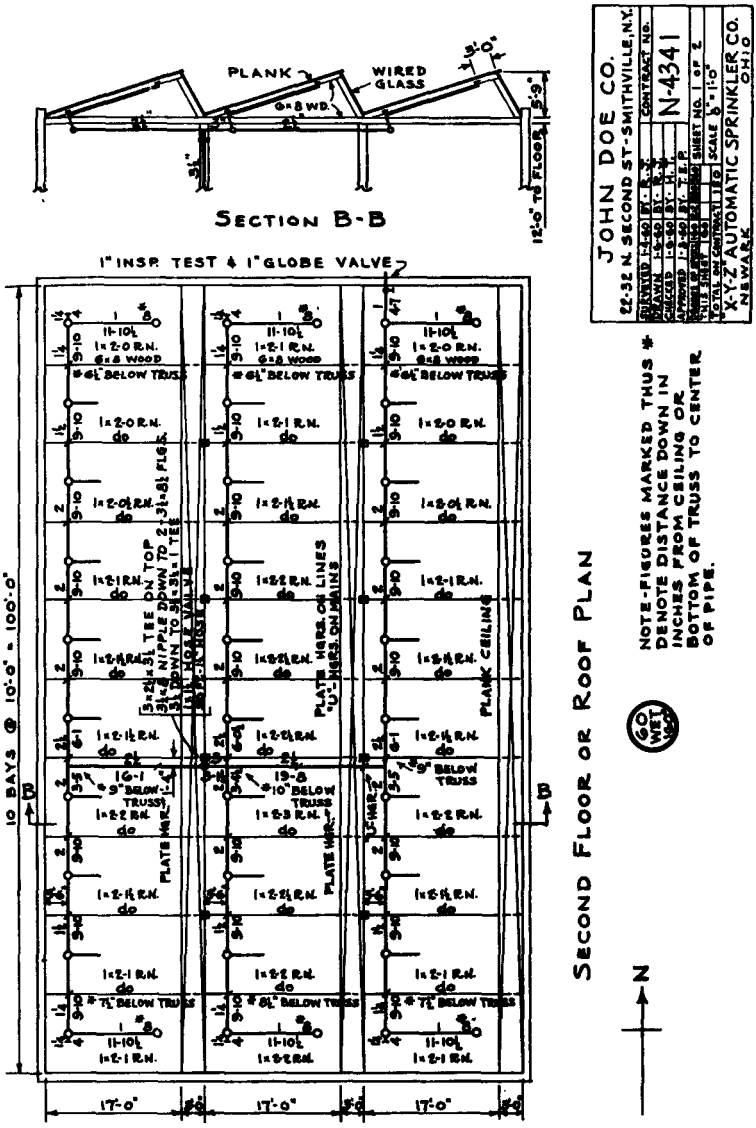


Fig. 1440-2. Typical Working Plans (cont.)

Location and size of blind spaces, closets, benches, tables, desks, etc. See Section 1110, and Paragraphs 4303–4327 inclusive, except Paragraphs 4306 and 4307.

Indicate on plans any questionable small enclosures in which no sprinklers are to be installed.

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 Section 2220.

Other sources of water supply, with pressure or elevation.

Make and type of sprinkler.

Temperature rating and location of high test sprinklers.

Number of sprinklers on each riser and on each system by floors. Total area protected by each system on each floor.

Number of sprinklers on each riser and total per floor.

Make, type, model and size of alarm or dry-pipe valve.

Make, type, model and size of pre-action or deluge valve.

Kind and location of alarm bells.

Total number of sprinklers on each dry-pipe system or pre-action or deluge system.

Approximate capacity in gallons of each dry-pipe system.

Cutting lengths of pipe.

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

Crosses, riser nipples and size.

Type of hangers, inserts and sleeves.

All control valves, checks, drain pipes and test pipes.

Small hand hose and hose equipment.

Where plans include underground pipe the weight or class and size of pipe, the type of valves, valve pits, and the depth that the top of the pipe is to be laid below grade should be given.

Provision for flushing. See Paragraph 3064.

When the equipment to be installed is an addition to an old group of sprinklers without additional feed from the yard system, enough of the old system should be indicated on the plans to show the total number of sprinklers to be supplied and to make all conditions clear.

Name and address of contractor.

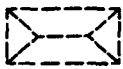
1450. Standard Plan Symbols.

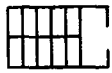
1451. The Standard Plan Symbols are as follows:

Elevator in masonry or noncombustible shaft.

Elevator in combustible shaft.

Open hoist or elevator.


Raised skylight.


Stairs in masonry or noncombustible shaft.


Stairs in combustible shaft.

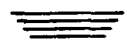

Open stairs.

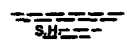

Enclosed stairs.

Beams or girders against ceiling; total obstruction.

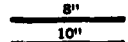
Beams or girders under joists, etc., partial obstruction.

Girders or trusses far enough below ceiling or of a size that obstruction is negligible.

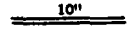

Open joists (Indicate direction).



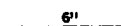
Sheathed joists.



Public water main

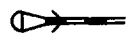


Private water main



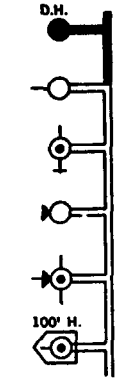
Private water main buried beneath building


Suction pipe


Foot valve and strainer


Deluge valve


Water meter (by-pass shown, if any).



Public hydrant (marked "DH, TH, QH" to indicate double, triple, etc., hydrant)

Private hydrant, non-frostproof, 1 hose outlet

Private hydrant, frostproof, 2 hose outlets (one has independent valve).

Private hydrant, non-frostproof, pumper connection.

Private hydrant, frostproof-3 outlets, and pumper connection

Housed hydrant, 100 ft. hose attached, one outlet.

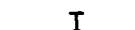

Alarm gong, with hood.


Dry valve (size indicated).

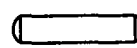

Dry valve with quick-opening device.


Fire department connection


Ordinary gate valve


Globe valve


Post indicator valve


Pressure tank (capacity and location indicated).

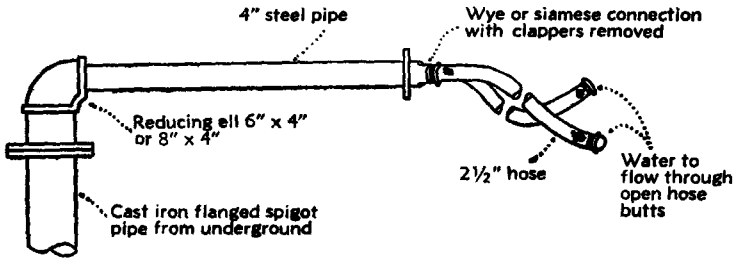

Indicator gate valve

Sprinkler riser (size indicated).

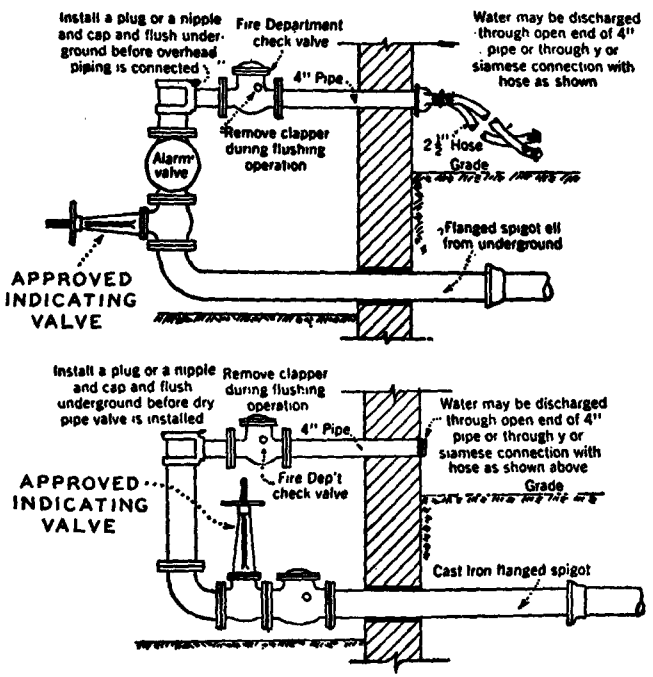

Alarm check valve


Valve in pit


Water flow indicator



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



Employing fire department connections.

Fig. 1621. Methods of Flushing Water Supply Connections.

1460. Sprinkler Systems in Buildings Subject to Flood.

1461. Where sprinklers are installed in buildings subject to recurring floods, special attention shall be given (1) to the ar-

rangement of piping and location of valves so that valves will be accessible during high water, (2) to the location of alarm devices and equipment so as to keep as much of the equipment as possible operable during high water, and (3) to the location and protection of pumps and air compressors and their power supply so as to provide every reasonable safeguard against interruption.

1500. Approval of Sprinkler Systems.

1510. Request for Inspection.

1511. Before asking final approval of an automatic sprinkler equipment by the authority having jurisdiction the installing company should 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 1700.)

1600. Acceptance Tests.

1610. Conduct of Tests.

1611. All tests should be made by contractor in presence of inspector of the authority having jurisdiction. When inspector is not available and permission is granted by the authority having jurisdiction, tests may be witnessed by owner or his representative and test certificate signed by same.

1620. Flushing of Underground Connections.

1621. Underground mains and lead-in connections to system risers shall be flushed thoroughly 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. Underground mains supplying wet pipe, dry pipe or pre-action sprinkler systems should be flushed at a rate of flow of not less than 750 gallons per minute for 6-inch pipe, 1,000 gallons per minute for 8-inch pipe, 1,500 gallons per minute for 10-inch pipe and 2,000 gallons per minute for 12-inch pipe. The minimum rate of flow for flushing underground connections to open sprinkler, deluge, and hydraulically designed systems should not be less than the water demand rate of the system which is determined by system design. For all systems, the flushing operations should be continued for a sufficient time to insure thorough cleaning. When planning the flushing operations, consideration shall be given to disposal of the water issuing from the test outlets. If the water supply will not produce the stipulated flow rate, the maximum flow rate available should be obtained by employing adequate discharge means.

1630. Hydrostatic Tests.

1631. TEST PRESSURE. All new systems including yard piping shall be tested hydrostatically at not less than 200 pounds per square inch pressure for two hours, or at 50 pounds per square inch in excess of the maximum static pressure when the maximum static pressure is in excess of 150 pounds.

1632. PERMISSIBLE LEAKAGE. The inside sprinkler piping should 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 Outside Protection Standard (NFPA No. 24) for permissible leakage in underground mains and leadins. The amount of leakage may be measured by pumping from a calibrated container.

1633. FIRE DEPARTMENT CONNECTION. Piping between the check valve in the fire department inlet pipe and the outside connection should be tested the same as the balance of the system.

1634. CORROSIVE CHEMICALS. Brine or other corrosive chemicals shall not be used for testing systems.

1635. To prevent the possibility of serious water damage in case of a break, pressure should be maintained by a small pump, the main controlling gate meanwhile being kept shut.

1636. TEST GASKET. In testing extensions to old systems a special type of self-indicating blank shall be used whenever a blank gasket has to be used for testing purposes. This testing blank shall have lugs painted red protruding beyond the flange in such a way as to clearly indicate its presence. Sprinkler installing companies shall have all blank gaskets numbered so as to keep track of their use and assure their return after the work is completed.

1640. Tests of Dry-Pipe Systems.

1641. HYDROSTATIC TEST. New dry-pipe systems shall be tested hydrostatically as specified in Paragraph 1631, except that at seasons of the year which will not permit testing with water they shall be tested for two hours with at least 50 lbs. per sq. in. air pressure. 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., to prevent injuring the valve.

1642. AIR TEST. In dry-pipe systems an air pressure of 40 lbs. per sq. in. shall be pumped up, allowed to stand 24 hours, and all leaks which allow a loss of pressure of over 1½ pounds for the 24 hours shall be stopped.

1643. OPERATING TEST OF DRY-PIPE VALVE. A working test of the dry-pipe valve and quick opening device, if installed, should be made before acceptance.

1650. Tests of Drainage Facilities.

1651. Tests of drainage facilities shall be made by opening the main drain valve while the control valve is wide open.

1700. CONTRACTOR'S MATERIAL AND TEST CERTIFICATE SPRINKLER SYSTEMS — WATER SPRAY SYSTEMS

Part "A" General

PROCEDURE

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

A certificate should be filled out and signed by both representatives. Copies should be prepared for inspecting authorities, owner, 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 inspecting authority's requirements or local ordinances.

Property name..... Date.....

Property address .....

PLANS

Accepted by inspection 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 of this new equipment? Yes ☐ No ☐

If no, explain.....

Has a copy of instruction and maintenance chart been left at plant? Yes ☐ No ☐

If no, explain.....

TEST DESCRIPTION

Flushing: Flow the required rate until mains are 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 750 GPM for 6-inch pipe and smaller, 1,000 GPM for 8-inch pipe, 1,500 GPM for 10-inch pipe, and 2,000 GPM for 12-inch pipe. Where supply cannot produce stipulated flow rates, obtain maximum available by using properly sized discharge devices.

Hydrostatic: Hydrostatic test should be made at not less than 200 PSI for two hours or 50 PSI above static pressure in excess of 150 PSI. Differential dry-pipe valve clappers should be left open during test to prevent damage. All aboveground piping leakage should be stopped.

Leakage: New pipe laid with rubber gasketed joints should, if the workmanship is satisfactory, have no leakage at the joints. Unsatisfactory amounts of leakage usually result from twisted, pinched or cut gaskets. However, some leakage might result from small amounts of grit or small imperfections. The amount of leakage at the joints should not exceed 2 quarts per hour per 100 joints irrespectively of pipe diameter. The leakage should be distributed over all joints. If such leakage occurs at a few joints the installation should be considered unsatisfactory and necessary repairs made.

New pipe laid with caulked lead or lead-substitute joints, should, if the workmanship is satisfactory, have little or no leakage at the joints. Any joint having leakage or more than a "slight drip" or "weeping" should be repaired. Leakage should not exceed 1 oz. (liquid measure) per hour per inch of pipe diameter per joint. The leakage should be distributed over all joints. If such leakage occurs almost entirely at a few joints, the installation should be considered unsatisfactory and necessary repairs made.

Pneumatic: Establish 40 PSI air pressure and measure drop which should not exceed 1½ PSI in 24 hours. Test pressure tanks at normal water level and air pressure and measure air pressure drop which should not exceed 1½ PSI in 24 hours.

Part "B" Underground Piping

LOCATION

Feeds bldgs.....

UNDERGROUND PIPES AND JOINTS

Pipe type and class.....Type joint.....

Conforms to.....Standard Yes ☐ No ☐

If no, explain.....

Joints needing anchorage clamped, strapped, or backed in accordance with.....Standard Yes ☐ No ☐

If no, explain.....

TESTS REQUIRED

Flushing Tests

New underground piping flushed according to.....Standard Yes ☐

by (Company).....

How flushing flow was obtained:
Public water ☐ Tank or reservoir ☐ Fire pump ☐

Through what type opening: Hydrant butt ☐ Open pipe ☐

Lead-ins flushed according to.....Standard Yes ☐

By (Company).....

How flushing flow was obtained:
Public water ☐ Tank or reservoir ☐ Fire pump ☐

Through what type opening: 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.....

.....

PARTS A AND B SIGNATURES

Name of sprinkler contractor.....

For sprinkler contractor (signed).....Date.....

For property owner (signed).....Title.....

Tests Witnessed By....., Title....., Date.....

Part "C" Sprinkler and Water Spray Aboveground Piping

(Fill out separate Part "C" for each riser)

LOCATION

Serves buildings:.....

TESTS REQUIRED

Hydrostatic: all piping.

Pneumatic: dry piping.

Equipment operation: all

Drain:.....

SPRINKLERS OR SPRAY NOZZLES

Make	Model	Size	Quantity	Temperature Rating
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....
.....	.....	.....	.....	.....

PIPE AND FITTINGS

Material and kind conforms to.....Standard

If none, explain.....

ALARM VALVE OR FLOW INDICATOR

ALARM DEVICE			MAXIMUM TIME TO OPERATE THROUGH TEST PIPE	
Type	Make	Model	Min	Sec
.....	.....	.....	.....	.....

DRY PIPE VALVES

Operating Test Results: Make.....Model.....Serial No.....

Time to Trip Through Test Pipe								Trip Point	Time Water Reached Test Outlet	
Without Q.O.D.		With Q.O.D.								
Min	Sec	Min	Sec	Water Pressure PSI		Air Pressure PSI		Air Pressure PSI	Min	Sec
.....	.....	.....	.....	.....		.....		.....	.....	.....

Alarm operated properly? Yes ☐ No ☐

If no, explain.....

DELUGE AND 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? Yes ☐ No ☐

Does each circuit operate valve release? Yes ☐ No ☐

Maximum time to operate release: Min.....Sec.....

TESTS

All piping hydrostatically tested at.....PSI for.....hours

Dry piping pneumatically tested: Yes ☐ No ☐

Equipment operates properly: Yes ☐ No ☐

If no, state reason.....

Drain test:

Reading of gage located near water supply test pipe:

Static presure.....PSI

Residual pressure with valve in test pipe open wide:

.....PSI

BLANK TESTING GASKETS

Number used.....Locations.....Number removed.....

WELDED OR BRAZED PIPING Yes ☐ No ☐

If Yes, do you certify as the sprinkler contractor that the welders or brazers are qualified for welding or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators-1968 Edition. Yes ☐ No ☐

REMARKS

Date left in service with all control valves open.....

PART "C" SIGNATURES

Name of sprinkler contractor.....

For sprinkler contractor (signed).....

For property owner (signed)..... Title.....

Tests Witnessed By....., Title....., Date.....

CHAPTER 2. WATER SUPPLIES.

2000. General Provisions.

2010. Number and Type.

2011. Every automatic sprinkler system shall have at least one automatic water supply of adequate pressure, capacity and reliability. The necessity for a second supply will depend on various factors such as those mentioned below.

2012. The authority having jurisdiction shall be consulted in every case as to the water supplies which will be required. The water supply needed for various occupancies, including extra hazard occupancies, must be determined by a study of the conditions obtaining in each case, giving primary consideration to the number of sprinklers which may be expected to operate from any one fire plus quantities needed simultaneously for hose streams.

2013. Determination of the water supply needed for extra hazard occupancies will require special consideration of the four factors: (1) Number of sprinklers that may operate, (2) amount or rate of discharge needed from each sprinkler, (3) required time of sprinkler discharge, and (4) amount of water needed simultaneously for hose streams.

2014. Where 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 the use of large orifice sprinklers, 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.

2015. Where separately published standards on various subjects contain specific provisions for water supplies, these should be consulted. (See Appendix for availability of Standards.)

2016. See Chapter 7 for special provisions applicable to determination of water supply requirements for hydraulically designed systems.

2100. Guide to Water Supply Requirements for Sprinkler Systems.

2110. Guide Tables.

2111. Table 2111 is a guide for pipe schedule sprinkler systems to determine the minimum volume of water and pres-

TABLE 2111.

GUIDE TO WATER SUPPLY REQUIREMENTS FOR SPRINKLER SYSTEMS

Occupancy Classification	*Minimum Residual Pressure Required Under the Roof (See Note 1)*	*Minimum Acceptable Flow at Base of Riser (See Note 2)*	*Duration in Minutes*
LIGHT HAZARD	15 psi	500–750 gpm (See Note 3)	60
ORDINARY HAZARD (GROUP 1)	15 psi or higher	500–1000 gpm	60–100
ORDINARY HAZARD (GROUP 2)	15 psi or higher	500–1500 gpm	60–100
ORDINARY HAZARD (GROUP 3)	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction.		60–120
GENERAL STORAGE WAREHOUSES, see Chapter 7.			
HIGH RISE BUILDINGS, see Chapter 8.			
WOODWORKERS SEE APPENDIX A	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction.		
EXTRA HAZARD	Pressure and flow requirements for sprinklers and hose streams to be determined by authority having jurisdiction.		

NOTES:

1. The pressure required at the base of the sprinkler riser(s) shall be the residual pressure required under the roof plus the pressure required to reach this elevation.

2. The lower figure is the minimum flow ordinarily acceptable for recognition as a supply to a sprinkler system. The higher flow should normally suffice for all cases under each group unless adverse conditions are present.

3. The requirement may be reduced to 250 gpm if building is limited in area or if building (including roof) is noncombustible construction.

sure normally required. THE TABLE IS TO BE USED ONLY WITH EXPERIENCED JUDGMENT, and the requirements for hose streams are to be added to the quantities given.

2112. 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) Areas 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.

2113. Figure 2113 is a guide to determine density, area of sprinkler operation and water supply requirements for hydraulically designed sprinkler systems. Systems shall be calculated to satisfy a single point on the appropriate design curve and interior piping shall be based on this design point. It is not necessary to meet all points on the selected curve (see Chapter 7). Total water supply available to the system at the base of the riser at the residual pressure required by the design shall be not less than shown in Table in Fig. 2113 but this total water supply need not be calculated through the overhead piping.

2120. Classification of Occupancy.

2121. In the following tables the occupancy referred to is the occupancy of the individual building being protected.

2122. LIGHT HAZARD: In Guide Table 2111, the Light Hazard class should include those properties where the amount and combustibility of the contents is low, and there is no obstruction to sprinkler distribution. This class excludes mercantiles,

Continued on 13–33

MINIMUM WATER SUPPLIES

HAZARD CLASSIFICATION	SPRINKLERS GPM	INSIDE & OUTSIDE HOSE - GPM	DURATION MIN
LIGHT	150	100	30
ORD - GP 1	450	250	60
ORD - GP 2	600	250	90
ORD - GP 3	750	500	90

FOR DRY SYSTEMS INCREASE AREA OF SPRINKLER OPERATION BY 30 PERCENT.

FOR COMBUSTIBLE CONSTRUCTION THE MINIMUM AREA OF APPLICATION SHALL BE 3,000 SQ. FT.

FOR HAZARD CLASSIFICATIONS OTHER THAN THOSE INDICATED SEE APPROPRIATE NFPA STANDARDS FOR DESIGN CRITERIA.

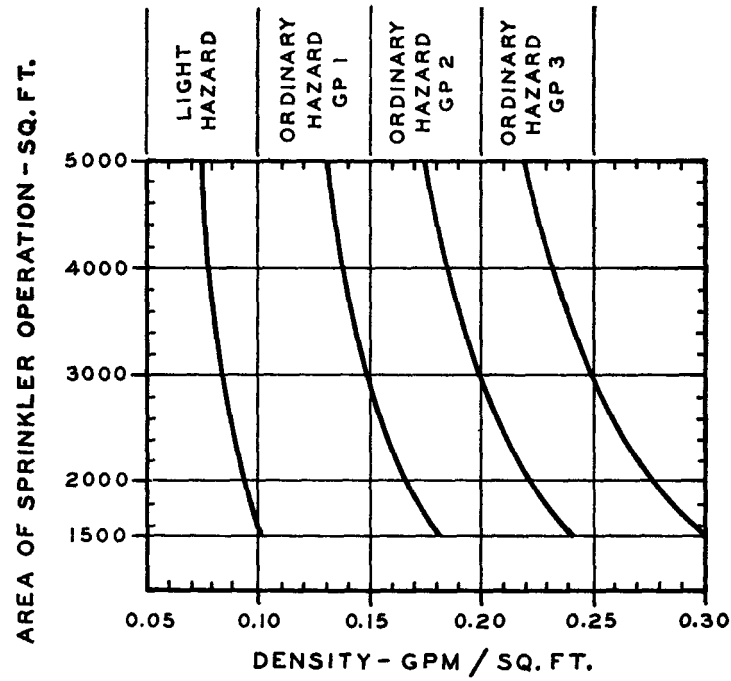


Fig. 2113. A guide for determining density, area of sprinkler operation and water supply requirements.

warehouse and manufacturing occupancies and includes only occupancies such as:

Apartments
Asylums
Churches
Clubs
Colleges and Universities
Dormitories
Dwellings
Hospitals
Hotels
Institutions
Libraries, except Large Stack Room Areas
Museums
Nursing, Convalescent and Care Homes
Office Buildings
Prisons
Public Buildings
Rooming Houses
Schools
Tenements

2123. ORDINARY HAZARD (GROUP 1): This group of the ordinary hazard class includes those properties where combustibility is low, with no flammable liquids or other quick burning materials, stock piles do not exceed 6 to 8 feet and other factors are favorable. Following are some examples of types of properties generally falling into this group:

Abrasive Works
Automobile Garages
Bakeries
Beverage Manufacturing
Bleacheries
Boiler Houses
Bottling Works
Breweries
Brick, Tile and Clay Products
Canneries
Cement Plants
Dairy Products Mfg. and Processing
Electric Generating Stations
Foundries
Fur Processing
Glass and Glass Products Factories
Ice Manufacturing
Laundries
Macaroni Factories
Millinery Manufacturing Plants
Restaurants
Slaughterhouses
Smelters
Steel Mills
Theatres and Auditoriums
Watch and Jewelry Manufacturing
Waterworks Pumping Stations
Wineries

2124. ORDINARY HAZARD (GROUP 2): This group of the ordinary hazard class includes those properties where combustibility of contents and ceiling heights are generally less favorable than those listed in Group No. 1, but there are only minor amounts of flammable liquids and essentially no obstruction. Examples of types of properties generally falling into this group are:

Cereal Mills
Chemical Works — Ordinary
Clothing Factories
*Cold Storage Warehouses
Confectionery Products Mfg.
Cotton and Woolen Mills
**Distilleries
Dye and Print Works
Grain Elevators, Tanks and Warehouses
*Leather Goods Manufacturing
Libraries, Large Stack Room Areas
*Lithographing
*Machine Shops
*Mercantiles
*Metal Working
Pharmaceutical Manufacturing
Printing and Publishing

Rope, Cordage and Twine Factories
Shoe Factories
Storage Buildings (having low factors of combustibility and obstruction)
Sugar Refining
Tanneries
Textile Knitting and Weaving Mills
Tobacco Products Manufacturing

2125. ORDINARY HAZARD (GROUP 3): This group of the ordinary hazard class includes those properties where features of combustibility of contents, ceiling heights and obstruction are unfavorable, separately or jointly. Following are some examples of the type of property falling into this group:

*Feed Mills
*Flour Mills
Paper and Pulp Mills
Paper Process Plants
Piers and Wharves
**Tire Manufacturing and Storage Warehouses (Paper, household furniture, paint, department store, etc.)
**Whisky Warehouses

2126. EXTRA HAZARD OCCUPANCIES: This class includes only those buildings or portions of buildings housing occupancies where the hazard is severe as determined by the authority having jurisdiction. These occupancies include such as:

**Aircraft Hangars
Chemical Works — Extra Hazard
Cotton Picker and Opening Operations
Explosives and Pyrotechnic Manufacturing
Linoleum and Oilcloth Manufacturing
Linseed Oil Mills
Oil Refineries
**Pyroxylin Plastic Mfg. and Processing
Shade Cloth Manufacturing
Solvent Extracting
Varnish Works

and other occupancies involving processing, mixing, storage and dispensing flammable and/or combustible liquids.

*Under conditions favorable to the individual property, and with special permission of the authority having jurisdiction, this class may, in some cases, qualify under the immediately preceding group.

**See Chapter 7 — Hydraulically Designed Sprinkler Systems and the Appendices for listing of separately published standards relating to water supply requirements for this class.

2127. Where severe hazards are not otherwise adequately protected, the authority having jurisdiction should be consulted for special rulings regarding water supplies, type of equipment, supplementary systems if required, pipe sizes, types of sprinklers and sprinkler spacing.

2200. Connections to Water Works Systems.

2210. Acceptability.

2211. A connection from a reliable water works system, of adequate capacity and pressure, is preferable as a single or a primary supply.

2212. SIZE OF MAINS. Connections should be made to street mains of ample size. Street mains preferably should be not smaller than 6 inches. Connections to dead end mains should be avoided.

2213. PRESSURE REGULATING VALVES. Pressure regulating valves should not be used except by special permission of the authority having jurisdiction.

2214. METERS. Where meters are used they shall be of approved type.

2220. Testing of Water Supply.

2221. To determine the value of public water as a supply for automatic sprinkler systems, it is generally necessary to make a flow test to determine how much water can be discharged at a residual pressure at grade sufficient to give the required residual pressure under the roof (with the volume flow hydraulically translated to the base of the riser) — *i.e.*, a pressure head represented by the height of the building plus the required residual pressure.

2222. The proper method of making such test is to use two hydrants in the vicinity of the property. The static pressure should be measured on the hydrant in front of or nearest to the property and the water allowed to flow from the hydrant next nearest the property; preferably the one farthest from the source of supply if main is fed only one way. The residual pressure will be that indicated at the hydrant where water is not flowing.

2223. Referring to Fig. 2223, the method of conducting the flow tests is as follows:

(1) Attach gauge to hydrant (A) and obtain static pressure.

(2) Either attach second gauge to hydrant (B) or use pitot tube at outlet. Have hydrant (B) opened wide and read pressure at both hydrants.

(3) Use the pressure at (B) to compute the gallons flowing and read the gauge on (A) to determine the residual pressure or that which will be available on the top line of sprinklers in the property.

2224. Water pressure in pounds for a given height in feet equals height multiplied by 0.434.

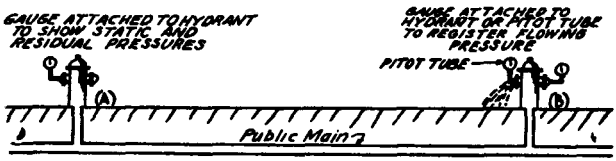


Fig. 2223. Method of Conducting Flow Tests.

2225. In making flow tests, whether from hydrants or from nozzles attached to hose, always measure the size of the orifice. While hydrant outlets are usually 2½ in. they are sometimes smaller and occasionally larger. The Underwriters' play pipe is 1⅛ in. and 1¾ in. with tip removed, but occasionally nozzles will be 1 in. or 1¼ in. and with the tip removed the opening may be only 1½ in.

2226. The pitot tube should be held approximately one-half the diameter of the hydrant or nozzle opening away from the opening. It should be held in the center of the stream, except that in using hydrant outlets the stream should be explored to get the average pressure.

2230. Reliability.

2231. In addition to flow tests, consideration should also be given to reliability of public water supply taking into account probable minimum pressure condition prevailing during such periods as at night, or during summer months when heavy draft may occur, also possibility of interruption by floods, or ice conditions in winter.

2300. Gravity Tanks.

2310. Acceptability.

2311. An elevated tank sized in accordance with Table 2111 or Figure 2113 is an acceptable water supply source. (See NFPA No. 22, Water Tanks for Private Fire Protection.)

2320. Capacity and Elevation.

2321. The elevation of the tank and arrangement of underground supply piping shall provide the volume and pressure required by Table 2111 or Figure 2113 designs.

2400. Pumps.

2410. Acceptability.

2411. A single automatically controlled fire pump sized in accordance with Table 2111 or Figure 2113 supplied under positive head is an acceptable water supply source. (See NFPA No. 20, Installation of Centrifugal Fire Pumps.)

2420. Supervision.

2421. Where a fire pump constitutes the sole sprinkler supply, it shall be provided with supervisory service from an approved central station, proprietary or remote station system.

2422. See sections dealing with sprinkler equipment supervisory and water flow alarm services in the Standard for Central Station Protective Signaling Systems, Watchman, Fire Alarm and Supervisory Service (NFPA No. 71), the Standard for Local Protective Signaling Systems, (NFPA No. 72A), the Standard for Auxiliary Protective Signaling Systems (NFPA No. 72B), Remote Station Protective Signaling Systems for Fire Alarm and Supervisory Service (NFPA No. 72C), or the Standard for Proprietary Protective Signaling Systems (NFPA No. 72D). See also separately published Standard for the Installation of Centrifugal Fire Pumps (NFPA No. 20), and Outside Protection (NFPA No. 24).

2500. Pressure Tanks.

2510. Acceptability.

2511. A pressure tank sized in accordance with Table 2111 or Figure 2113 is an acceptable water supply source. (See NFPA No. 22, Water Tanks for Private Fire Protection.)

2512. Pressure tanks shall be provided with an approved means for automatically maintaining the required air pressure. Where 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.

2520. Capacity.

2521. The size of the pressure tank required shall be in accordance with Table 2111 or Figure 2113 and shall include the extra capacity needed to fill dry pipe systems where installed. Minimum requirements where pressure tanks are not the sole water supply source shall be as indicated in Paragraphs 2522, 2523 or 2524.

2522. LIGHT HAZARD OCCUPANCY. Amount of available water, not less than 2,000 gallons.

2523. ORDINARY HAZARD OCCUPANCY. Amount of available water, not less than 3,000 gallons for Groups 1 and 2. For Group 3, refer to authority having jurisdiction.

2524. EXTRA HAZARD AND WOODWORKER OCCUPANCIES. Refer to authority having jurisdiction.

2525. For High Rise Buildings see Chapter 8.

2530. Water Level and Air Pressure.

2531. 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. by the gauge shall be maintained. When the bottom of the tank is located below the highest sprinklers served, the air pressure by the gauge shall be at least 75 lbs. plus three times the pressure caused by the column of water in the sprinkler system above the tank bottom.

2532. 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 pounds per sq. in.
A = ½ then P = 60 − 15 = 45 pounds per sq. in.
A = ⅔ then P = 45 − 15 = 30 pounds 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.

2533. The respective air pressures above are calculated to ensure that the last water will leave the tank at a pressure of 15 lbs. per square inch 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.

2534. Pressure tanks shall not be used to supply other than sprinklers and hand hose attached to sprinkler piping.

2535. See separately published Standard for Water Tanks for Private Fire Protection (NFPA No. 22).

2540. Location of Pressure Tanks.

2541. Pressure tanks should preferably be located above the top level of sprinklers, but may be located in the basement or elsewhere subject to the approval of the authority having jurisdiction.

2600. Fire Department Connections.

2610. When Required.

2611. A connection through which a fire department can pump water into the sprinkler system makes a desirable auxiliary supply. For this purpose, one or more fire department connec-

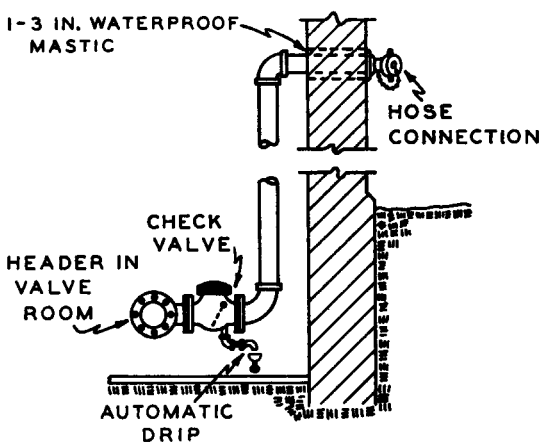


Fig. 2600. Fire Department Connection.

tions shall be provided in all cases except where permission of the authority having jurisdiction is obtained for their omission.

2620. Size.

2621. Pipe size shall not be less than 4 inches for fire engine connections and not less than 6 inches for fireboat connections, except that 3-inch pipe may be used to connect a single hose connection to a 3-inch or smaller riser. For hydraulically designed sprinkler systems the size of the fire department connection shall be sufficient to supply the water demand developed from Figure 2113.

2630. Arrangement. See Paragraph 3424.

2631. 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. (See paragraph 3427).

2632. On dry pipe systems with a single riser the connection shall be made between the approved indicating valve and the dry pipe valve.

2633. On systems with two or more risers the connection shall be made on the system side of all shut-off valves controlling other water supplies, but on the supply side of the riser shut-off valves so that with any one riser off, the connection will feed the remaining sprinklers.

2640. Valves.

2641. An approved straightway check valve shall be installed in each fire department connection, located as near as practicable to the point where it joins the system.

2642. There shall be no shut-off valve in the fire department connection.

2650. Support.

2651. Fire department connections shall be properly supported.

2660. Drainage.

2661. The piping between the check valve and the outside hose coupling shall be equipped with an approved automatic drip arranged to discharge to a proper place.

2670. Hose Connections.

2671. Hose connections shall be of approved type.

2672. Hose coupling threads shall conform to those used by the local fire department. National (American) Standard Fire Hose Coupling Screw Threads shall be used whenever they will fit the local fire department hose.

2673. Hose connections shall be equipped with standard caps, properly secured and arranged for easy removal by fire departments.

2674. Hose connections should be on the street side of building and shall be located and arranged so that hose lines can be readily and conveniently attached to the inlets without interference from any nearby objects including buildings, fences, posts, or other fire department connections.

2675. Hose connections shall be designated by a sign having raised letters at least one inch in size cast on plate or fitting reading for service designated: Viz. — "AUTO-SPKR.", "OPEN SPKR." or "AUTO SPKR. AND STANDPIPE."

2700. Size and Arrangement of Water Supply Connections.

2710. Size.

2711. Piping from water supply to the sprinkler riser should be at least as large as the riser but should not be less than 4 inches. For hydraulically designed sprinkler systems size of the piping shall be sufficient to supply the water demand developed from Figure 2113.

2712. 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 inches in size.

2720. Connection Between Underground and System Piping.

2721. The connection between the system piping and underground piping shall be made with a cast iron flanged piece, properly strapped, or fastened by other approved devices.

2722. Where riser is close to outside wall underground fittings of proper design and type should be used in order to avoid pipe joints being located in or under the wall. (See separately published Standard on Outside Protection, NFPA No. 24.)

2730. Interconnection of Water Supplies.

2731. All main water supplies should be connected with the sprinkler system at the base of riser, except that where a gravity or pressure tank or both, constitutes the only automatic source of water supply, special permission may be given to connect the tank or tanks with the sprinkler system at the top of the riser.

2732. Where a gravity tank and a pressure tank are connected to a common riser approved means shall be provided to prevent residual air pressure in the pressure tank (after water has been drained from it) from holding the gravity tank check valve closed, a condition known as air lock. Under normal conditions, air lock may be conveniently prevented in new equipment by connecting the gravity tank and pressure tank discharge pipes together 45 feet or more below the bottom of the gravity tank and placing the gravity tank check valve at the level of this connection.

2800. Water Supply Test Pipes and Gauges.

2810. Test Pipes.

2811. Suitable test pipes, which may also be used as drain pipes, shall be provided at such locations as will permit flowing

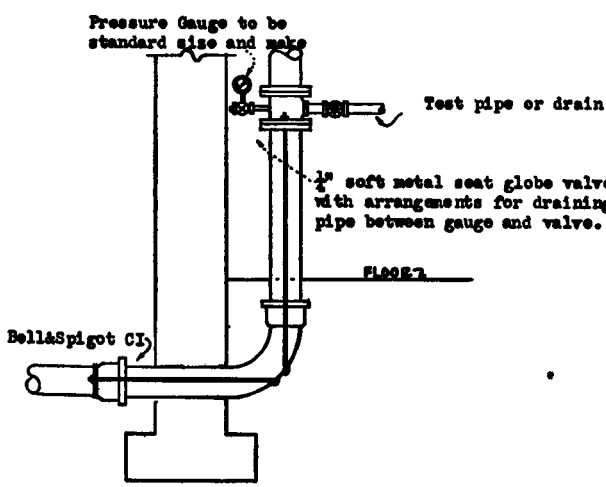


Fig. 2811-1. Test Pipe on Water Supply with Outside Control. Also applicable to an interior riser.

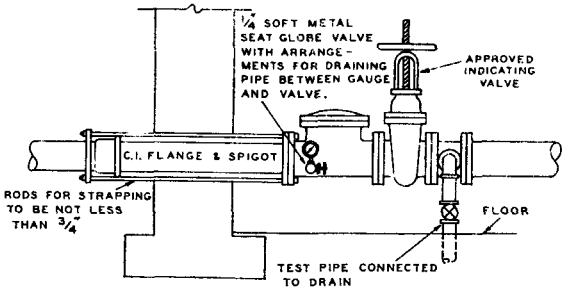


Fig. 2811-2. Water Supply Connection with Test Pipe.

Located on the system side of the gate valve, one test pipe may serve for more than one city connection. It will also indicate the condition of the gate valve. Located on the supply side of the check valve, it will serve to test out check valve by closing the waterworks gate or other outside valve.

tests to be made to ascertain whether water supplies and connections are in order. Such test pipes should be not less than the sizes specified in Section 3220 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 any water damage. The authority having jurisdiction shall be consulted as to the location and arrangement of test pipes. (See Sections 3220 and 3240.)

2820. Gauges.

2821. At or near each such test pipe a pressure gauge shall be installed with a connection not smaller than ¼ inch made to the main pipe. This gauge connection shall be equipped with a shut-off valve and with provision for draining. A plugged outlet ¼ inch in size should be located between each valve and gauge, for the purpose of installing the inspector's gauge.

2822. The required pressure gauges 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 so installed as to permit easy removal, and shall be located where they will not be subject to freezing.

2900. Special Provisions.

2910. Domestic Connections.

2911. Connections for domestic water service should be made on the water supply side of the check valve in the water supply main so that the use of the fire department connection

will not subject the domestic water system to high pressure. If the domestic consumption will significantly reduce the sprinkler water supply an increase in the size of the pipe supplying both the domestic and sprinkler water may be justified.

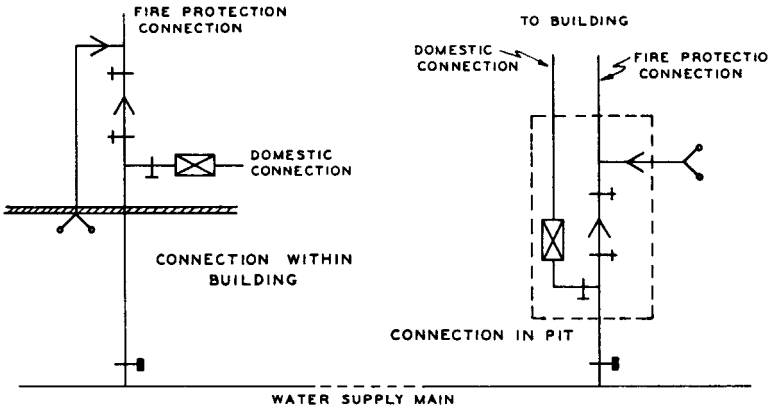


Fig. 2911. Connections for Domestic Water

2920. Water Hammer.

2921. Where connections are made from water mains, subject to severe water hammer (especially where pressure is in excess of 100 pounds), it may be desirable to provide either a relief valve, properly connected to a drain, or an air chamber in the connection. If an air chamber is used it should be located close to where the pipe comes through wall and on the supply side of all other valves and so located as to take the full force of water hammer. Air chambers shall have a capacity of not less than 4 cubic feet, shall be controlled by an approved indicating valve, and shall be provided with a drain at the bottom, also an air vent with control valve and plug to permit inspection.

2930. Penstocks, Flumes, Etc.

2931. Water supply connections from penstocks, flumes, rivers or lakes should be arranged to avoid mud and sediment, and should be provided with approved double removable screens or approved strainers installed in an approved manner.

CHAPTER 3. SYSTEM COMPONENTS.

3000. Piping.

3001. Piping Specifications.

3002. Pipe and tube used in sprinkler systems should be of the materials listed in Table No. 3002. The chemical properties, physical properties and dimensions of the materials listed in Table No. 3002 should conform at least to the standards cited in the table. Pipe and tube used in sprinkler systems should be designed to withstand a working pressure of not less than 175 psi. Whenever the word *pipe* is used, it shall be understood to also mean *tube*.

TABLE NO. 3002

Material and Dimensions	*Standard*
Ferrous Piping (Welded and Seamless)	
Black Steel Pipe	ASTM A-120-65 ASTM A-53-69a ANSI Standard B36.10-70*
Hot Dipped, Zinc Coated (Galvanized) Steel Pipe	ASTM A-120-69 ASTM A-53-69a ANSI Standard B36.10-70*
Non-Ferrous Tube (Drawn, Seamless)	
Copper (Listed)	ASTM B-75-68 or ASTM B88-70 ASTM B-251-66
Brazing Alloy	AWS A.5–69 Classification BCuP-3

*Standard Wall schedule 40 pipe permitted for pressures up to 300 psi. Schedule 30 pipe acceptable in sizes 8 in. and larger.

3003. Other types of pipe or tube may be used, but only those investigated and listed for this service by a nationally recognized testing and inspection agency and acceptable to the authority having jurisdiction.

3010. Definitions. (See Fig. 3010.)

3011. RISERS. The vertical supply pipes in a sprinkler system.

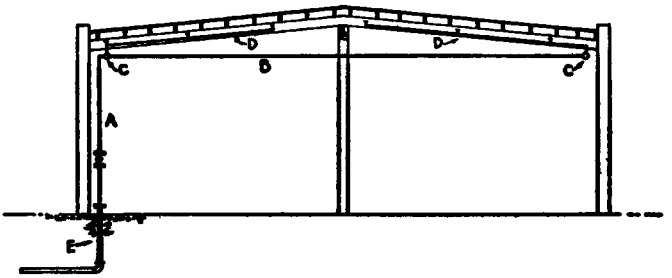


Fig. 3010. Building Elevation Showing Parts of Sprinkler Piping System. A — Riser; B — Feed Main; C — Cross Main; D — Branch Line; E — Underground Supply.

3012. FEED MAINS. Mains supplying risers or cross mains.

3013. CROSS MAINS. Pipes directly supplying the lines in which the sprinklers are placed.

3014. 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.

3020. Pipe Schedules.

3021. The number of automatic sprinklers on a given size pipe on one floor of one fire section should not exceed the number given in the following schedules for a given occupancy.

3022. When closed head systems are hydraulically designed in accordance with the provisions of Chapter 7, the pipe schedule provisions do not apply.

3023. The maximum floor area to be protected by one system on any one floor of one fire section shall be as follows:

Light Hazard	52,000 sq. ft.
Ordinary Hazard	52,000 sq. ft.
*Solid piled storage in excess of 15 feet in height or palletized or rack storage in excess of 12 feet in height	40,000 sq. ft.
Extra Hazard	25,000 sq. ft.

*See NFPA Nos. 231 and 231C for definitions of solid piled, palletized or rack storage.

Sprinkler spacing rules contained in Chapter 4 still apply.

3024. Size of Risers. Each system riser should be of sufficient size to supply all the sprinklers on the riser on any one floor of one fire section as determined by the standard schedules of pipe sizes. There should be one or more risers in each building and in each section of the building divided by fire walls. Where the conditions warrant, the sprinklers in an adjoining building or section cut off by fire walls may be fed from a system riser in another fire section or building.

3025. Slatted Floors and Large Floor Openings. Buildings having slatted floors, or large unprotected floor openings without approved stops, should be treated as one room with reference to the pipe sizes, and the feed main or risers should be of the size required for the total number of sprinklers.

3026. Mezzanines and Large Platforms. In buildings having mezzanine floors, large platforms, or large openings between floors which cannot be closed or satisfactorily cut off, the possibility that all or most of the sprinklers might be opened by a single fire should be considered in determining the size of risers. Where occupancy and construction are exceptionally good, and where there is little likelihood of a fire spreading beyond the vicinity of its origin, the size of the feed main should be based on the total number of sprinklers in the main area plus half the number in the area not cut off.

3027. Long Runs of Pipe. Where 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.

3030. Schedule for Light Hazard Occupancies.

3031. Branch lines should not exceed 8 sprinklers on either side of a cross main. Pipe sizes should be as follows, except as modified by Paragraphs 3032, 3033, and 3062.

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 Paragraph 3032	4 in. tube	See Paragraph 3032

3032. The area served by any one 4-inch pipe or tube size on any one floor of one fire section shall not exceed 52,000 square feet.

3033. Each large area requiring more than 100 sprinklers and without subdividing partitions (not necessarily fire walls) should be supplied by feed mains or risers sized for ordinary hazard occupancies.

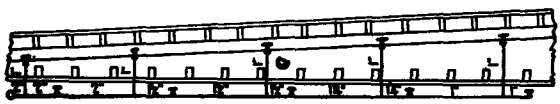


Fig. 3033-1. Arrangement of Branch Lines Supplying Sprinklers Above and Below a Ceiling.

3034. Where sprinklers are installed above and below a ceiling and such sprinklers are supplied from a common set of branch lines, such branch lines should not exceed 8 sprinklers above and 8 sprinklers below the ceiling on either side of the cross main. Pipe sizing up to and including 2½ inch should be as shown in the following schedule:

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

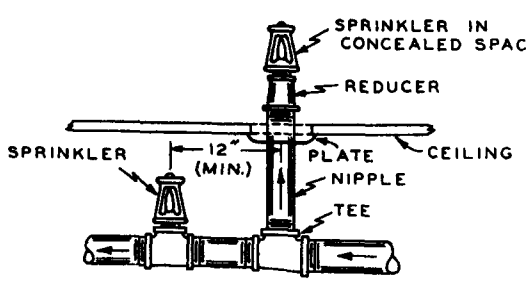


Fig. 3033-2. Sprinkler on Riser Nipple from Branch Line in Lower Fire Area.

For example, a 2½-inch steel pipe, which is permitted to supply 30 sprinklers in one fire area, may supply a total of 50 sprinklers where not over 30 sprinklers are above or below the ceiling. Where the total number of sprinklers above and below the ceiling exceeds 50, the pipe supplying more than 50 sprinklers should be increased to 3 inch, and sized thereafter according to the schedule shown in Paragraph 3031 for the number of sprinklers above or below the ceiling, whichever is larger.

3040. Schedule for Ordinary Hazard Occupancies.

3041. Branch lines should not exceed 8 sprinklers on either side of a cross main. Pipe sizes should be as follows, except as modified by Paragraphs 3042, 3043, and 3062.

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 Paragraph 3042	8 in. tube	See Paragraph 3042

3042. The area served by any one 8-inch pipe or tube size on any one floor of one fire section shall not exceed 52,000 square feet except that for solid piled storage in excess of 15 feet in height or palletized or rack storage in excess of 12 feet the area served by any one 8-inch pipe or tube size shall not exceed 40,000 square feet. Where single systems serve both such storage and Ordinary Hazard areas, storage area covered shall not exceed 40,000 square feet and total area covered shall not exceed 52,000 square feet.

3043. Where the distance between sprinklers on the branch lines exceeds 12 feet or the distance between the branch lines exceeds 12 feet, the number of sprinklers should be as follows for given sizes of pipe:

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, follow Paragraph 3041.

3044. Where sprinklers are installed above and below a ceiling and such sprinklers are supplied from a common set of branch lines, such branch lines should 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 inch should be as shown in the following schedule:

	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

For example, a 3-inch steel pipe, which is permitted to supply 40 sprinklers in one fire area, may supply a total of 60 sprinklers where not over 40 sprinklers are above or below the ceiling. Where the total number of sprinklers above and below the ceiling exceeds 60, the pipe supplying more than 60 sprinklers should be increased to 3½ inch and sized thereafter according to the schedule shown in Paragraph 3041 for the number of sprinklers above or below the ceiling, whichever is larger.

3050. Schedule for Extra Hazard Occupancies.

3051. Branch lines should not exceed 6 sprinklers on either side of cross main. The following pipe schedules are given only as a guide for installations having no unusual features.

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

(Continued)

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 Paragraph 3052	8	in. tube	See Paragraph 3052

3052. The area served by any one 8-inch pipe or tube size on any one floor of one fire section shall not exceed 25,000 square feet.

3053. For open sprinkler and deluge systems pipe schedule see Paragraph 5371.

3060. Special Provisions Applicable to Piping.

3061. (*Reserved for future use*).

3062. BRANCH LINES. When the occupancy is classified as Light or Ordinary Hazard Occupancy and when more than 8 sprinklers on a branch line are necessary, lines may be increased to 9 sprinklers by making the two end lengths 1 inch and 1¼ inch, respectively, and the sizes thereafter standard. In special cases, 10 sprinklers may be placed on a branch line by making the two end lengths 1 and 1¼ inch respectively and feeding the tenth sprinkler by a 2½-inch pipe. (See paragraph 7012).

3063. For sprinklers in storage racks see NFPA No. 231C, Rack Storage of Materials.

3064. PROVISION FOR FLUSHING SYSTEM. Provisions should be made to facilitate flushing of system piping by providing flushing connections consisting of a threaded capped nipple 4 inches long on the end of cross mains. All cross mains shall terminate in 1¼-inch or larger pipe. The nipples should be the same diameter as the end pipe but not larger than 2 inches. (See Fig. 3064). Flushing connections will ordinarily not be required for concealed piping systems, but will be required on deluge systems.

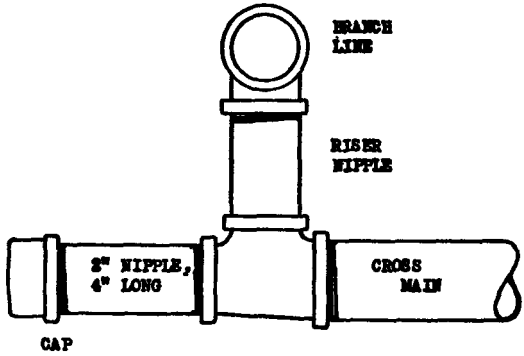
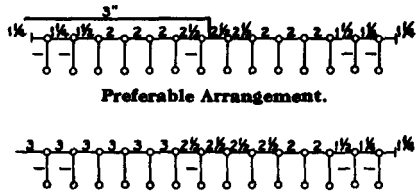


Fig. 3064. Flushing Connection.

3065. Branch Lines Having Two Sprinklers Only. Where cross mains supply numerous branch lines of only two sprinklers each, conditions approach those of long single branch lines and such two sprinkler branch lines should usually be centrally supplied; in addition, the following shall apply:



Preferable Arrangement.

Acceptable Arrangement.

Fig. 3065(a). Arrangement of Two-Sprinkler Branch Lines, Ordinary Hazard Occupancy.

(a) Ordinary Hazard: Where cross mains supply no more than ten branch lines of only two sprinklers each, follow Paragraphs 3041 and 3042. Branch lines up to 14 in number may be fed from one end, provided that 2-inch pipe does not supply more than eight sprinklers and 2½-inch pipe does not supply more than 16 sprinklers. [See Fig. 3065(a).]

(b) Extra Hazard: Where cross mains supply no more than eight branch lines of no more than two sprinklers each, follow Paragraph 3051. Branch lines up to 14 in number may be fed from one end, provided that 2½-inch pipe does not supply more than 12 sprinklers, and 3-inch pipe does not supply more than 20 sprinklers.

(c) See Paragraph 7012.

3066. STAIR TOWERS. Stairs, towers or other such construction with incomplete floors, if piped on independent risers, should be treated as one area with reference to pipe sizes, *i.e.*, feed main should be of sufficient size to accommodate the total number of sprinklers.

3067. RETURN BENDS. Where piping on wet systems is concealed, with sprinklers installed in pendent position below a ceiling, return bends will be required when the water supply to the sprinkler system is from a raw water source, millpond, or from open top reservoirs. Return bends should 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 should be 1 inch in size. In revamping existing systems, where it is not necessary to retain sprinklers in the concealed space, ½-inch or ¾-inch close nipples inserted in the existing sprinkler fittings may be used with 1-inch pipe and fittings for the other portions of the return bend. Where water supply is potable, return bends will not be required on wet systems. (See Fig. 3067.)"

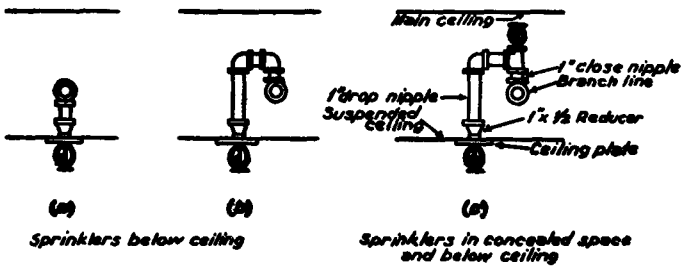


Fig. 3067. Pendent Sprinklers at Suspended Ceiling.

3068. PIPING IN CONCRETE. Where piping is installed in cinder concrete it shall be placed in properly constructed ducts or thoroughly encased in portland cement or its equivalent. In no case shall the piping system be installed so as to form a part of the floor arch reinforcement.

3069. SLEEVES FOR PIPE RISERS. (See Fig. 3069.)

(a) Sprinkler piping passing through floors of concrete or waterproof construction should have properly designed substantial thimbles or sleeves projecting three to six inches above the floor to prevent possible floor leakage. The space between the pipe and sleeve should be caulked with oakum or equivalent ma-

terial. If floors are of cinder concrete, thimbles or sleeves should extend all the way through to protect the piping against corrosion.

(b) It is desirable that ordinary floors through which pipes pass should be made reasonably tight around the risers. (See Section 1140.)

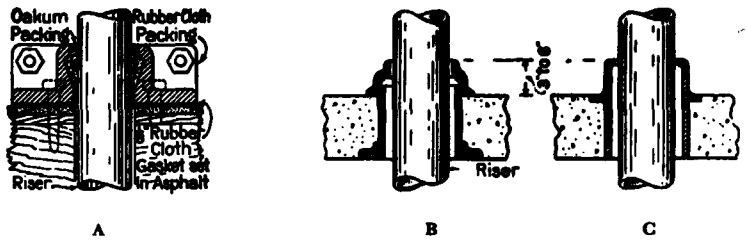


Fig. 3069. Watertight Riser Sleeves.
A — For wood or concrete floors; B and C — for concrete floors.

3070. DRY PIPE UNDERGROUND. When necessary to place pipe which will be under air pressure underground, the pipe should be steel or wrought iron and protected against corrosion (see Section 3130), or it may be gasketed joint cast-iron pipe.

3071. DOMESTIC CONNECTIONS. Sprinkler piping shall not be used in any way for domestic water service. Circulation of water in sprinkler pipes is objectionable, owing to increased corrosion, deposit of sediment, and condensation drip from pipes. (See Section 2910.)

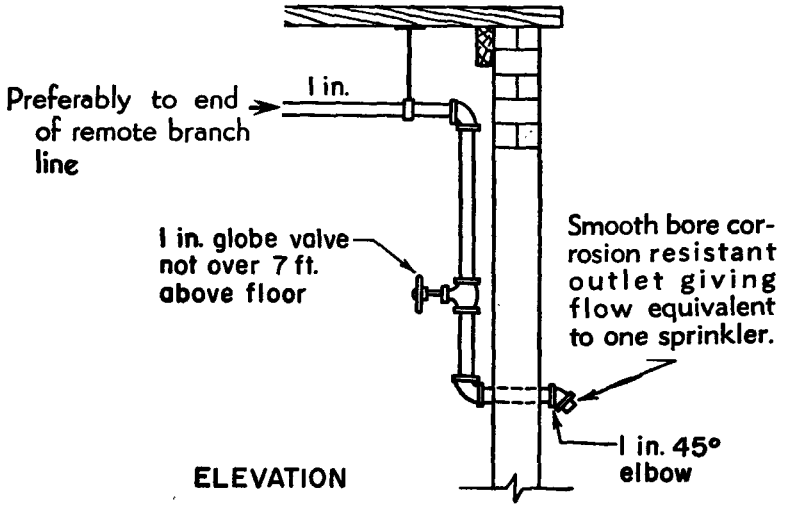
3072. HAND HOSE CONNECTIONS (SMALL). Hand hose, to be used for fire purposes only, may be attached to sprinkler pipes within a room subject to the following restrictions:

(a) Piping shall be 1-inch size for runs up to 20 feet and 1¼-inch size for runs between 20 and 80 feet.

(b) Hose shall be not larger than 1½ inch.

(c) Nozzle discharge shall not exceed the discharge from one nominal ½-inch orifice sprinkler. (See Paragraph 3641.)

(d) Hose should not be connected to any sprinkler pipe smaller than 2½ inch and never attached to a dry-pipe system. For details of hand hose installation, see Standard for the Installation of Standpipe and Hose Systems (NFPA No. 14).



NOTE: Not less than 4 feet of exposed test pipe in warm room beyond valve when pipe extends through wall to outside.

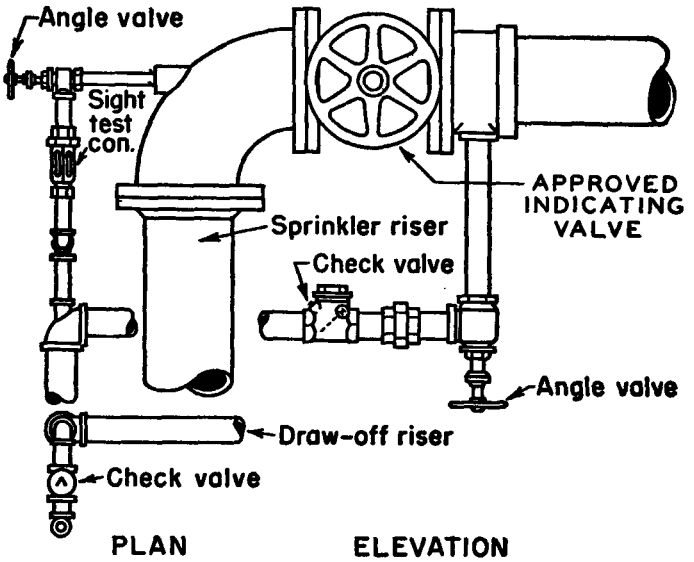


Fig. 3081. One-inch System Test Pipes on Wet-Pipe Systems.
Connect to top of main riser or to sprinkler pipe in the highest part of system. The drawing on the upper portion of the page shows the preferred arrangement. In special cases, the connection may be made in the manner shown in the lower drawing.

3073. HOSE CONNECTIONS FOR FIRE DEPARTMENT USE. In buildings of Light or Ordinary Hazard Occupancy 2½-inch hose valves for fire department use may be attached to wet pipe sprinkler systems subject to the following restrictions:

(a) The riser and hose valves shall be located in a fire-resistive stair enclosure.

(b) Sprinklers shall be under control of separate floor control valves located in the fire-resistive stair enclosure.

(c) the *minimum* size of the riser shall be 6 inch.

(d) The water supply and riser shall be adequate for sprinklers and standpipes combined.

(e) For Fire Department connections, serving standpipes and sprinklers, refer to Paragraph 2675.

3080. System Test Pipes.

3081. WET SYSTEMS. A test pipe of not less than 1-inch diameter terminating in a smooth bore corrosion resistant outlet giving a flow equivalent to one sprinkler shall be provided. This test pipe shall be provided for each system through a pipe not less than 1 inch in diameter, 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, subject to the approval of the authority having jurisdiction. In this event, the test connection shall be made using an approved sight test connection containing a smooth bore corrosion resistant orifice giving a flow equivalent to one sprinkler. (See Fig. 3081.) The test valve shall be located at an accessible point, and preferably not over seven feet above the floor. The control valve on the test connection shall be located at a point not exposed to freezing.

3082. In those 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. (See Fig. 3082).

3083. DRY-PIPE SYSTEMS. A 1-inch inspector's test with a smooth bore corrosion resistant outlet giving a flow equivalent to one sprinkler shall be installed on the end of the most distant sprinkler line in the upper story and be equipped with a 1-inch shut-off valve and cast-iron plug. (See Fig. 3083.)

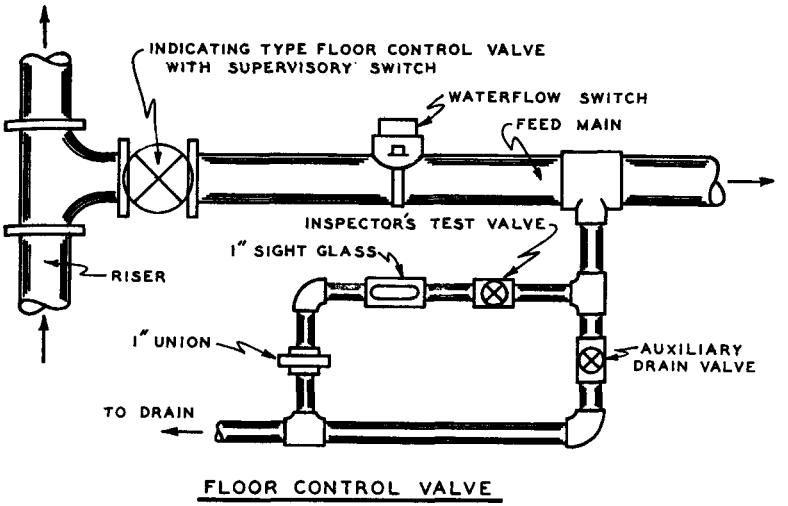


Fig. 3082. Floor control valve.

3090. Joining of Pipe and Fittings.

3091. All threaded fittings and pipe shall have threads cut to ANSI Standard B 2.1. Care should be taken that the pipe does not extend into the fitting sufficiently to reduce the waterway.

3092. Pipe shall be properly reamed after cutting to remove all burrs and fins.

3093. Joint compound shall be applied to the threads of the pipe and not in the fitting.

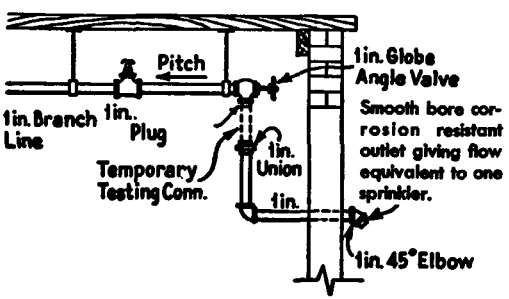


Fig. 3083. One-inch System Test Pipes on Dry-Pipe Systems.

3094. Other types of joints must be made or installed in accordance with the requirements of the listing thereof by a nationally recognized testing and inspection agency.

3095. Brazed joints for the connection of pipe or tube and fittings may be used. The fire hazard of the process shall be suitably safeguarded.

3100. Protection of Piping Against Freezing (3110), Corrosion (3130) and Earthquake Damage (3150).

3110. Protection Against Freezing.

3111. Supply Pipes.

3112. Where supply pipes or risers pass through low unheated basements or open spaces under buildings, so as to be exposed to frost, they shall be properly protected by a method outlined in Paragraphs 3113, 3114 or 3115.

3113. An acceptable method, especially where the space is over 18 inches high, is by an enclosure properly heated or filled with heavy earth or other suitable insulating material. The enclosure should extend below the bottom of the pipe and through the top flooring of the ground floor. In severe climates, where space is filled, the enclosure should be of sufficient size to permit a filling of not less than four feet, all around the pipe. The en-

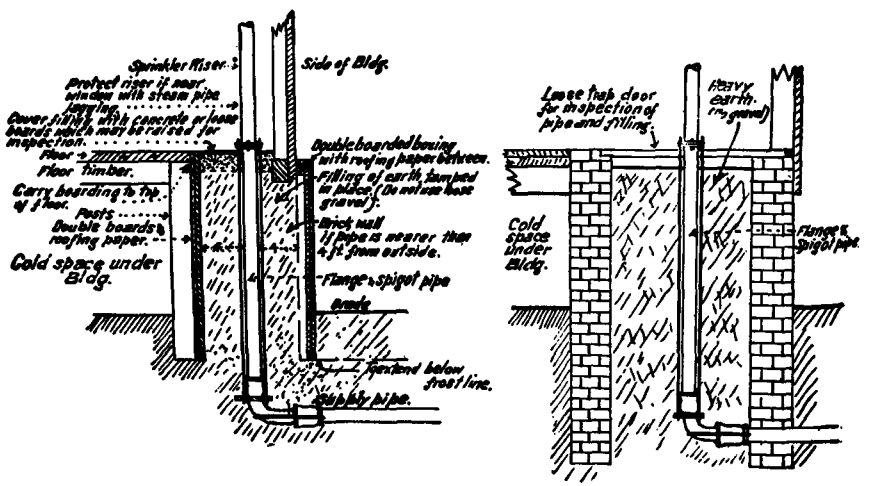


Fig. 3111. Protection of Sprinkler Risers Against Freezing.

closure should preferably be of brick, but may be of wood, and if the latter, should be at least double-walled with tar paper between. If wood is used, it shall be of a kind that will endure underground or be treated with creosote or other acceptable preservative.

3114. Where the space is not more than 18 inches high, the flooring of ground floor may be cut away and the space around the pipe enclosed according to either of the above methods, except that the area may be reduced so that there will be not less than one foot clear space all around the pipe, thus exposing pipe to the heated room above. The opening at floor level should not be covered except by a metal grid.

3115. Care should be taken in laying the underground connection, to extend it sufficiently far into the building to give the required spaces called for above. The pipe may be offset, if desired, at or above the floor level.

3120. Feed Mains in Unheated Areas.

3121. Where necessary to extend feed mains of wet pipe systems through an open area or through cold rooms, passageways or other areas exposed to frost, the pipe shall be adequately protected against freezing by insulating coverings, frostproof casings, or other suitable means.

3130. Protection of Pipe Against Corrosion.

3131. Where corrosive conditions exist, types of pipe, tube, fittings, hangers, and protective coatings that resist corrosion should be used.

3132. Galvanized steel pipe or copper tube may be required in overhead feed mains running from one building to another where exposed to the weather unless black steel pipe is otherwise protected against corrosion.

3133. Where it may be necessary to use wrought iron or steel pipe underground as a connection from a system to sprinklers in a detached building, the pipe should be protected against corrosion before being buried. Galvanized pipe tarred or black pipe wrapped and tarred, are acceptable.

3134. In some places it is satisfactory to rely solely on the protective value of a paint coating, this to be maintained by repainting at intervals from one to five years, the period depending on the severity of the exposure.

3135. If corrosive conditions are not of great intensity and the degree of humidity is not abnormally high, good results can be obtained by using two field coats of some high-grade paint such as sublimed blue lead in linseed oil, red lead in linseed oil or red lead in spar varnish. In locations where metal cannot be protected from attack or kept dry to receive the first field coating, a shop priming coat should be specified, this to be touched up promptly after installation and the whole to be finished with one or preferably two final coats. It is desirable under such conditions to vary colors for successive coats in order to ensure adequate coverage. For instance, use red oxide inhibitive type paint for the shop or priming coat, and sublimed blue lead and/or 50 per cent red lead — 50 per cent spar varnish for finishing.

3136. In applying, keep paint thoroughly stirred and apply only when surface is clean and dry — never in a damp or cold atmosphere.

3137. When a protective coating is applied to old piping, be sure to first remove all corrosion, scale, and grease. Otherwise, little benefit will be derived from the coating. Piping should be carefully examined at frequent intervals and if evidence of pitting, checking, blistering, or other failure is noted, the pipe should be cleaned and another coat of protective paint applied.

3138. In locations where appearance is not a factor and where temperatures do not greatly exceed 100° F., a coat of one of the inhibitive types of greases will give good protection. This type of material comes in the form of a light petrolatum and can be readily applied with a brush after installation work has been completed.

3139. When moisture conditions are extremely severe but corrosive fumes are not much of a factor, copper tube or galvanized steel pipe, fittings and hangers may be suitable. The threaded ends of steel pipe should be sealed in with a suitable coating such as asphalt base liquid and canvas. This form of protection involves painting the band of the fitting and the pipe for a distance of 4 inches to 6 inches with a heavy asphalt compound. Strips of lightweight canvas cut to a width of about 2 inches should be wrapped over the end of the fitting and on the surface of the pipe for a distance of about 4 inches from the face of the fitting. The canvas surfaces should in turn be sealed in with a follow-up coat of the asphalt compound.

3140. 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 should be employed or resort

should be made to the use of some form of corrosion resisting material. This is not intended to call for protection of concealed piping installed under normal conditions.

3141. Cast-iron pipe of the type which can be threaded is now available and is advantageous for use where corrosion is severe. This comes in wrought pipe sizes and with a wall thickness equal to that of extra heavy wrought material. This is made from special alloyed irons and affords good resistance to rusting and to attack by corrosive atmospheric conditions. Such material should be protected by paint, asphalt asbestos type coating, or grease to retard or prevent surface attack. The combination of iron pipe and iron fittings is effective due to the heavy thickness of the pipe wall, the similarity of the metal at the joints, and the particularly good bond which the cast pipe provides for the paint or other coatings applied to it.

3142. A silicon-bronze alloy should be used in the form of rod, strap, or castings for hangers employed wherever corrosive attack is severe and when galvanized metal is not used. This strong corrosion resisting type of bronze can be substituted for steel without increase in size or change in design of the ordinary hanger.

3150. Protection of Piping Against Damage Due to Earthquakes.

3151. FLEXIBILITY.

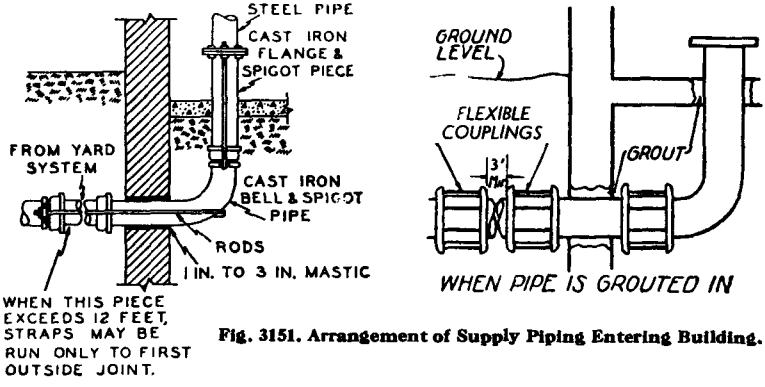


Fig. 3151. Arrangement of Supply Piping Entering Building.

3152. Breakage of sprinkler piping caused by building movement can be greatly lessened and in many cases prevented by increasing the flexibility between major parts of the sprinkler system. One part of the piping should never be held rigidly and another be free to move without provisions for relieving the strain. Flexibility can be provided by the use of flexible couplings at critical points and allowing clearances at walls and floors. If too freely hung, however, sections of the sprinkler system will oscillate excessively or shift out of line. This action can be prevented by anchors or hangers which will damp oscillations or check movement, but not rigidly hold piping.

3153. The top and bottom of risers are critical points where the installation of approved flexible couplings is advisable. In a multi-story building a flexible coupling may be advisable also at the floor and another at the ceiling line in an intermediate story if structural weakness or unusual flexibility is present. A pair of couplings should usually be provided on a monitor riser. A pair of approved flexible couplings with a length of pipe between, readily permits a considerable horizontal offset in any direction. Piping crossing the joint between two buildings usually needs a pair of flexible couplings as the buildings will vibrate differently unless identical in all respects. Flexible couplings may be omitted at pipes less than 3½-inch diameter.

3154. One- to two-inch clearance should be provided around pipes at all floors. In one-story buildings the space at the ground floor can be filled with asphalt mastic. In multi-story buildings a sleeve should be cast in concrete floors, extending three to six inches above the top of the wearing surface and capped with a pipe collar, to prevent passage of water, smoke or fire. Tight metal collars are advisable about pipes to cover such holes through wooden floors in multi-story buildings.

3155. Riser drains, fire department connections and auxiliary piping should not be cemented into nearby walls or floors, if they can throw a strain on riser piping. Similarly, pipes which pass horizontally through walls should not be cemented solidly in them, or strains will accumulate at this point. Holes through fire walls should be packed with mineral wool or other suitable material held in place with pipe collars on each side. Pipes passing through foundation walls or pit walls in soft ground should have clearance with these walls but holes should be made watertight.

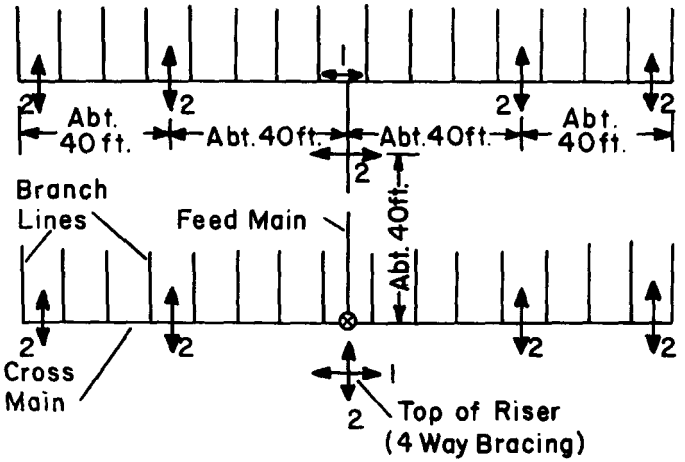
3156. Tank risers or discharge pipes should be treated the same as sprinkler risers for their portion within a building. The

discharge pipe of tanks on buildings shall have a control valve above the roof line so any pipe-break within the building can be controlled.

3160. SWAY BRACING.

3161. Feed and cross mains must be braced to prevent excessive oscillation. The tops of risers shall be secured against drifting in any direction. Branch lines will not require bracing.

3162. It is the intent to laterally brace the piping so that it will withstand a force equal to 50 per cent of the weight of the piping, valve attachments and water. It is felt that if the lateral bracing is designed to withstand this force without breaking or



1 Indicates suitable location of hangers to oppose the movement of feed and cross mains in the direction along the main. One hanger will be sufficient for each main unless it is of exceptional length or contains offsets or changes in direction. Two-inch and smaller pipes do not require this type of bracing.

2 Indicates suitable location of hangers to oppose transverse (perpendicular to pipe) movement of feed and cross mains. They should be located at intervals of 30 to 40 feet. The end hanger of this type should be on the last piece of cross or feed main.

Fig. 3164. Typical Locations of Sway Bracing Hangers.

permanently deforming, the system will be reasonably safe from earthquake forces.

3163. All piping outside of buildings which is not buried shall be securely anchored to prevent swaying.

3164. Where a system is hung with U-type hangers they may satisfy most of the requirements for sway bracing except, in general, the longitudinal hangers as numbered "1" in Figure 3164 will be necessary in addition. U-type hangers are better lateral braces when the legs are bent out 10°.

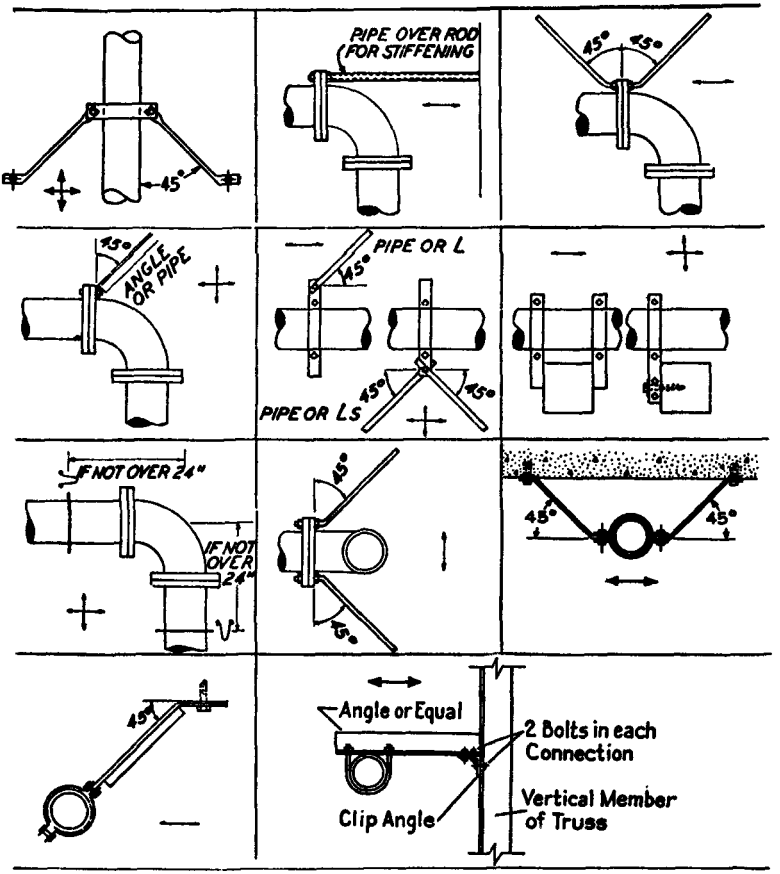


Fig. 3168. Acceptable Types of Sway Bracing.

3165. Where a system is hung with single rods it will generally be necessary to provide all sway bracing by the installation of special hangers. (Very short rods, less than 6 inches, are fairly satisfactory.)

3166. Large piping should not be held by small branches. The piping should not be fastened to two dissimilar parts of the building such as a wall and a roof which will move differently.

3167. Transverse braces may also act as longitudinal braces if they are within 24 inches of the center line of the pipe being braced longitudinally, except that branch lines cannot hold cross mains. In general the last piece of pipe at the end of a feeder or cross main will require a transverse brace suitable for the loads involved. Earthquake braces should not be connected to a pair of companion flanges.

3168. In most cases specially placed U-type hangers, or pipe clamps with rods or angle braces, will satisfy bracing requirements. Any properly detailed design will be acceptable. Fig. 3168 illustrates some acceptable arrangements of sway bracing.

3169. In the design of sway braces, the slenderness ratio l/r should not exceed 200 where "l" is the distance between the center lines of supports and "r" is the least radius of gyration, both in inches. For example, a flat bar 2 inches x ⅜ inch should not be over 1 foot 9 inches between fastenings. The maximum length of shapes used for sway bracing is shown in Table 3169.

TABLE 3169.

Item	*Max. Length l/r=200*	*Item*	*Max. Length l/r=200*
ANGLES		FLATS	
1½ x 1½ x ¼ in.	4 ft. 10 in.	1½ x ¼ in.	1 ft. 2 in.
2 x 2 x ¼ in.	6 ft. 6 in.	2 x ¼ in.	1 ft. 2 in.
2½ x 2 x ¼ in.	7 ft. 0 in.	2 x ⅜ in.	1 ft. 9 in.
2½ x 2½ x ¼ in.	8 ft. 2 in.	PIPE	
3 x 2½ x ¼ in.	8 ft. 10 in.	1 in.	7 ft. 0 in.
3 x 3 x 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.		

3200. Drainage.

3210. Pitching of Piping for Drainage.

3211. All sprinkler pipe and fittings shall be so installed that the system may be drained. Where practicable, all piping should be arranged to drain to the main drain valve.

3212. On wet pipe systems, sprinkler pipes may be installed level. Trapped piping shall be drained in accordance with Section 3230.

3213. On dry pipe systems sprinkler pipe on branch lines shall be pitched at least ½ inch in 10 feet and the pipe of cross and feed mains shall be given a pitch of not less than ¼ inch in 10 feet. A pitch of ¾ inch to 1 inch should be provided for short branch lines and ½ inch in 10 feet for cross and feed mains in refrigerated areas and in buildings of light construction where floor may settle under heavy loads.

3214. Where settling may occur and deprive a dry pipe system of its drainage, ends of lines should not be raised to violate Section 4200. The drainage should be restored by shortening the vertical piping.

3220. System or Main Drain Connections and Drain Valves. (See Fig. 3220.)

3221. Provisions shall be made to properly drain all parts of the system.

3222. On all risers 4 inches or larger, 2-inch drain pipes and valves shall be provided.

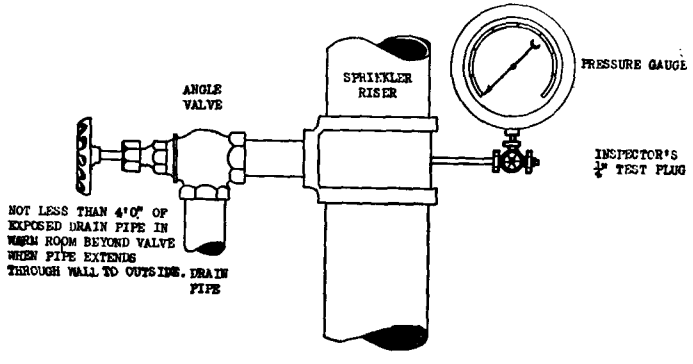


Fig. 3220. Drain Connection for Sprinkler Riser.

3223. On risers 2½ inches to 3½ inches inclusive, drain pipes and valves not smaller than 1¼ inch shall be provided.

3224. On smaller risers, drain pipe and valves not smaller than ¾ inch shall be provided.

3225. All sectional control valves shall have a drain valve of suitable size so located as to drain that portion of the system controlled by the cut-off valve.

3226. The test valves required by Paragraph 2811 may be used as the main drain valves.

3230. Auxiliary Drains. (See Fig. 3230.)

3231. Auxiliary drains shall be provided to drain all low or trapped points of systems.

3232. Auxiliary drains on wet pipe and deluge systems shall not be smaller than as follows:

2-inch and smaller supply pipe ..... ¾-inch drain
2½-inch supply pipe ..... 1-inch drain
3-inch and larger supply pipe .....1¼-inch drain

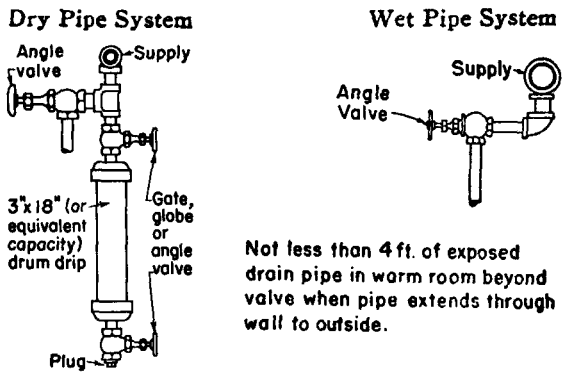


Fig. 3230. Auxiliary Drains.

3233. On wet pipe and deluge systems, trapped sprinklers in groups of six or more shall be provided with a drain valve and either a brass plug or a nipple and cap or drain connection.

3234. On dry-pipe systems, where three or less sprinklers are trapped, a ½-inch renewable disc drain valve, plugged with a cast-iron plug or with a nipple and cap, shall be installed.

3235. On dry-pipe systems having trapped sprinklers in groups of four to twenty, a 1¼-inch by 12-inch condensate nipple with a 1¼-inch by ½-inch reducing coupling and a ½-inch globe valve at the bottom with a ½-inch cast-iron plug or with a ½-inch nipple and cap shall be provided.

3236. On dry-pipe systems having trapped sprinklers in groups of 21 or more, a two-valve drum drip and a 1¼-inch draw-off valve shall be provided.

3237. Drum Drips. Drum drip should be of approximately ½-gallon capacity and provided with either a ¾-inch gate, globe or angle valve on each side of the drum drip. Lower valve on the drum drip shall be plugged with a cast-iron plug or with a nipple and cap.

3238. Tie-in Drains for Dry-Pipe Systems. Pipe sizes for branch line tie-in drains should be one inch for twenty or less sprinklers, and 1¼ inch for more than twenty sprinklers with 1¼-inch drop to 1¼-inch or larger branch line pipe on floor below.

3240. Discharge of Drain Valves.

3241. Each drain pipe should preferably discharge outside the building at a point visible from the drain valve and free from the possibility of causing water damage. Where it is 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. Direct interconnections should not be made between sewers and sprinkler drains of systems supplied with public water. The drain discharge should be in conformity with any local health or water department regulations, or sanitary code. The drain connection should be of a size to carry off water from open drains while they are discharging under normal water pressures.

3242. Where drain pipes are buried underground, either cast-iron or galvanized pipe should be used.

3243. Drain pipes should not terminate in blind spaces under the building.

3244. Drain pipes when exposed should be fitted with a hood or down turned elbow to prevent obstruction.

3245. Drain pipes shall be so arranged as not to expose any part of the sprinkler system to frost. All drains should have at least 4 feet of pipe beyond the valve, in a warm room.

3246. Approved angle valves should be used on all main drains. Wherever possible, drains should be located in a warm place.

3300. Fittings.

3310. Type of Fittings.

3311. Fittings shall be of a type specifically approved for sprinkler systems and of a design suitable for the working pressures involved, but not less than 175 psi cold water pressure.

3312. If fittings are of cast iron, extra heavy pattern shall be used in sizes larger than 2 inches where the normal pressure in the piping system exceeds one hundred and seventy-five pounds.

If fittings are of malleable iron, standard weight pattern will be acceptable in sizes up to 6 inches inclusive when the normal pressure in the pipe system does not exceed three hundred pounds.

Fittings made of materials other than cast iron or malleable iron and specifically approved for use in sprinkler systems may be used at piping system pressures up to the working pressure limits specified in their approval.

3313. Where water pressures are 175 to 300 lbs. the ANSI Standards permit the use of "Standard Wall" pipe and "extra heavy" valves. Until pressure ratings for valves are standardized, the manufacturers' ratings should be observed.

3314. Welded Piping. All inside piping shall be joined by means of screwed, flanged or flexible gasketed joints or other acceptable fittings. Cross main headers, sections of feed mains, or risers may be shop welded using acceptable welding fittings with screwed branch outlets. Welding and brazing shall conform to American National Standard For Pressure Piping, B 31.1.0 — 1967. Welding and torch cutting shall not be permitted as a means of installing or repairing sprinkler systems.

3315. Welding fittings should comply with ANSI Standard B16.9 — 1964, ANSI Standard B16.25 — 1964 and ASTM Designation A-234-65.

3316. Where risers are 3 inches in size or larger, a flange joint shall be used at the riser at each floor. (See Fig. 3316.)

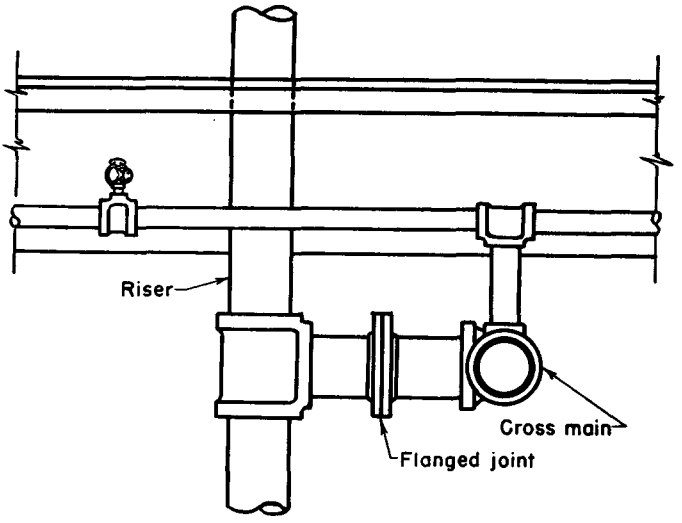


Fig. 3316. One Arrangement of Flanged Joint at Sprinkler Riser.

3317. CERTIFICATION OF WELDERS AND BRAZERS. Welders or brazers shall be certified by contractor as being qualified for welding and/or brazing in accordance with the requirements of ASME Boiler and Pressure Vessel Code, Section IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators 1968 Edition. (See Appendix C.)

3318. Where welding is planned, contractor shall so specify the section to be shop welded on drawings, and the type of welding fittings to be used.

3320. Couplings and Unions.

3321. Couplings and unions should not be used except where pipe is more than 20 feet in length between fittings. Screwed unions shall not be used on pipe larger than 2 inches. Couplings and unions of other than screwed type shall be of types approved specifically for use in sprinkler systems. Unions, screwed or flexible gasketed couplings, or flanges may be used to facilitate installation.

3322. 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.

3330. Reducers, Bushings.

3331. A one-piece reducing fitting of good design should be used wherever a change is made in the size of the pipe. Hexagonal or face bushings should be used in reducing the size of openings of fittings only when standard fittings of the required size are not available.

3400. Valves.

3410. Types of Valves to be Used.

3411. All valves on connections to water supplies and in supply pipes to sprinklers shall be approved indicating type. Underground valves of approved type equipped with approved indicator post comply with this requirement. Such valves should be supervised so that closing will result in an alarm.

3412. Drain valves and test valves shall be of approved type.

3413. Check valves shall be of approved straightway type and may be installed in a vertical or horizontal position.

3420. Valves Controlling Water Supplies.

3421. Each system shall be provided with an approved indicating valve so located as to control all sources of water supply except fire department connections when arranged as specified in Section 2630.

3422. At least one approved indicating valve shall be installed in each source of water supply except fire department connections.

3423. Where there is more than one source of water supply, a check valve shall be installed in each connection, except that where cushion tanks are used with automatic fire pumps no check valve is required in the cushion tank connection.

3424. Where there is but one water supply connection a check valve shall be installed if there is likelihood of water circulation, or if there is a fire department connection on the system.

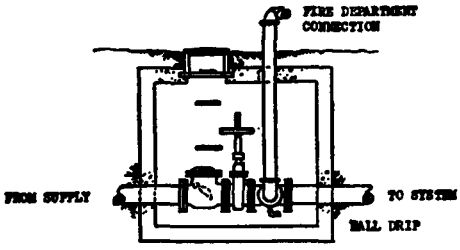


Fig. 3424. Pit for Gate Valve, Check Valve and Fire Department Connection.

3425. Where 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 in a vertical position immediately inside of the building; in case there is no outside control the system indicating valve should be placed at the wall flanged ahead of all fittings. Such an arrangement eliminates a pit and in most cases one additional cast-iron socket quarter bend.

3426. Where either a wet or dry pipe sprinkler system is supplied by city water and a fire department connection and has more than one riser with approved indicating valve in each, and the whole system is controlled by one outside post indicator valve, it will be satisfactory to install the main check valve in the water supply connection immediately inside building. (See Paragraph 2633.)

3427. Where a wet pipe sprinkler system is supplied by city water and a fire department connection with only one riser, the alarm valve will be considered as a check valve and an additional check valve will not be required.

3428. Where a gravity tank is located on a tower in the yard, the valve on the tank side of the check valve should be of an approved indicating type; the other should be either an approved indicating valve or an indicator post valve. Where a gravity tank is located on a building both valves should be of the approved indicating type; and all fittings inside the building, except the drain tee and heater connections, shall be under control of an approved indicating valve.

3429. In a city connection serving as one source of supply the city valve in the connection may serve as one of the required valves. An approved indicating valve or an indicator post valve should be installed on the system side of the check valve.

3430. A connection from public water system should not extend into or through a building unless such connection is under the control of an outside indicator post or approved indicating valve or under the control of an inside approved indicating valve located near outside wall of the building.

3431. When a pump, located in a combustible pump house or exposed to danger from fire or falling walls, or a tank, discharges into a yard main fed by another supply, either the check valve in the connection should be located in a pit or the valve should be of the indicator post type, located a safe distance outside of buildings.

3432. Check valves on tank or pump connections when located underground may be placed inside of buildings and at a safe distance from the tank riser or pump, except in cases where the building is entirely of one fire area, when it is ordinarily considered satisfactory to locate the check valve overhead in the lowest level.

3433. All valves controlling water supplies for sprinklers shall be located where readily accessible and when necessary, permanent ladders, clamped treads on risers, chains and wheels, or other accepted means should be provided.

3440. Sectional Valves in Underground Fire Mains.

3441. Large yard systems shall have sectional controlling valves at appropriate points, in order to permit sectionalizing the system in the event of a break, or for the making of repairs or extensions. (See Standard for Outside Protection, NFPA No. 24.)

3450. Floor Control Valves.

3451. Floor control valves may be installed in accordance with paragraph 3073 or in special cases where area or height, or number of tenants is excessive, both in manufacturing or mercantile buildings, or where contents are more than ordinarily susceptible to damage. Floor valves should be located where they are readily accessible, preferably in cutoff stair towers.

3460. Indicator Posts for Gate Valves.

3461. Where sprinklers are supplied from a yard main, an approved outside indicator post gate valve should be placed in the connecting pipe at a safe distance from the building.

3462. Indicator post valves should be located not less than 40 feet from buildings; but where necessary to place a valve close to a building, it should be located at a blank part of the wall.

3463. When a building has no basement, and outside post indicator control cannot be furnished, short post indicator may be installed in a horizontal position in riser with handwheel projecting outside of wall.

3470. Pits for Underground Valves.

3471. Pits for underground valves, except those located at the base of a tank riser, are described in the Standard for Outside Protection (NFPA No. 24). For pits protecting valves located at the base of a tank riser, refer to the Standard for Water Tanks for Private Fire Protection (NFPA No. 22).

3480. Identification of Valves.

3481. All control, drain, test and alarm valves shall be provided with identification signs of the standard design adopted by the automatic sprinkler industry, or their equivalent. Such identification signs shall be of the design illustrated in Fig. 3481.

3500. Hangers.

3510. General.

3511. Sprinkler piping should be substantially supported from the building structure which should be designed to support the added load of the water-filled pipe plus 250 pounds applied at the point of hanging. In all cases, sprinkler piping should be supported independently of the ceiling sheathing. In cases where sprinkler protection is installed below duct-work, piping should be substantially supported from the building structure or from the steel angles supporting the duct-work provided the angles are of adequate size and shape to support the combined weight of the ductwork and water-filled sprinkler branch line piping. (As a minimum, angle iron must conform to Table 3516.)

3512. Hangers shall be a type approved for use with the pipe or tube involved. Sprinkler piping should be supported by round mild steel U-type or approved adjustable hangers.

3513. Approved C-type hangers are acceptable for use on steel beams when provided with a strap as shown by "L" in Fig. 3510 or when cup-pointed set screws with locknuts are provided for these hangers by the manufacturer. Strap or locknut may be

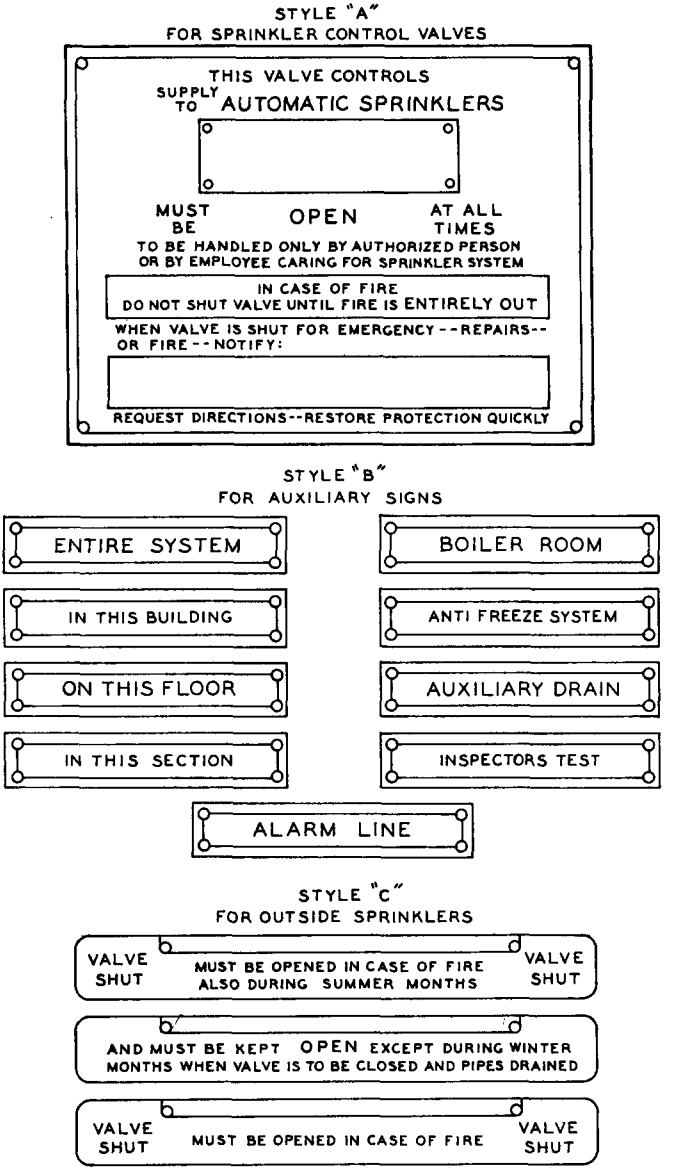


Fig. 3481. Identification Signs

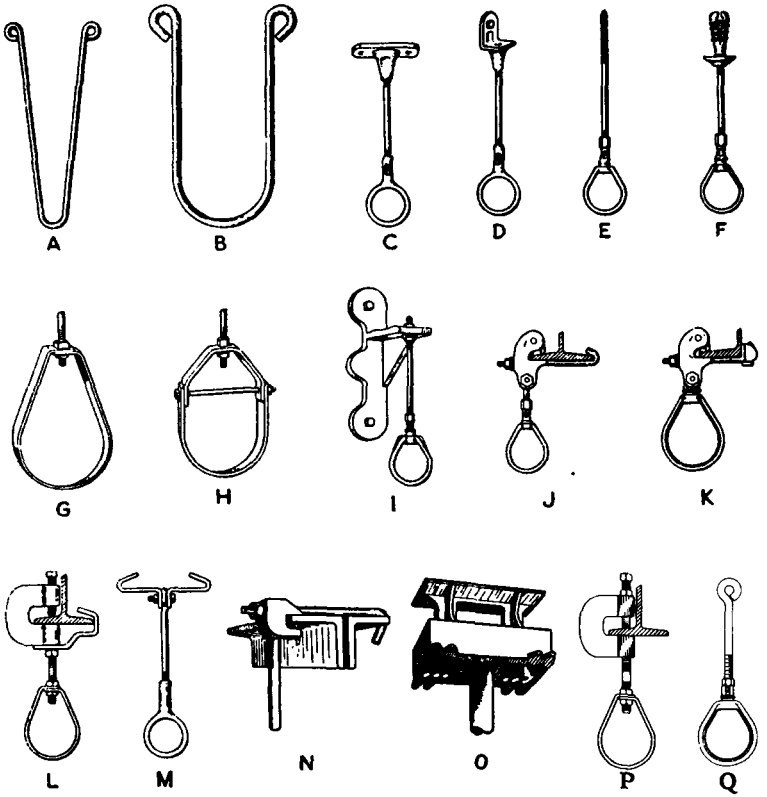


Fig. 3510. Common Types of Acceptable Hangers.

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 Case.
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 — "CB-Universal" Concrete Insert.
P — C-type Clamp without Retaining Strap.
Q — Eye Rod and Ring Hanger.

omitted in situations where there is no material vibration of structural members provided C-type hanger is specifically approved for use without such strap or locknut. Straps shall be not less than ⅛ by 1 inch in section.

3514. If hangers or parts of hangers are made of flat iron or steel, the thickness of the metal must be at least 5/16 inch, unless protected by a suitable corrosion-resistant material and the strength of the hangers must, in any case, be comparable to that of other approved types.

3515. Under metal decking branch line hangers 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 shall be not less than ⅜ inch.

TABLE 3516

Trapeze Bars — One- to Eight-Foot Spans

SPAN OF TRAPEZE BARS / PIPE SIZE →	2" OR LESS	2 ½"	3"	3 ½"	4"	5"	6"	8"
1'-0"	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE
1'-6"	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE	3"x2"x3/16" 1½" PIPE
2'-0"	1½"x1½"x3/16" 1" PIPE	1½"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE
2'-6"	1½"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE	3"x2"x¼" 2" PIPE
3'-0"	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1" PIPE	2"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE	3"x2"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE	3½"x2½"x¼" 2½" PIPE
4'-0"	2"x1½"x3/16" 1¼" PIPE	2"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1½" PIPE	2½"x1½"x3/16" 1½" PIPE	3"x2"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE	3"x2"x¼" 2" PIPE	3½"x2½"x5/16" 2½" PIPE
5'-0"	2½"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1¼" PIPE	2½"x1½"x3/16" 1½" PIPE	3"x2"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE	3"x2"x¼" 2" PIPE	3½"x2½"x¼" 2½" PIPE	4"x4"x¼" 2½" PIPE
6'-0"	2½"x1½"x3/16" 1½" PIPE	2½"x1½"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE	3"x2"x3/16" 2" PIPE	3"x2"x¼" 2" PIPE	3½"x2½"x¼" 2½" PIPE	4"x3"x¼" 2½" PIPE	4"x4"x5/16" 3" PIPE
7'-0"	2½"x1½"x3/16" 1½" PIPE	3"x2"x3/16" 2" PIPE	3"x2"x3/16" 2" PIPE	3"x3"x3/16" 2" PIPE	3"x2"x¼" 2½" PIPE	3½"x2½"x¼" 2½" PIPE	4"x3"x¼" 3" PIPE	4"x3"x5/16" 3" PIPE
8'-0"	3"x2"x3/16" 2" PIPE	3"x2"x3/16" 2" PIPE	3"x3"x3/16" 2½" PIPE	3"x2"x¼" 2½" PIPE	3½"x2½"x¼" 2½" PIPE	3½"x2½"x5/16" 3" PIPE	4"x3"x5/16" 3" PIPE	5"x3½"x¼" 3½" PIPE

3516. For trapeze hangers, the minimum size of steel angle or pipe span between purlins or joists shall be as shown in Table 3516, all angles to be used with longer leg vertical. The angles shown are selected for economy and availability. Any other sizes or shapes giving equal or greater section modulus will be acceptable. The trapeze bar shall be secured to prevent slippage.

3517. For the size of hanger rods, "U" hooks, drive and lag screws for support of steel angle or pipe of the trapeze bars, see Section 3540.

3518. Pipe rings hung from coach screw hooks should be avoided. They should never be used on branch lines. Hangers which permit wide lateral motion of the pipe, particularly on branch lines, are not acceptable. Toggle hangers should be used only for the support of branch lines and under ceilings of hollow tile or metal lath and plaster, in buildings of fire-resistive or noncombustible construction.

3520. Hangers in Concrete.

3521. In concrete construction, approved inserts set in the concrete may be installed for the support of hangers. The use of wood plugs is not permitted.

3522. Hangers should be installed without regard to the support of the sleeves where pipes are run through concrete beams. Such sleeves should not normally be used for the support of pipes.

3523. Expansion shields for supporting pipes under concrete construction should preferably be used in a horizontal position in the sides of beams, but in good, sound concrete having gravel or crushed stone aggregate, they may be used in the vertical position to support pipes 4 inches or less in diameter. In all cases, the suitability of the concrete should be definitely determined before using expansion shields. Where increaser couplings are used, they shall be attached immediately adjacent to the expansion shield.

3524. For the support of pipes 4 inches and larger, expansion shields if used in the vertical position should 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 4 inches and larger may be supported entirely by expansion shields in the vertical position, but spaced not over 10 feet apart.

3525. Expansion shields should not be used in ceilings of gypsum or similar soft material. In cinder concrete, expansion shields should likewise not be used except on branch lines and even then they should alternate with through bolts or hangers attached to beams.

3526. It is important in all cases, and especially so where expansion shields are used in the vertical position, that the holes be made of the proper size and be drilled with care to provide for a uniform contact with the shield over its entire circumference. Depth of the hole should in no case be less than specified for the type of shield used.

3527. Holes for shields in the side of concrete beams should ordinarily be above the center line of the beam and always well above the bottom reinforcement.

3528. Where pipes are run through concrete beams, sleeves at least two sizes larger than the piping should be used.

3529. Listed hangers may be attached to precast, prestressed concrete construction only when the building owner, or his architect or engineer, grants assurance that the building construction is adequate to support the water-filled pipe with suitable factor of safety.

3530. Powder Driven Studs and Welding Studs.

3531. Powder driven studs, welding studs, and the tools used for installing these devices shall be listed by a nationally recognized 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.

3532. Powder driven studs should not be used in steel less than $\frac{3}{16}$ inch total thickness. The size of sprinkler pipe supported by powder driven studs in steel shall not exceed 5 inches.

3533. Powder driven studs should be used in concrete only where the authority having jurisdiction approves such use on the basis of a test of the acceptability of the studs made in the actual concrete on the job. The ability of concrete to hold the studs varies widely according to type of aggregate and quality of concrete, and it should be established in each case by testing to determine that the studs will hold a minimum load of 750 lbs. for 2-inch or smaller pipe, 1000 lbs. for $2\frac{1}{2}$, 3, or $3\frac{1}{2}$ inch pipe, and 1200 lbs. for 4 or 5 inch pipe. The size of sprinkler pipe supported by powder driven studs in concrete shall not exceed 5 inches.

3534. Studs or other hanger parts should not be attached by welding to steel less than 3/16 inch in thickness.

3535. Where increaser couplings are used, they shall be attached directly to the powder driven stud or welding stud.

3540. Ceiling Flanges, Rods and "U" Hooks.

3541. CEILING FLANGES. For pipe sizes up to 2 inches, ceiling flanges shall have at least two supporting screw holes; for sizes 2½ inches to 8 inches, not less than three holes, preferably so located that no two holes are in the same line as the grain in the planking.

3542. RODS. The size of rods for hangers shall not be less than that given in the following table. Such sizes are nominal diameters associated with machined threads. For rolled threads the rod size shall be not less than the root diameter of the thread.

Pipe Size	*Dia. of Rod*	*Pipe Size*	*Dia. of Rod*
Up to 2 in.	3/8 in.	6 in.	3/4 in.
2½ in., 3 in., 3½ in.	½ in.	8 in.	7/8 in.
4 in., 5 in.	5/8 in.		

3543. "U" HOOKS. The size of the rod material of "U" hooks shall be not less than that given in the following table:

Pipe Size	*Hook Material Dia.*	*Pipe Size*	*Hook Material Dia.*
Up to 2 in.	5/16 in.	5 in.	½ in.
2½ in., 3 in.	3/8 in.	6 in.	5/8 in.
3½ in., 4 in.	7/16 in.	8 in.	3/4 in.

3544. SCREWS. For ceiling flanges and "U" hooks screw dimensions shall be not less than those given in the following table:

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 ⅜ in. x 2½ in.
4 in., 5 in., 6 in.	Lag Screw ½ in. x 3 in.
8 in.	Lag Screw ⅝ in. x 3 in.

3545. The size bolt or lag (coach) screw used with eye rod on the side of a beam shall be not less than that indicated in the following table:

TABLE 3545

Size of Rod	*Size of Bolt or Lag Screw*	*Length of Lag Screw Used with Wood Beams*
⅜"	⅜"	2½"
½"	½"	3"
⅝"	½"	3"
¾"	½"	3"
⅞"	⅝"	3"

3546. 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.

3547. Screws in the side of a timber or joist should be not less than 2½ inches from the lower edge when supporting branch lines, and not less than 3 inches when supporting main lines. This shall not apply to 2-inch or thicker nailing strips resting on top of steel beams.

3548. When the thickness of planking and thickness of flange does not permit the use of screws 2 inches long, screws 1¾ inches long may be permitted.

3549. 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 the following table:

Diameter of Rod	*Nominal Plank Thickness*	*Nominal Width of Beam Face*
Up to ⅝ in.	3 in.	2 in.
½ in.	4 in.	2 in.
⅝ in.	4 in.	3 in.
¾ in.	4 in.	4 in.

Lag screw rods should not be used for support of pipes larger than 6 inches. All holes for lag screw rods should be predrilled ⅛ inch less in diameter than the root diameter of the lag screw thread.

3550. Maximum Distance Between Hangers

3551. With steel or wrought iron pipe or cold drawn copper tube as specified in Paragraph 3003, the maximum distance between hangers shall not exceed 12 feet for 1- and 1¼-inch sizes nor 15 feet for sizes 1½ inch and larger except as provided for in Section 3570 of this Sprinkler Standard. See Figure 3551 (a).

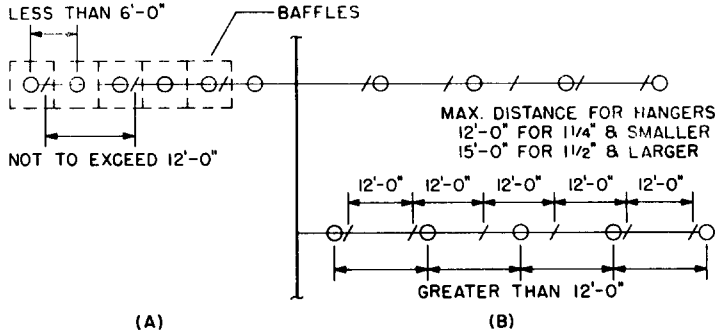


Fig. 3551. Distance Between Hangers.

3560. Location of Hangers on Branch Lines.

NOTE: This Section is applicable to the support of steel or wrought iron pipe as described in Paragraph 3002 and is also applicable to the support of copper tube conforming to Paragraph 3003, both subject to the additional restrictions contained in Section 3550.

3561. On branch lines, there should ordinarily be at least one hanger for each length of pipe. Further specifications and modification of this rule are included in Paragraphs 3562–3567, inclusive.

3562. The minimum distance between hangers and upright sprinklers should be in accordance with Table 3562.

TABLE 3562

Size of Hanger	*Minimum Distance Between Sprinkler and Hanger*
½ in. or less	3 in.
1 in. or less, but more than ½ in.	6 in.
More than 1 in.	12 in.

3563. If necessary, the unsupported length between the end sprinkler and the last hanger may be extended to 36 inches for 1-inch pipe, or 48 inches for 1¼-inch pipe. Where these limits are exceeded, the pipe should be extended beyond the end sprinkler for an additional hanger.

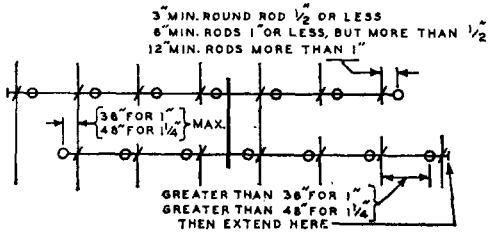


Fig. 3562. Distance Sprinkler to Hanger.

3564. Where one hanger for each length of pipe would require hangers closer than 6 feet apart, hangers may be spaced up to, but not exceeding 12 feet.

3565. Starter lengths less than 6 feet 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.

3566. One-inch arms not over 12 inches long for copper tube, nor 24 inches long for steel pipe from branch lines or cross mains do not require hangers.

3567. In special cases it may be necessary to make provisions to take care of the thrust of branch lines in a steeply pitched roof especially where there is a long nipple between the cross main and the branch. This may be done by installing a clamp on the pipe just above the lower hanger.

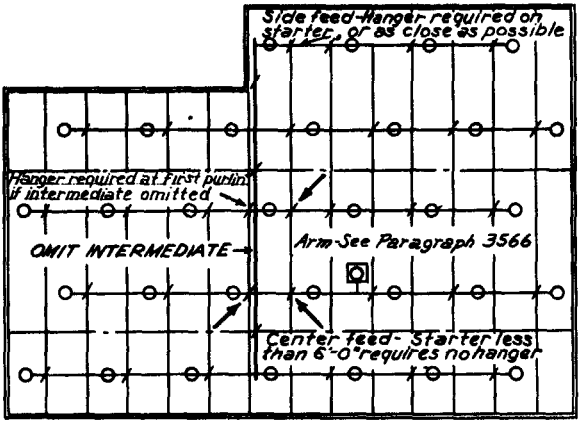


Fig. 3566. Hanger Omissions.

3570. Location of Hangers on Cross Mains.

NOTE: This Section is applicable to the support of steel or wrought iron pipe as described in Paragraph 3002 and is also applicable to the support of copper tube conforming to Paragraph 3003, both subject to the additional restrictions contained in Section 3550.

3571. On cross mains there should ordinarily be one hanger between each two branch lines. In cases where cross mains are supported from floor or roof framing members and intermediate hanging may require the use of trapeze hangers, intermediate hangers may be omitted as outlined in Paragraphs 3572–3575, inclusive.

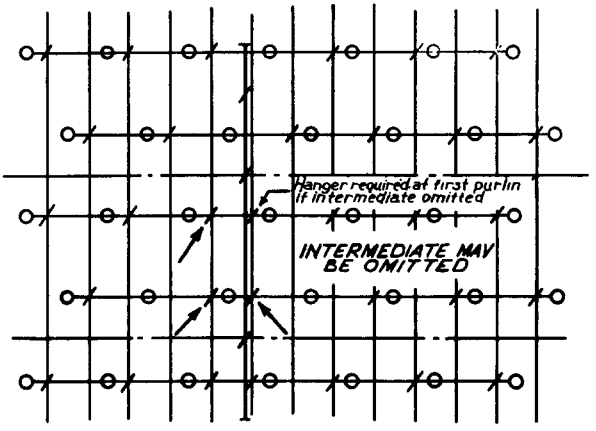


Fig. 3572. Hangers on Cross Main.

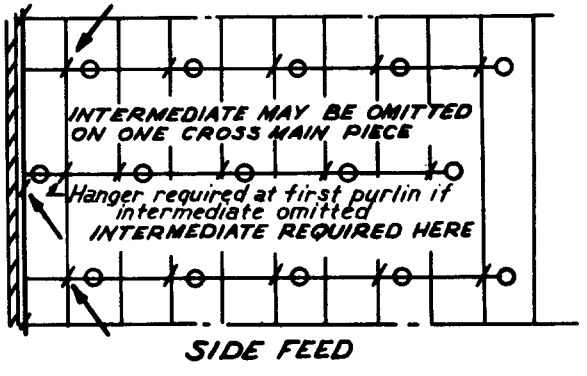


Fig. 3573. Hanger Omissions on Side Feed System.

3572. 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. Remaining branch line hangers should be installed in accordance with Section 3560.

3573. In bays having three side fed branch lines, 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. Remaining branch line hangers should be installed in accordance with Section 3560.

3574. In bays having three center feed branch lines, both intermediate hangers may be omitted provided that a hanger attached to a purlin is installed on each branch line as near to the cross main as the locations of the purlins permit. Remaining branch line hangers should be installed in accordance with Section 3560.

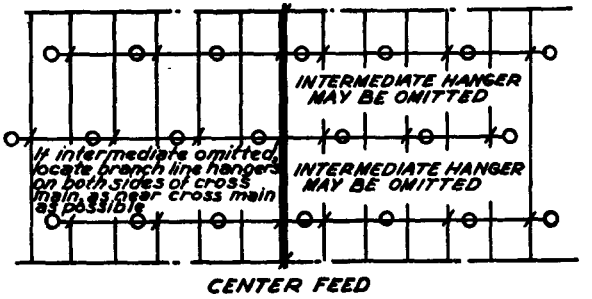


Fig. 3574. Hangers on Cross Main — Center Feed System.

3575. At the end of the cross main, intermediate trapeze hangers should be installed unless the cross main is extended to the next framing member with an ordinary hanger installed at this point, in which event, intermediate hangers may be omitted in accordance with Paragraphs 3572–3574, inclusive.

3580. Location of Hangers on Feed Mains.

NOTE: This Section is applicable to the support of steel or wrought iron pipe as described in Paragraph 3002 and is also applicable to the support of copper tube conforming to Paragraph 3003, both subject to the additional restrictions contained in Section 3550.

3581. On feed mains there should be at least one hanger for each 15 feet of pipe.

3590. Support of Risers.

3591. Risers shall be adequately supported by attachments direct to the riser or by hangers located on the horizontal connections close to the riser.

3592. Where risers are supported at the ground and are without offsets additional support at every fourth floor above will ordinarily be ample. Where risers do not rise from the ground, direct support should be provided, preferably at every floor.

3593. In buildings of heavy construction and ten stories in height no support is required above the fifth floor.

3594. In buildings of heavy construction and more than ten stories, supports are required at the ground (first) level, fifth and ninth levels, and every fourth story above.

3595. In buildings of light construction additional supports are required.

3596. Sprinkler and tank risers in vertical shafts should be supported equivalent to the above.

3597. Clamps supporting pipe by means of set screws shall not be used.

3600. Sprinklers.

3601. Standard and Old Style Sprinklers.

3602. During the years 1952 and 1953 sprinklers were redesigned which resulted in greatly improved water distribution. The redesign of the deflectors was the principal reason for the improvement. As a result of these changes, water is discharged in all directions below the plane of the deflector. The spray pattern is roughly that of a half sphere completely filled with water spray. Little or no water is discharged upward to wet the ceiling.

3603. The distribution pattern for approved standard sprinklers is more uniform than from the old style sprinklers and at a distance four feet below the deflector covers a circular area of useful intensity of water discharge of a diameter of about sixteen feet when discharging at fifteen gallons per minute. The area covered is generally independent of the type of ceiling and tends to be larger at distances over four feet and smaller at distances less than four feet.

3604. The 1955 issue of the Standard for the Installation of Sprinkler Systems was revised principally on the basis of improved water distribution by the redesigned sprinkler which up to that time was known as the spray type.

3605. This redesigned sprinkler is known as the standard sprinkler.

3606. The former so-called conventional or regular sprinkler is known as the old style sprinkler.

3607. Standard sprinklers may be used to replace old style sprinklers without system changes except for installation under piers and wharves where construction features may require upward discharge to wet the underside of decks and structural members supporting the decks. In these cases, 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.

3608. Old style sprinklers may be used to replace old style sprinklers.

3609. 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.

3610. Types of Sprinklers.

3611. Sprinklers shall be of approved makes and types. Sprinklers shall not be altered in any respect, nor have any type of ornamentation or coatings applied after shipment from the place of manufacture.

3612. 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. Sprinklers should be installed with the frame parallel to the branch line pipe to reduce to minimum the obstruction of the discharge pattern.

3613. The authority having jurisdiction shall be consulted in every case involving special use of sprinklers as contemplated by this section of the Standard. Sprinklers used for the special purposes and locations described in Paragraphs 3614 to 3634 inclusive shall be of types specifically approved for such use.

3614. Open sprinklers may be used to protect special hazards, for protection against exposures, or in other special locations.

3615. For small enclosures and other special locations or conditions not requiring as much water as is discharged by a

nominal ½-inch orifice sprinkler, sprinklers having smaller discharge orifices may be used.

3616. 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 No. 87, Standard for the Construction and Protection of Piers and Wharves.)

3620. Corrosion-Resistant Sprinklers.

3621. Approved 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, 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.

3622. Special care shall be taken in the handling and installation of wax-coated or similar sprinklers to avoid damaging the coating.

3623. Corrosion-resistant coatings shall not be applied to sprinklers by anyone other than the manufacturer of the sprinklers, except that in all cases any damage to the protective coating occurring at the time of installation shall be repaired at once using only the coating of the manufacturer of the sprinkler in approved manner so that none of the sprinkler will be exposed after the installation has been completed. Otherwise, corrosion will attack the exposed metal and will in time creep under the coating.

3630. Sidewall Sprinklers.

3631. Sidewall sprinklers are special purpose sprinklers and the authority having jurisdiction should be consulted where sidewall sprinklers are to be used.

3632. Where a standard sprinkler system can be installed without interfering with the decorative scheme, sidewall sprinklers should not be used.

3633. Where, to preserve appearance, concealed sprinkler piping and standard sprinklers can be installed, sidewall sprinklers should not be used.

3634. Unless specifically tested and listed for ordinary hazard occupancies, the use of sidewall sprinklers should be confined to light hazard occupancies as defined in Paragraph 1311.

3640. Discharge Capacities.

3641. The following Table 3641 shows the nominal discharge capacities of approved sprinklers having a nominal ½-inch orifice at various pressures up to 100 psi.

TABLE 3641.

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

3642. The following Table 3642 shows the K factor, relative discharge and identification for sprinklers having different orifice sizes.

TABLE 3642

Nominal Orifice (In.)	*"K" * Factor*	*Percent of Nominal ½-inch Discharge*	*Identification* †
¼	1.3–1.5	25	½ in. IPT — Pintle
5/16	1.8–2.0	33.3	½ in. IPT — Pintle
⅜	2.6–2.9	50	½ in. IPT — Pintle
7/16	4.0–4.4	75	½ in. IPT — Pintle
½	5.3–5.8	100	½ in. IPT
17/32	7.4–8.2	140	¾ in. IPT or ½ in. IPT — Pintle

*"K" factor is the constant in the formula.

$$Q = K\sqrt{P}$$

Where Q = Flow in GPM
P = Pressure in PSI

†With the exception of ½-inch orifice and 17/32-inch orifice, ¾-in. IPT (iron pipe thread) sprinklers, the nominal orifice size is cast or stamped on the wrench boss of the sprinkler frame. Large orifice sprinklers having ½-inch iron pipe thread shall not be installed in new sprinkler systems.

TABLE 3655-1.
DISTANCE OF SPRINKLERS FROM HEAT SOURCES

Type of Heat Condition	*Ordinary Degree Rating*	*Intermediate Degree Rating*	*High Degree Rating*
1. HEATING DUCTS a. Above	a. More than 2'-6"	a. 2'-6" or less	—
b. Side and Below	b. More than 1'-0"	b. 1'-0" or less	—
c. Diffuser Downward Discharge Horizontal Discharge	c. Any distance except as shown under INTERMEDIATE	c. *Downward:* Cylinder with 1'-0" radius from edge, extending 1'-0" below and 2'-6" above c. *Horizontal:* Semi-cylinder with 2'-6" radius in direction of flow, extending 1'-0" below and 2'-6" above	—
2. UNIT HEATER a. Horizontal Discharge	—	a. *Discharge Side:* 7'-0" to 20'-0" radius pie-shaped cylinder [See Fig. 3656(a)] extending 7'-0" above and 2'-0" below Unit Heater; also 7'-0" radius cylinder more than 7'-0" above Unit Heater	a. 7'-0" radius cylinder extending 7'-0" above and 2'-0" below Unit Heater
b. Vertical Downward Discharge [Note: For Sprinklers Below Unit Heater See Fig. 3656(a)]	—	b. 7'-0" radius cylinder extending upward from an elevation 7'-0" above Unit Heater	b. 7'-0" radius cylinder extending from the top of the Unit Heater to an elevation 7 0" above Unit Heater
3. STEAM MAINS (Uncovered) a. Above	a. More than 2'-6"	a. 2'-6" or less	—
b. Side and Below	b. More than 1'-0"	b. 1'-0" or less	—
c. Blow-off Valve	c. More than 7'-0"	—	c. 7'-0" or less

3650. Temperature Ratings.

3651. The standard temperature ratings of automatic sprinklers are shown in Table 3651. Automatic sprinklers shall have their frame arms colored in accordance with the color code designated in Table 3651, with the following exceptions:

(a) The color identification for coated sprinklers may be a dot on the top of the deflector, the color of the coated material or colored frame arms.

(b) Color identification is not required for plated sprinklers, ceiling sprinklers or similar decorative types.

3652. Where higher temperature sprinklers are necessary to meet extraordinary conditions, special sprinklers as high as 600 are obtainable.

3653. The use of sprinklers with temperature ratings higher than ordinary shall be in accordance with the maximum ceiling temperatures given in Table 3651, except as provided in Paragraph 3654.

TABLE 3651

TEMPERATURE RATINGS, CLASSIFICATIONS AND COLOR CODINGS

Maximum Ceiling Temperature °F	*Temperature Rating °F*	*Temperature Classification*	*Color Code*
100	135 to 170	Ordinary	Uncolored
150	175 to 225	Intermediate	White
225	250 to 300	High	Blue
300	325 to 375	Extra High	Red
375	400 to 475	Very Extra High	Green
475	500 to 575	Ultra High	Orange

3654. Where 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 without the disadvantage of a potential increase in fire damage, this alternative should be given first consideration. For situa-

TABLE 3655-2.

RATINGS OF SPRINKLERS IN SPECIFIED LOCATIONS

Location	*Ordinary Degree Rating*	*Intermediate Degree Rating*	*High Degree Rating*
SKYLIGHTS	—	Glass	—
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: The above tables are to be considered a guide only. A check of job condition by means of thermometers may be necessary.

tions involving rack storage, refer to NFPA No. 231C, Rack Storage of Materials.

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 over-all water demand. However, some increase in fire damage and fire temperatures should be expected when sprinklers of Intermediate or High Temperature Classification are used.

3655. Information regarding the highest temperature that may be encountered in any location in a particular installation should 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.

3656. The following general practices should be observed when installing high temperature sprinklers, unless special rulings have been made based on temperature readings.

(a) Sprinklers near unit heaters.

Where steam pressure is not more than 15 lbs., sprinklers in the Heater Zone should be High and sprinklers in the Danger Zone Intermediate Temperature Classification.

(b) Sprinklers located within 12 inches to one side or 30 inches above an uncovered steam main, heating coil or radiator, should be Intermediate Temperature Classification.

(c) Sprinklers within 7 feet of a low pressure blow-off valve which discharges free in a large room, should be High Temperature Classification.

(d) Sprinklers under glass skylights exposed to the direct rays of the sun should be Intermediate Temperature Classification.

(e) Sprinklers in an unventilated concealed space under an uninsulated wood or metal roof, or in an unventilated attic, or in a building having an unventilated peak roof of thin boards or metal, should be Intermediate Temperature Classification.

(f) Sprinklers in unventilated show windows having high-powered electric lights near the ceiling should be Intermediate Temperature Classification.

(g) At intervals some occupancies employ high temperature fumigation processes requiring consideration in the selection of sprinkler temperature ratings.

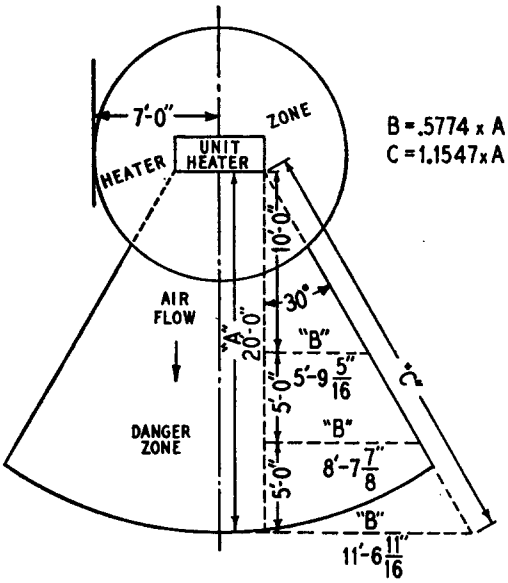


Fig. 3656(a). Heater and Danger Zones at Unit Heaters.

(h) Where a locomotive enters a building, sprinklers should be located not nearer than 5 feet from the center line of the track.

(i) Consideration should be given to the selection of sprinklers protecting commercial-type cooking equipment and ventilation systems. Sprinklers with temperature classifications of Intermediate, High or Extra High usually will be required as determined by use of a temperature measuring device (see paragraph 4328).

(j) Representative solder type sprinklers with temperature classification of Extra High (325–575F) or greater which are exposed on a semi-continuous to continuous maximum allowable ambient temperature condition should be tested at 5-year intervals for operation by a recognized testing laboratory.

3657. In case of change of occupancy involving temperature change, the sprinklers should be changed accordingly.

3660. Stock of Extra Sprinklers.

3661. There shall be maintained on the premises a supply of extra sprinklers (never less than six) so that any sprinklers

that have operated or been injured 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 should be kept in a cabinet located where the temperature to which they are subjected will at no time exceed 100° F. Cabinets are furnished in standard sizes of 6 and 12 sprinkler capacities.

3662. A special sprinkler wrench should also be provided and kept in the cabinet, to be used in the removal and installation of sprinklers.

3663. The number of sprinklers carried for replacement purposes should be governed by:

(a) Size of system.

(b) Location of protected property to source of sprinkler supply.

(c) Number of sprinklers likely to be opened by extraordinary conditions such as flash fire.

3664. Ordinarily, under average conditions, the stock of emergency sprinklers should be as follows:

For equipments not over 300 sprinklers.. 6 sprinklers

For equipments 300 to 1,000 sprinklers...12 sprinklers

For equipments above 1,000 sprinklers...24 sprinklers

Stock of emergency sprinklers should include all types and ratings installed.

3665. For equipments aboard vessels or in isolated locations, a greater number of sprinklers should be carried, to permit equipment to be put back into service promptly after a fire.

3670. Guards and Shields.

3671. 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.

3672. Sprinklers under the gridiron of theatres should be provided with metal shields.

3673. Baffles over automatic sprinklers under steel grating floors should not be less than 18 inches in least dimension. The deflector should be located not more than 4 inches below the baffle.

3680. Painting and Ornamental Finishes

3681. When the sprinkler piping is given any kind of coat-

ing, such as whitewash or paint, care must be exercised to see that no portion of the automatic sprinklers is coated. When painting sprinkler piping or painting in areas near sprinklers, the sprinklers may be protected by covering with a paper bag which shall be removed immediately after the painting has been finished.

3682. Sprinkler frames may be factory painted or enameled for the purpose of identifying sprinklers of different temperature ratings in accordance with Paragraph 3651. Otherwise, sprinklers shall be not painted and any sprinklers which have been painted, except for factory applied coatings applied for identification of temperature ratings shall be replaced with new approved sprinklers. Painting of sprinklers may retard the thermal response of the fusible element, may interfere with the free movement of parts and may render the sprinkler inoperative. Moreover, painting may invite the application of subsequent coatings, thus increasing the possibility of a malfunction of the sprinkler.

3683. Ornamental finishes shall not be applied to sprinklers by anyone other than the manufacturer of the sprinklers and only sprinklers approved with such finishes shall be used.

3690. Clear Space Below Sprinklers.

3691. A minimum of 18 inches clearance shall be maintained between top of storage and sprinkler deflectors. A minimum of 36 inches clearance should be maintained between sprinkler deflectors and top of storage in excess of 15 feet high in solid piles, or in excess of 12 feet high in rack or palletized storage, except as noted in Paragraph 3692.

3692. For solid piled storage in excess of 15 feet high or palletized storage in excess of 12 feet high where sprinkler spacing, density and area of application are designed for such conditions, clearance less than 36 inches but not less than 18 inches is permissible.

3700. Sprinkler Alarms.

3710. Definition.

3711. 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 will result in an audible alarm signal on the premises.

3720. Where Required.

3721. Water flow alarms shall be provided on all sprinkler installations except where permission of the authority having jurisdiction is obtained for their omission. Central station water flow alarm service is desirable but central station water flow alarm service does not necessarily waive the local alarm requirement. All systems should be equipped with either outdoor water motor or electric alarm gongs.

3722. Under conditions where central station water flow alarm service is not available it may be advisable to connect electrical alarm units to public Fire Department headquarters or nearest Fire Department station or other suitable place where aid may be readily secured.

3730. Water Flow Detecting Devices.

3731. ALARM CHECK VALVES. The alarm apparatus for a wet-pipe system shall consist of an approved alarm check valve or other approved water flow detecting alarm device with the necessary attachments required to give an alarm.

3732. DRY-PIPE VALVES. The alarm apparatus for a dry-pipe system shall consist of approved 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.

3733. PRE-ACTION AND DELUGE VALVES. The alarm apparatus for pre-action and deluge systems shall consist of approved electric alarm attachments, actuated by a thermostatic system independently of flow of water in the system. A mechanical alarm (water motor gong) may also be required.

3734. PADDLE TYPE DETECTORS. Water flow indicators (paddle type) should not be installed in dry-pipe, pre-action or deluge systems as the surge of water when valve trips would seriously damage the device.

3740. Attachments — General.

3741. An alarm unit shall include an approved mechanical alarm, horn or siren, or an approved weatherproof electric gong, bell, horn or siren on the outside of the building or approved electric gongs, bells, horns, or sirens inside the building, or a combination of such devices, as required by the authority having jurisdiction.

3742. All alarm apparatus shall be so located and installed that all parts are readily accessible for inspection, removal, and repair, and shall be substantially supported. Outdoor mechanical or electrically operated bells shall be of weatherproof and guarded type.

3743. On each alarm check valve used under conditions of variable water pressure, a retarding device shall be installed. Suitable 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.

3744. Dry-pipe, pre-action and deluge valves shall be fitted with a test connection for electric alarm switch and/or water motor gong. 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.

3745. It is not advisable to test a water motor alarm in extremely cold weather and where they are used a properly valved pipe bypass from a compressed air supply may be provided for test purposes.

3746. A control valve shall be installed in connection with pressure-type contactor and 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 will be accepted as complying with this paragraph.

3750. Attachments — Mechanically Operated.

3751. Water-motor-operated devices shall be located as near the alarm valve, dry-pipe valve or other waterflow detecting device as practicable in order to avoid long runs or many fittings in the pipe to the water-motor-operated device. The total length of the pipe should not exceed 75 feet nor shall the water-motor-operated device be located over 20 feet above the alarm device or dry-pipe valve. If absolutely necessary to exceed 75 feet, the pipe line to the water-motor-operated device shall be increased one or more sizes to compensate for loss of pressure due to hydraulic friction. For all types of sprinkler systems employing water-motor-operated alarms, an approved ¾-inch

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 of a size not less than ¾ inch, and larger for long runs of piping or where pressures are low. Piping shall be arranged to drain properly through a brass bushed orifice not larger than ⅛ inch. Drains shall be conducted to a proper place. (See Sections 3240 and 3780.)

3752. No single mechanical alarm device should be connected to more than three sprinkler systems and the systems controlled by the valves should be in the same fire area.

3760. Attachments — Electrically Operated.

3761. (a) 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.

1. Central Station Protective Signaling Systems (NFPA No. 71).
2. Auxiliary Protective Signaling Systems (No. 72B).
3. Remote Station Protective Signaling Systems (NFPA No. 72C).
4. Proprietary Protective Signaling Systems (NFPA No. 72D).

(b) 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 No. 72A and in accordance with the provisions of the following Paragraphs 3762, 3763 and 3764. These standards permit local electrical waterflow alarms to be of open circuit type.

3762. Waterflow devices, controlling electric alarm circuits, should be provided with means for testing the electrical supply, circuits, connection and devices. An actual waterflow, through the use of a test connection, shall be the method employed for testing the operation of the sprinkler alarm unit as a whole.

3763. No single electrical waterflow alarm sounding device should be connected to more than three sprinkler systems; these

systems should be in the same fire area. 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 shall 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. This light shall remain in operation during the entire period of the electrical circuit interruption.

3764. Outdoor electric alarm devices shall be of a type specifically approved 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 Paragraph 3761.

3770. Identification Signs.

3771. It is desirable and often essential to provide approved identification signs for outside alarm devices. The sign should be located near the device in a conspicuous position and shall be worded as follows: "Sprinkler Fire Alarm — when bell rings call fire department or police." (See Fig. 3771.)

3780. Drains.

3781. Where vents are necessary for satisfactory electric alarm switch operation, such vents should be properly piped to a drain.

Fig. 3771. Identification Sign.

3782. 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 pressure.

3783. Drain from retarding chamber and electric alarm switch should preferably discharge through an open cone and be run separate from main system drains to a safe and visible point of free discharge or to sewer or ground drain. Drain from water-motor-operated alarm device may run separately to sewer or ground drain or may be connected to drain from retarding chamber at a point between such sewer and a check valve on this drain, a union or plug being inserted in the drain from the alarm device to permit inspection. Where checks are used they shall be so located as to have the equivalent of at least a four-foot head and shall not be installed in a vertical position.

3784. Where drains are connected with a sewer, a proper trap shall be provided.

3785. Where exposed to frost and where it is necessary to drain alarm valves outside the wall, an open discharge cone should be provided inside to break the pipe line so that cold will not be conducted directly into the retarding chamber. Cold air has been known to enter drain pipes from retarding chambers of alarm valves sufficiently to cause trouble by freezing in the alarm check valve. (See Section 3240.)

CHAPTER 4. SPACING, LOCATION AND POSITION OF SPRINKLERS.

4000. General Information.

4011. (*Reserved for future use.*)

4020. Basic Fundamentals.

4021. The basic fundamentals for providing proper protection are namely: (1) Sprinklers should be 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.

4022. The installation requirements are specific for the usual arrangement of structural members. There will be arrangements of structural members not specifically detailed by the requirements. By applying the basic fundamentals, layouts for such construction can vary from specific illustrations provided the maxima specified for the Spacing of Sprinklers (Section 4100) and Position of Sprinklers (Section 4200) are not exceeded.

4030. Partial Installations.

4031. Installation of sprinklers throughout the premises is necessary for complete protection to life and property. However, 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 limited protection to property or to provide opportunity for safe exit from the building.

4032. Where such partial sprinkler installations are installed, the standards of this pamphlet should be used in so far as they are applicable. The authority having jurisdiction should be consulted in each case.

4033. 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.

4040. Definitions.

4041. SMOOTH CEILING CONSTRUCTION. The term Smooth Ceiling Construction as used in this Standard includes, namely:

(a) Mushroom, flat slab, pan type or joisted type reinforced concrete.

(b) Continuous smooth bays formed by wood, concrete or steel beams spaced more than 7½ feet 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 feet on centers.

(d) Smooth monolithic ceilings of at least ¾ inches of cement plaster, fibered gypsum plaster, perlite or vermiculite plaster on metal lath or equivalent or combination of materials of equivalent fire-resistive rating attached to the underside of wood or bar joists.

(e) In (b), (c) and (d) above, the roof and floor decks may be noncombustible or combustible. Item (b) would include standard mill construction.

(f) Open web type steel beams regardless of spacing.

(g) Suspended ceilings of noncombustible construction.

4042. 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 inches or greater nominal thickness or concrete or steel beams spaced 3 to 7½ feet 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.]

4043. 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.

4044. WOOD JOIST CONSTRUCTION. The term Wood Joist

Construction refers to wood boards or planks on wooden beams spaced less than 3 feet on centers. Wooden beams less than 4 inches nominal thickness spaced more than 3 feet on centers are also considered as wood joist construction.

4045. HIGH PILED STORAGE. High piled storage is defined as solid piled storage in excess of 15 feet in height or palletized or rack storage in excess of 12 feet in height. See Appendix for availability of information for sprinkler protection of high piled storage.

NOTE: To determine piling height, see Paragraph 3690 for clear space below sprinklers and see rules on position of sprinkler below ceiling.

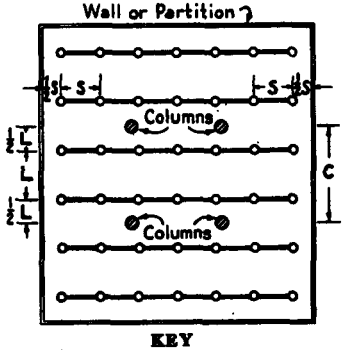
4100. Spacing and Location of Sprinklers. (See also Sections 4200 and 4300.)

4110. Distance Between the Branch Lines and Between Sprinklers on the Branch Lines.

4111. For Light Hazard Occupancies the maximum allowable distance between branch lines and between sprinklers on the branch lines is 15 feet.

Mushroom and Pan Type Reinforced Concrete

Maximum Spacing: 130 Square Feet Per Sprinkler
$L \times S = 130$ or less



KEY

C=Column spacing.
L=Distance between branch lines, limit 15 feet.
S=Distance between sprinklers on branch lines, limit 15 feet.

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.			

Fig. 4100-A. Layout of Sprinklers Under Smooth Ceiling Construction — Ordinary Hazard Occupancy.

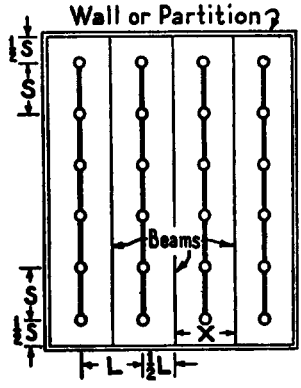
4112. For Ordinary Hazard Occupancies the maximum allowable distance between the branch lines and between sprinklers on the branch lines is 15 feet, except in buildings used for high piled storage (as defined in Paragraph 4045) the maximum allowable distance between the branch lines and between sprinklers on the branch lines is 12 feet. However, in bays 25 feet wide a spacing of 12′ 6″ between sprinkler lines is permitted provided the allotted area of 100 square feet per sprinkler is not exceeded.

4113. For Extra Hazard Occupancy, the maximum allowable distance between the branch lines and between sprinklers on the branch lines is 12 feet.

4114. DISTANCE FROM WALLS. The distance from the walls to the end sprinklers on the branch lines should not exceed one-half of the allowable distance between sprinklers on the branch lines. The distance from the walls to the end branch lines should

Continuous Smooth Bays with Beams Supported on Columns

Maximum Spacing: 130 Square Feet Per Sprinkler
L×S = 130 or less



KEY

L = Distance between branch lines, limit 15 feet.

S = Distance between sprinklers on branch lines, limit 15 feet.

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.			

Fig. 4100-B. Layout of Sprinklers Under Smooth Ceiling Construction — Ordinary Hazard Occupancy.

not exceed one-half the allowable distance between the branch lines. For exception relating to small rooms, refer to Paragraph 4330.

4130. Protection Area Limitations.

4131. Light Hazard Occupancy.

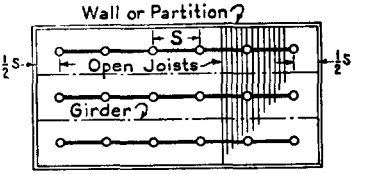
(a) Under smooth ceiling construction and under beam and girder construction (as defined in Paragraphs 4041 and 4042) the protection area per sprinkler shall not exceed 200 square feet. A protection area of 200 square feet per sprinkler may be permitted for sprinklers under a combustible suspended ceiling as described in Section 4305 (a) provided that there is a full complement of sprinklers in the space immediately above such a ceiling, and the space is unfloored and unoccupied. For hydraulically designed sprinkler systems the protection area limit per sprinkler may be increased to 225 square feet.

(b) Under open wood joist construction (as defined in Paragraph 4044) the protection area per sprinkler shall not exceed 130 square feet.

(c) For other types of construction the protection area per sprinkler shall not exceed 168 square feet.

Joists Above Girders or Framed into Girders; Branch Lines Uniformly Spaced between Girders

Maximum Spacing: 130 Square Feet Per Sprinkler
$L \times S = 130$ or less



KEY

L=Distance between branch lines, limit 15 feet.

S=Distance between sprinklers on branch lines, limit 15 feet.

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.

Fig. 4106-C. Layout of Sprinklers Under Open Wood Joist Construction — Light and Ordinary Hazard Occupancies.

4132. ORDINARY HAZARD OCCUPANCY. For all types of construction the protection area per sprinkler shall not exceed 130 square feet, except that in buildings used for high piled storage (as defined in Paragraph 4045) the protection area per sprinkler shall not exceed 100 square feet. (See also NFPA 231C, Rack Storage of Materials.)

4133. EXTRA HAZARD OCCUPANCY. The protection area per sprinkler shall not exceed 90 square feet for any type of building construction, except protection area per sprinkler shall not exceed 100 square feet where the system is hydraulically designed.

4140. Location of Sprinklers and Branch Lines with Respect to Structural Members.

4141. Sprinklers may be located under beams, in bays, or combination of both, but the locations must meet the provisions outlined in general terms in Paragraph 4142.

4142. In addition to meeting the limitations specified for protection area per sprinkler (Section 4130) and distance between lines and distance between sprinklers on lines (Section 4110) the sprinklers must be so located that there will be minimum interference to the discharge pattern by structural members such as beams, girders and trusses (Section 4150). Also, sprinklers must be located the proper distance below beams and ceilings as specified in Section 4200.

4143. 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. Where 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 Sections 4150 and 4200.

4144. Where there are two sets of joists under a roof or ceiling and there is no flooring over the lower set, sprinklers should be installed above and below the lower set of joists where there is a clearance of from 6 inches to 12 inches between the top of the lower joist and bottom of the upper joist. (See Fig. 4144.)

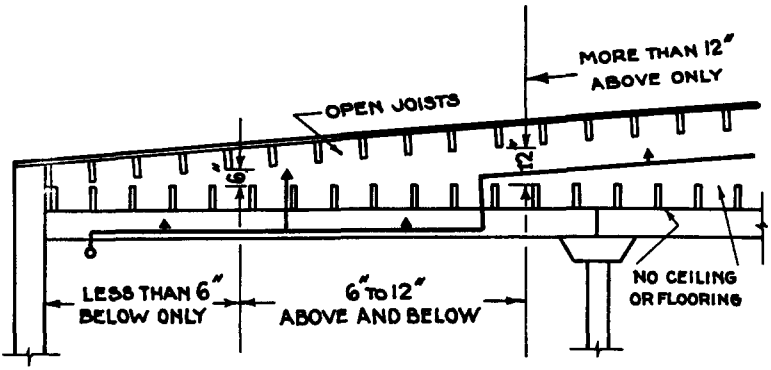


Fig. 4144. Arrangement of Sprinklers under Two Sets of Open Joists — no sheathing on lower joists.

TABLE 4145.

TYPE OF CEILING	LOCATION OF BRANCH LINES
Smooth Continuous:	
Concrete mushroom	Either direction.
Concrete pan-type or flat	Either direction.
Sheathed (ceiling attached to bottom of beams, wood joists or bar joists):	
Girders beneath sheathing	Across the beams or joists.
No girders beneath sheathing	Whichever direction facilitates easy and proper hanging.
Bays more than 7½ feet wide:	
Formed by beams supported on columns	Parallel to beams.
Formed by beams supported on girders or trusses	Either across beams or parallel to beams in the bays above girders or trusses.
Supported directly on girders	Parallel to girders.
Supported directly on trusses	Either direction, parallel to or through trusses.
Beam and Girder: Wood or steel beams spaced 3 to 7½ feet apart	Across beams.
Open Bar Joist	Across the joist or trusses (either through or under them).
Open Joists (wood, steel or concrete)	Across joists.

4145. The direction in which branch lines are usually run in the common types of ceiling construction and framing is shown in Table 4145.

4150. Clearance Between Sprinklers and Structural Members.

4151. TRUSSES. Sprinklers should be at least 2 feet laterally from truss members (web or chord) more than 4 inches wide, and at least 1 foot laterally from truss members 4 inches or less in width. Where 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 inches wide, and the deflector is at least 6 inches above the chord member. However, when sprinklers are located laterally beside chord members, clearances between the chord members and the sprinkler deflectors should be in accordance with Paragraph 4156.

4152. GIRDERS. Sprinklers should be at least 3 feet 9 inches from girders except that they may be located directly above girders with the top flange not more than 8 inches wide, in which case the deflectors should be at least 6 inches above the top of the girder.

4153. Where wood joists are framed into supporting girders, the girders may be disregarded in the spacing of the branch lines providing sprinkler deflectors are at such elevation that the girders offer no obstruction to the spray discharge pattern.

4154. OPEN WEB-TYPE STEEL BEAMS (CASTELLATED). 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 Section 4110,

(b) sprinklers in the beam openings are located within one inch horizontally of the opening center line,

(c) the branch line is located within one inch horizontally of the opening center line, and

(d) sprinklers on alternate lines are staggered.

4155. BAR JOISTS. Sprinklers should be at least three inches laterally from web members of open bar joists which do not exceed ½ inch or 6 inches laterally from web members which do not exceed 1 inch. When the dimension of the web member exceeds 1 inch, see Paragraph 4151.

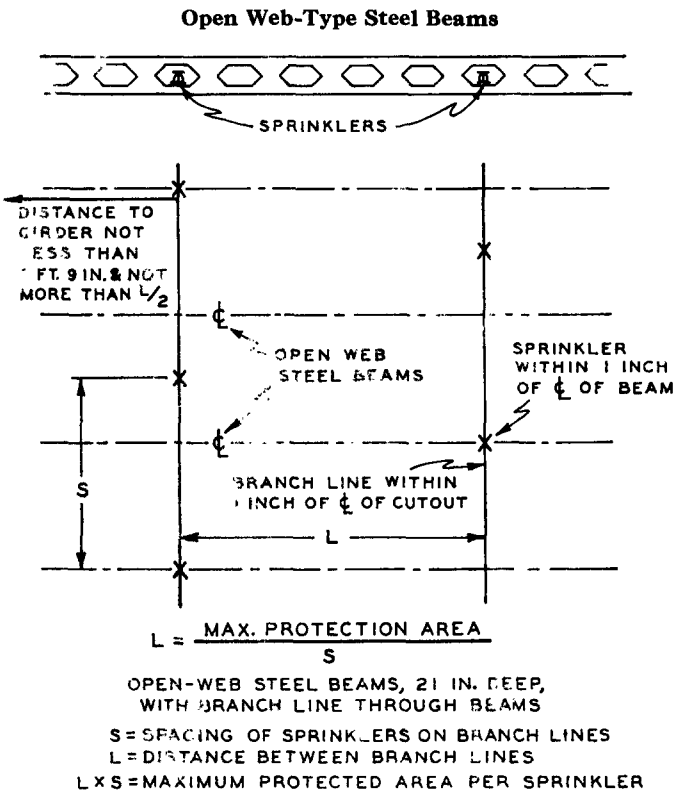


Fig. 4154. Location of Branch Lines and Sprinklers

4156. BEAMS. It is essential that if deflectors of sprinklers in bays are above the bottom of the beams, they be at sufficient distances from the beams, as shown in Table 4156 and Fig. 4156 to avoid obstruction to the sprinkler discharge pattern.

4157. POSITION OF DEFLECTORS. Deflectors of sprinklers should 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 inch per foot may be considered as level in the application of this rule and sprinklers may be installed with deflectors horizontal.

TABLE 4156.

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.

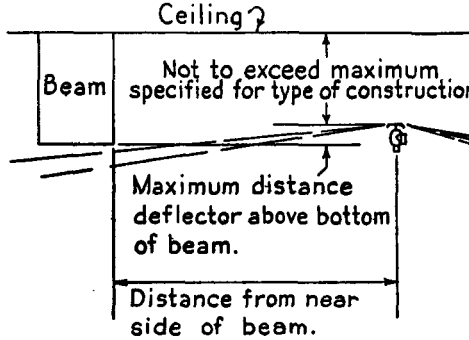


Fig. 4156. Position of Deflector, Upright or Pendent, When Located Above Bottom of Beam.

4200. Position of Sprinklers.

4210. General.

4211. Where branch lines run across the beams, the deflectors of sprinklers located in the bays should preferably be located above the bottom of the beam and in no case more than 4 inches below the bottom level of the beams.

4220. Smooth Ceiling Construction. (As defined in Paragraph 4041.)

4221. Deflectors of sprinklers in bays should be located not less than 3 inches below ceilings, and not more than 10 inches

below combustible ceilings or 12 inches below noncombustible ceilings.

4222. Deflectors of sprinklers under beams should be located 1 inch to 4 inches below beams, and not more than 14 inches below combustible ceilings or not more than 16 inches below noncombustible ceilings.

4223. When sprinklers approved for pendent use are installed in the pendent position under smooth ceilings the deflectors should be not less than 2½ inches from ceiling. Special approved type pendent sprinklers (flush type, ceiling type) may have deflectors nearer the ceiling.

4224. If panel construction, see Paragraph 4233.

4230. Beam and Girder Construction. (As defined in Paragraph 4042.)

4231. Deflectors of sprinklers in bays should be located not less than 3 inches below and not more than 16 inches below combustible or noncombustible roof or floor decks.

4232. Deflectors of sprinklers under beams should be located not less than 1 inch and not more than 4 inches below beams and not more than 20 inches below combustible or noncombustible roof or floor decks.

4233. PANEL CONSTRUCTION. (a) Beam and girder construction by definition is limited to bays not over 7½ feet wide. For the purposes of this Section, bays in panel construction may be wider if the panel does not exceed 300 square feet in area. Nailing strips not exceeding 2 inches nominal thickness on beams only will not prevent the use of the panel area credit.

(b) Deflectors of sprinklers in bays formed by beams framed into girders resulting in panels up to 300 square feet should be located not less than 3 inches below and not more than 18 inches below combustible or noncombustible roof or floor decks.

(c) Deflectors of sprinklers under beams framed into girders forming panels up to 300 square feet should be located 1 inch to 4 inches below beams and not more than 22 inches below combustible and noncombustible roof or floor decks.

4234. When concrete tee construction is encountered with the stems of the tees spaced less than 7½ feet on centers but more than three feet on centers, the sprinklers may be spaced midway between and above the bottom of the stems in viola-

tion of Paragraphs 4231, 4232 and 4233 provided that Table 4156 is followed.

4240. Open Bar Joist Construction. (As defined in Paragraph 4043.)

4241. Deflectors of sprinklers should be located not less than 3 inches below and not more than 10 inches below combustible or not more than 12 inches below noncombustible roof or floor decks.

4250. Open Wood Joist Construction. (As defined in Paragraph 4044.)

4251. In open joist construction, with joists spaced 3 feet or less on centers, sprinklers should be located with deflectors 1 inch to not more than 6 inches below the bottom of the joists. If open joists are spaced more than 3 feet on centers, sprinklers should be located with deflectors placed in accordance with Sections 4220 or 4230.

4260. Location Under Sheathed or Suspended Ceiling Under Any Type of Construction.

4261. The position of sprinklers under sheathed or suspended ceilings with any type of construction should be the same as for smooth ceiling construction, Paragraphs 4221 and 4223.

4300. Locations or Conditions Involving Special Consideration.

4301. Combustible Form Board. Where roof and floor decks consist of poured gypsum or concrete on combustible form board supported on steel supports, the position of sprinklers shall be the same as for noncombustible construction.

4302. Metal Roof Decks. Where roof decks are metal with combustible vapor seal, the position of sprinklers shall be the same as for combustible construction.

4303. Special Occupancy Considerations. (a) Subject to the approval of the authority having jurisdiction, sprinklers may be omitted in rooms or areas where sprinklers are considered undesirable because of the nature of the contents, or in rooms or areas of noncombustible construction with wholly noncombustible

contents and which are not exposed by other areas. Sprinklers should not be omitted from any room merely because it is damp or of fire-resistive construction.

(b) It is not advisable to install sprinklers where the application of water or flame and water to the contents may constitute a serious life or fire hazard, as in the manufacture or storage of quantities of aluminum powder, calcium carbide, calcium phosphide, metallic sodium and potassium, quicklime, magnesium powder, and sodium peroxide. The manufacture and storage of such materials should be confined to specially cut-off, unsprinklered rooms or buildings of fire-resistive construction.

4304. Spaces Under Ground Floors. Sprinklers should be installed in all spaces below combustible ground floors, except that by special permission sprinklers may be omitted where 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 wind-borne 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 flammable liquids are used on the floor above.

4305. Blind Spaces. (a) Sprinklers should be installed in all blind spaces enclosed wholly or partly by exposed combustible construction, as in walls, floors and ceilings, except as modified by Paragraph (b) & (c) below. In spaces formed by studs or joists, sprinklers should be provided where there is 6 inches 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 Paragraph 4114. In bar joist construction, sprinklers should be installed wherever the total depth of the space exceeds 6 inches 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 does not exceed 24 inches in depth.

(b) Sprinklers may be omitted from combustible blind spaces where any of the following conditions prevail:

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

(2) Where concealed space is entirely filled with a non-

combustible 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.

(3) Where there are small concealed spaces over rooms not exceeding 50 square feet in area.

(c) In blind spaces having exposed combustible construction or containing exposed combustibles in localized areas, the combustibles shall be protected as follows:

(1) 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 feet apart nor more then 6 feet 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 feet from the ends of the partitions.

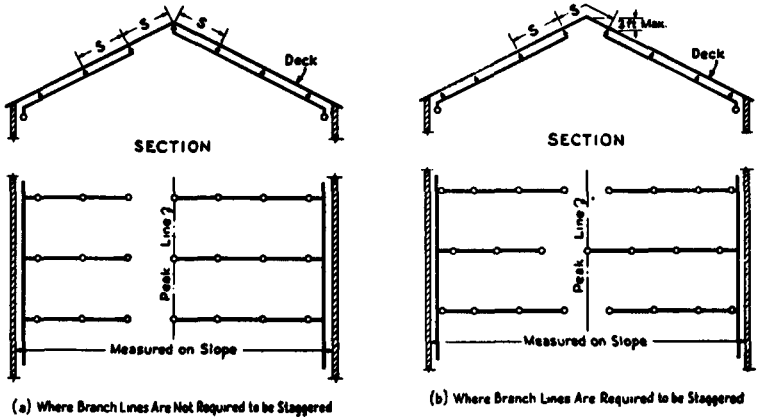
(2) If the exposed combustibles are in the horizontal plane, permission may be given to protect the area of the combustibles on a light hazard spacing and add a row of sprinklers not over 6 feet outside the outline of the area and not over 12 feet along the outline. Where the outline returns to a wall or other obstruction, the last sprinkler should not be over 6 feet from wall or obstruction.

4306. Spacing of Sprinklers Under Pitched Roofs.

(a) Under pitched roofs having a pitch in excess of 1 foot in 3 and where branch lines are run parallel to the peak, one line of sprinklers should be located in the peak of the roof or a line of sprinklers should be located on each side down from the peak a distance not greater than one-half the distance between branch lines. Where branch lines are run up the slopes, the end sprinklers on branch lines on one slope should be located in the peak or end sprinklers on branch lines on both slopes should be located down from the peak a distance not greater than one-half the allowable distance between sprinklers on the branch lines. In any case the deflectors of the highest sprinklers should be not more than 3 feet vertically below the peak. [See 4306(d).]

(b) The spacing of sprinklers should be in accordance with Section 4100 of this Standard. The distances between sprinklers on branch lines should be measured on a line parallel with the roof.

(c) In sawtooth roofs the end sprinklers on the branch lines should usually be not over 3 feet from the peak of the sawtooth.



S = spacing of sprinklers on branch lines

Fig. 4306(a). Sprinklers at Pitched Roofs. Branch Lines Run Up the Slope.

(d) Interference with the discharge pattern may result where sprinklers are located in peaks of a steeply pitched roof. To minimize this interference the distance from peak to deflectors may be increased over that specified in Paragraph 4306(a). It is desirable to maintain a horizontal clearance of not less than 2 feet. [See Figures 4306(a) and 4306(d).]

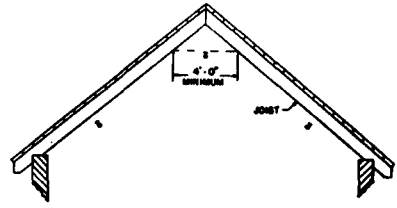


Fig. 4306(d). Desirable Horizontal Clearance for Sprinklers at Peak of Pitched Roof.

4307. SPACING OF SPRINKLERS UNDER CURVED ROOF BUILDINGS.

(a) Where 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.

(b) Deflectors of sprinklers should be parallel with the curve of the roof or tilted slightly toward the peak of the roof. Deflectors of sprinklers should be located as described for beam and girder construction or for the closest comparable type of ceiling construction.

(c) Where 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.

4308. NARROW POCKETS. 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. See Table 4156 showing Maximum Allowable Distance Deflector Above Bottom of Beam.

4309. ELEVATORS AND STAIRS.

(a) VERTICAL SHAFTS. (1) Within vertical shafts having combustible sides, sprinklers shall be provided for each 200 square feet of combustible surface, in addition to sprinklers at tops of shafts. Such sprinklers should be installed at each floor when practicable, and always when shaft is trapped. In vertical shafts of noncombustible construction there shall be at least one sprinkler at the top. In vertical shafts with noncombustible sides there should be at least one sprinkler near the bottom.

(2) Where practicable, sprinklers shall be "staggered" at the alternate floor levels, particularly when only one sprinkler is installed at each floor level.

(3) Where vertical openings are not protected by standard enclosures, sprinklers should be so placed as to fully cover them. This necessitates placing sprinklers close to such openings at each floor level.

(b) STAIRWAYS should be sprinklered underneath whether risers are open or not.

(c) 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.

4310. 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.

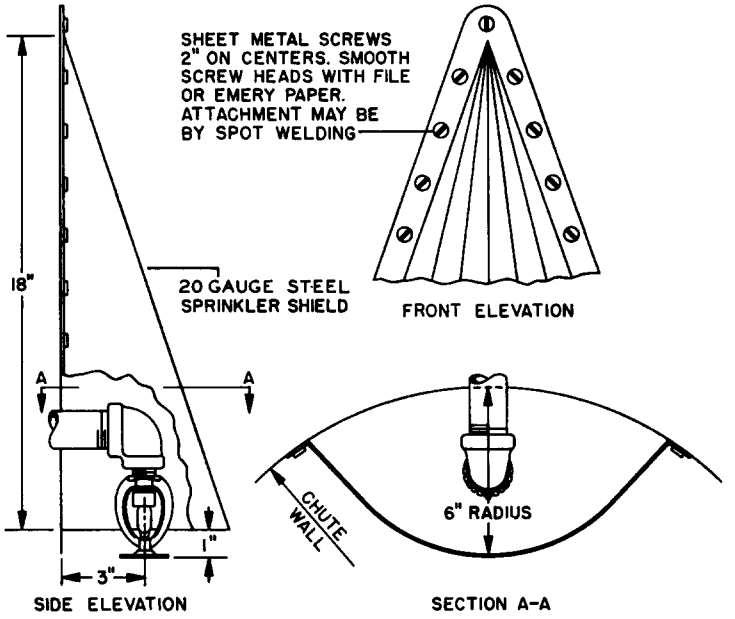


Fig. 4310. Protective deflector canopy for protecting sprinklers in building service chutes.

The room or area into which the chute discharges shall also be protected by automatic sprinklers. The installation of sprinklers at floor levels shall be so arranged as to protect the sprinklers from mechanical injury, from falling materials, and not cause obstruction within the chute. This can usually be accomplished by recessing the sprinkler in the wall of the chute and by providing a protective deflector canopy over the sprinkler. Sprinklers should be placed so that there will be minimum interference of the discharge therefrom. (See also Paragraph 4033.)

NOTE: Sprinklers with special directional discharge characteristics may be advantageous.

4311. EXTERIOR DOCKS AND PLATFORMS. (a) Sprinklers should be installed under awnings or roofs over outside loading platforms.

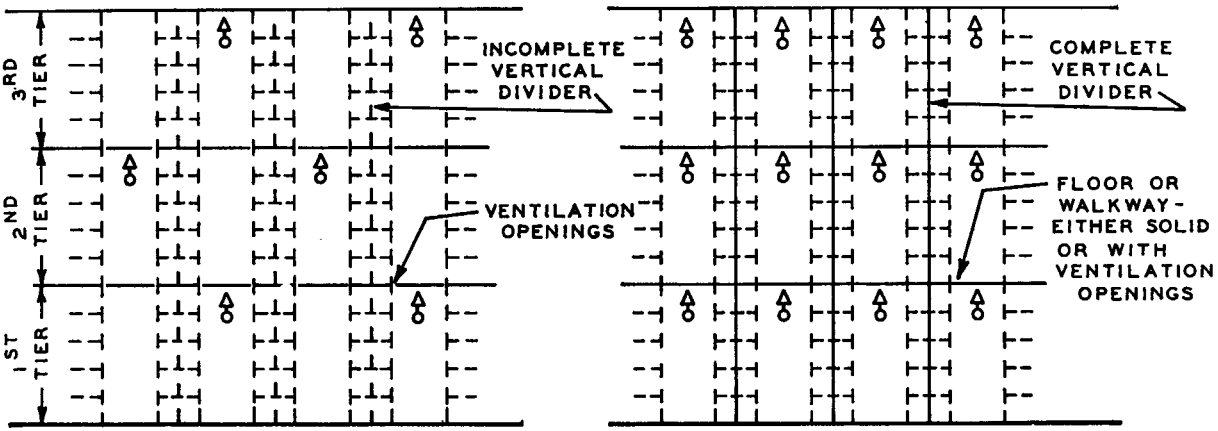
(b) Sprinklers should be installed under exterior docks and platforms of combustible construction unless such space is closed off and protected against accumulation of wind-borne debris.

4312. OVERHEAD DOORS. Where overhead doors form an obstruction to water distribution from sprinklers above, additional sprinkler protection may be required. When piping can be attached to the door structural framing, locate and space sprinklers under the doors in accordance with the rules for Ordinary Hazard Occupancy. When piping cannot be attached to the door structural framing, space sprinklers not over 12 feet apart around the perimeter of the three accessible sides of the doors and at least 12 inches in from the edges of the doors. Deflectors should not be more than 10 inches below the doors in the open position. Sidewall sprinklers may be used when their distribution would be more effective than that from standard sprinklers. Where doors are substantially glass construction and when these doors, in an open position, will merely be over a traffic aisle, sprinkler protection is not necessarily required.

4313. DECKS. Sprinklers should be installed under decks and galleries unless they do not exceed 4 feet in width, with at least 6 inches clearance from the wall or partition and with arrangements to keep all stock a similar distance from the wall or partition. (See Section 1110.)

4314. LIBRARY STACK ROOMS. For single tier stacks where 18 in. clearance can be provided between sprinkler deflectors and top of stacks, sprinklers should be located without regard to stacks. For multi-tier stacks and for single tier stacks where 18 in. clearance is not available between sprinkler deflectors and tops of stacks, branch lines should be located in alternate aisle 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 should be staggered in a vertical plane. When vertical shelf dividers are complete, so that lateral spread of sprinkler discharge will be prevented, branch lines should be located in each aisle. See Fig. 4314.

4315. TABLES. (a) Sprinklers should be installed under cutting, pressing, sewing machine and other work tables over 4 feet wide. Sprinklers may be omitted under tables less than 5½ feet but wider than 4 feet if the tables are of temporary or semi-permanent nature, as determined by the authority having jurisdiction, and tight vertical partitions of galvanized iron or other noncombustible material are provided not over 10 feet apart.



SPRINKLERS IN MULTITIER LIBRARY BOOKSTACKS

FIG. 4314

(b) Partitions should be full width of table, extend from underside of table to floor and from front edge to back edge of table; should be substantially fastened to the underside of table and to floor, and should be reinforced with angle or channel iron uprights.

(c) The outer edges of each partition should be smoothly finished (rounded if of metal) so as to prevent injury to employees.

(d) Special instructions should be obtained relative to the installation of "stops" under tables of unusual construction.

4316. OBSTRUCTIONS. Timbers, uprights, hangers, piping, lighting fixtures, ducts, etc., are likely to interfere with the proper distribution of water from sprinklers. Therefore, sprinklers should be so located or spaced that any interference is held to a minimum. The required clearance between such members and sprinklers is dependent upon the size of the obstruction to water distribution. The clearances should not be less than those specified between sprinklers and truss members in Paragraphs 4151 and 4155. (See also Paragraph 4156.)

4317. DUCTS. Sprinklers should be installed under ducts which are over 4 feet wide, and under ducts of less width if distribution from ceiling sprinklers is obstructed.

4318. STOCK FIXTURES. Sprinklers should be installed in all stock fixtures which exceed 5 feet in width, also in those which are less than 5 feet but more than 2½ feet in width unless bulkheaded with tight partitions. Sprinklers should be installed in any compartments which are larger than 5 feet deep, 8 feet long and 3 feet high.

4319. LIGHTING FIXTURES. (a) Lighting fixtures of the pendent or surface mounted type may offer obstruction to discharge from sprinklers unless the clearances specified in Table 4156 are provided.

(b) Branch sprinkler lines should be run parallel to and between lines of fixtures and should be sufficient in number to provide proper floor and ceiling coverage. Pendent fixtures located below the level of the sprinkler deflectors and also surface mounted fixtures may necessitate additional branch lines.

4320. GENERATOR AND TRANSFORMER ROOMS. Sprinkler protection should ordinarily be provided in generator and transformer rooms. Hoods or shields to protect generators, switchboards and other important electrical equipment shall be non-

combustible and should be arranged to minimize interference with sprinkler protection. Where walls, floor and ceiling are of fire-resistive construction, sprinklers may be omitted.

4321. OPEN GRID CEILINGS. The installation of open grid egg crate, louver or honeycomb ceilings beneath sprinklers restricts the sidewise travel of the sprinkler discharge and may change the character of discharge.

The following rules are applicable to open grid ceilings in which the openings are ¼ inch or larger in least dimension, where the thickness or depth of the material does not exceed the least dimension of the openings and where such openings constitute at least 70 percent of the area of the ceiling material. Other types of open grid ceilings should not be installed beneath sprinklers unless they are listed by a nationally recognized testing laboratory and are installed in accordance with the instructions contained in each package of the ceiling material.

NOTE: Ceilings made of highly flammable material may spread fire faster than sprinklers can control.

(a) In light hazard occupancies where spacing of sprinklers of either standard or old style is not wider than 10 by 10 feet, a minimum clearance of at least 18 inches should be provided between the sprinkler deflectors and the upper surface of the open grid ceiling. Where spacing is wider than 10 by 10 feet but not wider than 10 by 12 feet, a clearance of at least 24 inches should be provided from standard sprinklers and at least 36 inches from old style sprinklers. Where spacing is wider than 10 by 12 feet, a clearance of at least 48 inches should be provided from standard sprinklers; any old style sprinklers should be replaced with standard sprinklers.

(b) In ordinary hazard occupancies, open grid ceilings should be installed beneath sprinklers only where such use is approved by the authority having jurisdiction, and should be installed beneath standard sprinklers only. Where sprinkler spacing is not wider than 10 by 10 feet, a minimum clearance of at least 24 inches should be provided between the sprinkler deflectors and the upper surface of the open grid ceiling. Where spacing is wider than 10 by 10 feet, a clearance of at least 36 inches should be provided.

4322. TRANSLUCENT CEILINGS. Translucent ceilings shall not be installed beneath sprinklers unless such ceilings are listed by a nationally recognized fire testing laboratory and are installed in accordance with their listing. The authority having jurisdiction should be consulted in all cases.

4323. VAULTS.

(a) FUR VAULTS. (1) Sprinklers in fur storage vaults should be located centrally over the aisles between racks and should be spaced not over 5 feet apart along the aisles.

(2) Where sprinklers are spaced 5 feet 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

(3) Sprinklers shall be of approved old style having orifice sizes selected to provide as closely as possible but not less than 20 gallons per minute per sprinkler, based on the water pressure available.

NOTE: See Standard on Fur Storage, Fumigation and Cleaning (NFPA No. 81). 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.

(b) SAFE DEPOSIT OR OTHER VAULTS of fire-resistive construction will not ordinarily require sprinkler protection when used for the storage of records, files and other documents, when stored in metal cabinets or on metal shelving.

4324. MACHINERY AND SMALL ENCLOSURES. (a) Sprinklers should be installed under stairs, inside elevator wells, in belt, cable, pipe, gear and pulley boxes, in cold storage rooms and coolers in other occupancies, inside small enclosures, such as drying and heating boxes, tenter and drying room enclosures, chutes, combustible air ducts, conveyor trunks, bucket elevator enclosures and in all bins, hoppers, lockers, cupboards and closets unless they have tops entirely open and are so located that sprinklers can properly spray therein.

(b) ENCLOSURES with cloth, paper or other similar flammable ceiling should be sprinklered. Sprinklers above unsprinklered enclosures will ordinarily restrict a fire to the enclosure and immediate vicinity but should not be considered as protection for the enclosure and its contents. Many sprinklers may open in such a fire involving water damage over a large area.

(c) Special instructions should be obtained relative to placing sprinklers inside show windows, telephone booths, boxed machines, metal air ducts, ventilators and concealed spaces, and under large shelves, benches, tables, overhead storage racks, plat-

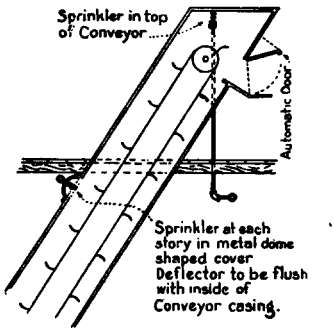


Fig. 4324(a). Sprinklers in Conveyor Enclosure.

forms and similar water sheds, and over electrical generating and transforming apparatus and switchboards.

4325. CONVEYOR ENCLOSURES, DRYERS, ETC. The general rules for the spacing of sprinklers will, in most cases, suggest the proper arrangement for boxed machines, dryer enclosures, large beltways, and similar locations. Special treatment is, however, necessary for picker trunks, or small belt and conveyor enclosures where there is not room inside the enclosure for pipes or sprinklers.

For small beltways and conveyor enclosures, pipes may be run outside the enclosures and sprinklers installed in dome-shaped covers about 10 inches in diameter. Where sprinklers can be nippled into the boxing without forming an obstruction, this should be done and dome-shaped covers omitted.

4326. PICKER TRUNKS. Sprinklers in picker trunks should be not over 7 feet apart, except in wide trunks, requiring more than one line, where sprinklers may be spaced 8 feet apart.

4327. PAPER MILL MACHINERY. (a) Sprinklers should be installed under hoods over paper machines. Sprinkler piping may be run above hoods over paper machines, dry cans, and similar equipment where dripping of condensation from sprinkler piping must be avoided, and the sprinklers nippled through. The lower sprinklers under the hoods should be located just outside of the line of the cylinders or rolls.

(b) Automatic sprinkler protection is needed in certain types of economizers such as used in paper mills. Where economizers are subject to freezing temperatures, special types of sprinkler protection should be provided.

4328. COMMERCIAL-TYPE COOKING EQUIPMENT AND VENTILATION SYSTEMS

(a) 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 Standard for Vapor Removal from Commercial Cooking Equipment, NFPA No. 96). 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.

(b) Sprinklers with temperature classifications of Intermediate, High or Extra High usually will be required as determined by use of a temperature measuring device. 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. or by use of thermal control valves.

(c) Distance between sprinklers shall not exceed 10 feet within and under exhaust hoods and in horizontal ducts. The first sprinkler in a horizontal duct shall be installed at the duct entrance.

(d) One standard ½-inch 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 and should be arranged to operate at not less than 30 psi. However, a single sprinkler shall not protect more than 30 inches of deep fat fryer surface in any dimension and the provisions of 4328(d) should not be applied in the protection of individual deep fat fryers exceeding this size. Sprinklers protecting deep fat fryers shall have their deflectors located at least 1 inch below the lower edge of the hood, and not less than 2 feet nor more than 3 feet 6 inches above the deep fat fryer cooking surface.

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

(f) 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 feet.

(g) 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.

(h) Automatic sprinklers protecting commercial-type cooking equipment and ventilation systems should be controlled by separate, readily accessible indicating type control valves that are properly identified (see Paragraph 3491).

(i) Release devices shall be checked at least twice a year for proper operation. Fusible links and automatic sprinklers shall be replaced annually. Other actuating devices shall be properly cleaned.

4329. BAFFLES. Baffles should be installed wherever sprinklers are less than 6 feet apart to prevent the sprinkler first opening from wetting adjoining sprinklers, thus delaying their operation. Baffles should be located midway between sprinklers and arranged to baffle the actuating elements. Baffles may be of sheet metal, about 8 inches wide and 6 inches high. When placed on branch line piping, the top of baffles should extend 2 to 3 inches above the deflectors.

4330. SMALL ROOMS: In small rooms such as rest rooms, toilets, closets and offices with smooth ceilings, sprinklers may be located a maximum distance of 7 ft. 6 in. from any two walls of this room providing the total area of the room divided by the number of sprinklers does not exceed the limitation of Paragraphs 4131 and 4132. The maximum area of such a room is defined as 800 sq. ft. for Light Hazard and 520 sq. ft. for Ordinary Hazard Occupancies.

4400. Sidewall Sprinklers. (See Section 3630.)

4410. Distance Between the Branch Lines and Sprinklers on the Branch Lines.

4411. DISTANCE BETWEEN THE BRANCH LINES. Rooms having widths in excess of 15 feet up to 30 feet shall have sprinklers on two opposite walls with spacing as elsewhere required in Section 4400 and sprinklers regularly staggered. Construction may necessitate additional branch lines of sprinklers in rooms over 20 feet in width. (See Fig. 4411.)

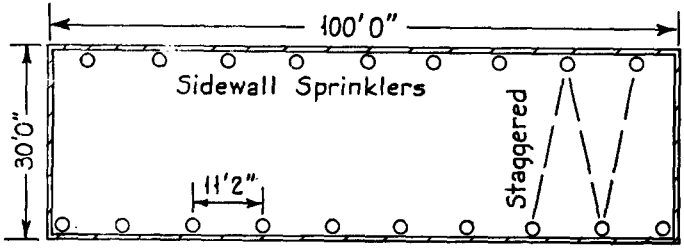


Fig. 4411. Spacing of Sidewall Sprinklers under Smooth Ceilings, with Light Hazard Occupancy.

4412. DISTANCE BETWEEN THE SPRINKLERS ON THE BRANCH LINES. Sidewall sprinklers should be located not more than 10 feet apart on walls for ordinary hazard occupancies and not more than 14 feet apart for light hazard occupancies. The installation of sidewall sprinklers other than beneath smooth ceilings will require special rulings.

4420. Protection Area Limitations for Light Hazard Occupancy.

4421. With noncombustible smooth ceiling the protection area allotted per sprinkler shall not exceed 196 square feet with the distance between sprinklers on lines not in excess of 14 feet.

4422. With combustible smooth ceiling sheathed with plasterboard, metal, or wood lath and plaster the protection area allotted per sprinkler shall not exceed 168 square feet with the distance between sprinklers on lines not in excess of 14 feet. Where sheathing is combustible such as wood, fiberboard or other combustible material the protection area allotted per sprinkler shall not exceed 120 square feet with the distance between sprinklers on lines not in excess of 14 feet.

4430. Protection Area Limitations for Ordinary Hazard Occupancy.

4431. With noncombustible smooth ceiling the protection area allotted per sprinkler shall not exceed 100 square feet with the distance between sprinklers on lines not in excess of 10 feet.

4432. 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 square feet per sprinkler with the distance between sprinklers on lines not in excess of 10 feet.

4440. Position of Sidewall Sprinklers. (See Fig. 4440.)

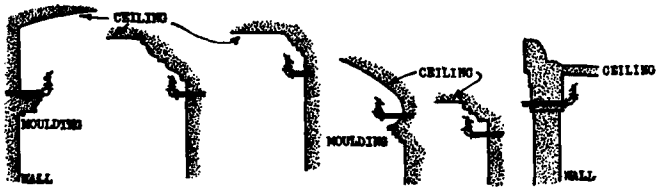


Fig. 4440. Suggested Arrangements for Sidewall Sprinklers — placed to receive early heat waves and provide effective distribution.

4441. Ordinarily, deflectors should be at a distance from walls and ceilings not exceeding 6 inches and never less than 4 inches.

4442. Special consideration should be given to placing sidewall sprinklers so that they will be favored to the greatest possible extent in receiving the heat from a fire and at the same time most effectively distribute the water discharged by them. This is likely to be particularly important where heavy decorative molding is encountered near the junction of walls and ceilings.

4443. Where the ceiling above and the wall to the rear of sidewall sprinklers are smooth and at right angles to each other good results are obtainable with the sprinklers placed vertical.

4444. Where the ceiling contour is sloping or there is other reason for greater than ordinary ceiling protection due to construction, occupancy, etc., increased ceiling coverage is obtainable by tilting the sprinklers to conform with the ceiling slope.

CHAPTER 5. TYPES OF SYSTEMS.

5010. General.

5011. Systems described in this Chapter shall comply with all other portions of this Standard, except as modified in Chapter 5.

5100. Wet-Pipe Systems.

5110. Definition.

5111. 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.

5120. Devices for Test Purposes.

5121. PRESSURE GAUGES. Approved pressure gauges conforming to Paragraph 2822 shall be installed in sprinkler risers, above and below each alarm check valve.

5200. Dry-Pipe Systems.

5210. General

5211. DEFINITION. A system employing automatic sprinklers attached to a piping system containing air under pressure, the release of which as from the opening of sprinklers 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.

Differential dry-pipe valves utilize two seat rings, one to control entry of water and a second to seal air pressure in the sprinkler piping. Differential ratios of water pressure to air pressure when this type of valve operates may be nominally 6 to 1.

Mechanical dry-pipe valves were of the earliest design and achieved their differential through external lever and escapement mechanisms.

Latched-clapper dry-pipe valves usually utilize a diaphragm sensor to release the single water-controlling clapper at a preselected air pressure.

Low differential dry-pipe valves utilize a single clapper which is held shut by air pressure in excess of the water pressure. They are equipped with a pilot valve or split seat ring to provide the fire alarm feature upon operation. The water pressure to air pressure ratio at the time of tripping is usually between 1.0 and 1.2 to 1.

5212. WHEN INSTALLED. A dry-pipe system should be installed only where a wet-pipe system is impracticable, as in rooms or buildings which cannot be properly heated. The use of an approved dry-pipe system is, however, far preferable to entirely shutting off the water supply during cold weather.

5213. SMALL SYSTEMS. Where it is necessary to have but 25 per cent or less of the total number of sprinklers in a building on a dry-pipe system, only such sprinklers should be thus piped; the remainder should be placed on a wet system. This may require small dry-pipe systems or pre-action systems for show windows, blind attics or other minor portions exposed to freezing. Such small systems may be supplied from the wet-pipe system and control valves shall be readily accessible. No sprinklers should be shut off in cold weather without the consent of the authority having jurisdiction, and in no case should the number of sprinklers so shut off exceed ten.

5214. DRY PENDENT SPRINKLERS. Sprinklers should be installed in the upright position. 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 within a heated area is permitted.

5220. Subdivision of Systems.

5221. Where two or more dry-pipe valves are used, systems should preferably be divided horizontally.

5222. Where required by the authority having jurisdiction in buildings of large single area such as piers, storage sheds, foundries, car shops, large attics, etc., substantial curtains preferably of noncombustible material extending down 24 inches or more below the ceiling shall be provided to separate sprinkler systems or subdivide areas. (See Fig. 1132.)

5230. Size of Systems.

5231. SPRINKLER AND VOLUME LIMITATIONS.

(a) Not more than 600 sprinklers should be controlled by one dry-pipe valve.

(b) Except as provided in paragraph 5231 (c), not more than 750-gallon system capacity should be controlled by one dry-pipe valve, unless check valves are installed in branches of the system as provided for in Paragraph 5232.

(c). Where the piping volume exceeds 750 gallons the system should deliver water to the inspector's test pipe in not

more than 60 seconds, starting at the normal air pressure on the system.

5232. CHECK VALVES IN DRY PIPE SYSTEMS. Check valves may be 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. Using such an arrangement, the capacity of no system branch should exceed 600 gallons. A hole ⅛-inch 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 O.S.&Y. or approved indicating drain valve, connected on a by-pass around each check valve shall be provided as a means for draining the system. Such check valves shall be located in the heated dry pipe valve enclosure to prevent the formation of ice in winter.

5233. The capacities of the various sizes of pipe given in Table 5232 are for convenience in calculating the air capacity of a system.

TABLE 5232.

CAPACITY OF 1 FOOT OF PIPE.
(Based on actual internal diameter)

Diameter	*Gallons*	*Diameter*	*Gallons*
¾ in.	.028	3 in.	.383
1 in.	.045	3½ in.	.513
1¼ in.	.078	4 in.	.660
1½ in.	.106	5 in.	1.040
2 in.	.174	6 in.	1.501
2½ in.	.248	8 in.	2.66

5234. EIGHT-INCH SYSTEMS. Where an 8-inch riser is employed in connection with a dry-pipe system, a 6-inch dry-pipe valve and a 6-inch gate valve between taper reducers may be used.

5235. DRY PIPE SYSTEM SERVING SEVERAL REMOTE UNHEATED AREAS. Where a single dry pipe valve is used to supply piping and sprinklers located in several small unheated areas which are remote from each other, the dry pipe valve and riser, subject to the approval of the authority having jurisdiction, may be sized according to the number of sprinklers in the largest area. A check valve with ⅛-inch hole in clapper should be installed in the supply piping to each area and shall be located in a heated area. Each area so checked shall have an auxiliary drain and a dry pipe type inspector's test connection. The compressed air supply should be of sufficient capacity to restore normal air pressure in the entire system within 30 minutes.

5240. Quick-Opening Devices.

5241. WHEN REQUIRED. Dry pipe valves controlling systems having capacity of more than 500 gallons shall be provided with an approved quick opening device.

5242. LOCATION OF QUICK-OPENING DEVICES. The quick-opening device shall be located as close as possible to the dry-pipe valve. Protection of the restriction orifice and other operating parts of the quick-opening device against submergence necessitates that the connection to the riser shall be at a point above which water (priming water and back drainage) is not to be expected when the dry-pipe valve and quick-opening device are set, except where design features of particular quick-opening devices make these requirements unnecessary.

NOTE: In the case of dry-pipe valves having relatively small priming chambers and in which the normal quantity of priming water fills, or nearly fills, the entire priming chamber, the object contemplated by this rule will be met by requiring connection of the quick-opening device at a point on the riser above the dry-pipe valve, which will provide a capacity measure between the normal priming level of the air chamber and the connection of 1½, 2 and 3 gallons for 4-, 5- and 6-inch risers, respectively. Making the connection 24 inches above the normal priming water level will ordinarily provide this capacity.

5243. 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.

5244. A globe or gate valve shall also be installed in the connection between the quick-opening device and the intermediate chamber of the dry-pipe valve whenever necessary to prevent the escape of water if the dry-pipe valve should trip with the quick-opening device disconnected. A check valve may be used instead of a gate valve whenever it will serve the same purpose.

5245. The piping between sprinkler system and accelerator, and from accelerator to intermediate chamber of dry pipe valve, should be galvanized, brass, or copper.

5250. Location and Protection of Dry-Pipe Valve.

5251. The dry-pipe valve should be located in an accessible place and as near as practicable to the sprinkler system it controls. It should be properly protected against freezing and mechanical injury.

5252. To protect supply pipe from frost, avoid low space under floor.

5253. Where exposed to cold, the dry-pipe valve should preferably be located in an approved valve room or enclosure and, where this is not possible, in an underground pit acceptable to the authority having jurisdiction. Room should be of sufficient size to give at least 2½ feet of free space at the sides and in front of, also above and below the dry-pipe valve or valves, and this room, if feasible, should not be built until the valve is in position.

5254. Size of enclosures should be governed by the number and arrangement of dry-pipe valves, so as to give ready access to these devices.

5255. Valve room should be electrically lighted and properly heated by electric heater (installation to comply with the National Electrical Code, NFPA No. 70), steam, hot water or hot air.

5256. Latches for doors should be arranged to hold door tight to frame. Latches similar to those used on refrigerators are recommended.

5257. The supply for the sprinkler protection in the dry-pipe valve enclosure shall be from the dry side of the system.

5258. SKETCHES OF DRY-PIPE VALVE ENCLOSURES. The enclosures shown in Figs. 5258–1 to 5258–6, inclusive, are intended to serve as illustrations of those already in successful use, rather than as standards, from which to select or modify the design most suitable for local needs, in consideration of the varying climatic conditions. The sketches are not drawn to scale.

5259. Protection against excessive 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.

5260. Cold Storage Rooms.

5261. Careful installation and maintenance, and some special arrangements of piping and devices as outlined in this section are needed to avoid the formation of ice and frost inside piping in cold storage rooms which will be maintained at or below 32° F. Conditions are particularly favorable to condensation where pipes enter cold rooms from rooms having temperatures above freezing. Periodic examinations of piping are needed to detect these formations.

5262. Fittings for this purpose should be provided at the following locations:

(a) Wherever a cross main connects to a riser or feed

Continued on page 13–138

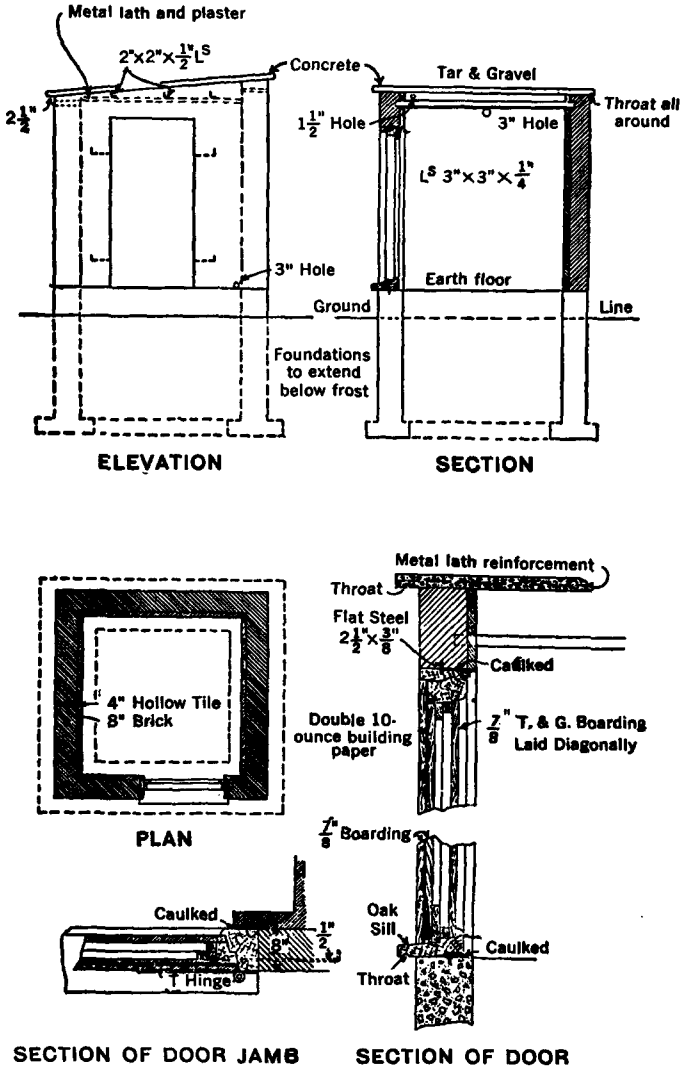
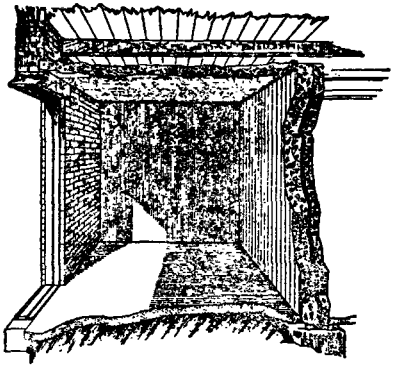


Fig. 5258-1. Dry-Pipe Valve Enclosures — Fire-Resistive Construction, Located Outside of Building with no Direct Communication to Building.



SECTIONAL VIEW

Outer and inner walls should be bonded to provide greater stability and insure even settlement but not so as to interfere with circulation of air. Corners should be protected by angle iron or other suitable means, where subject to mechanical injury. Provision should be made in the erection by metal sleeves or otherwise for the needed openings for the piping.

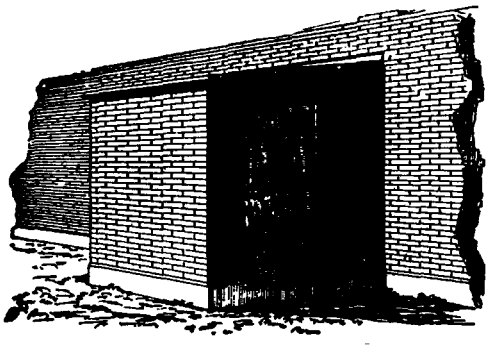
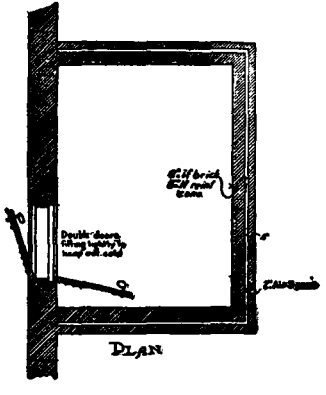
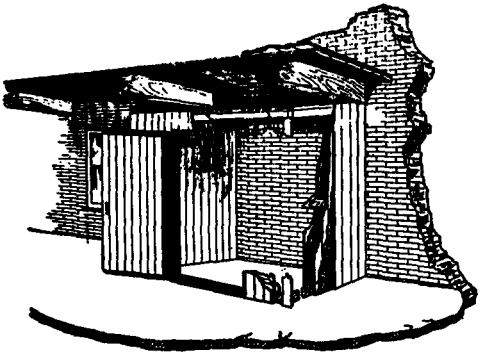


Fig. 5258-3. Dry-Pipe Valve Enclosures — Fire-Resistive Construction, Located Outside of Building with no Direct Communication to Building.



PLAN

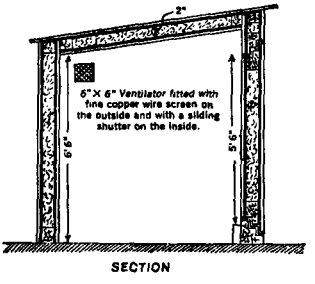
Fig. 5258-2. Dry-Pipe Valve Enclosure — Fire-Resistive Construction, Located in Building but with Entrance from Outside Only. Walls and roof may be either of brick or concrete. Where fire heat is used to warm enclosure ventilation should be provided.



Sectional View

Fig. 5258-4. Dry-Pipe Valve Enclosure — Combustible Construction, Located Inside Building.

Air space may be increased and filled with insulating material. Where exposed to frost, floor should be double and filled with insulating material. With this type, any heating should preferably be steam, or at least electric. If gas, the inside should be protected and ventilation provided. With fire heat, a better enclosure would be one of expanded metal and cement. Walls should be double, each side at least two inches thick with two inches air space between, floor should be concrete. Ventilation should be provided and door should be of metal or standard tin clad.



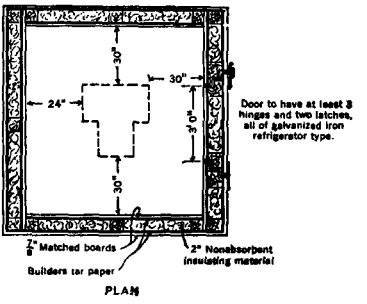
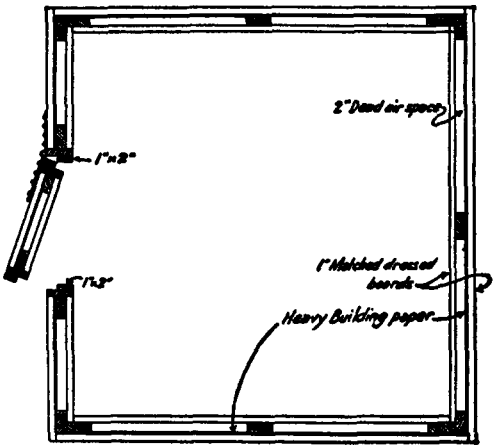
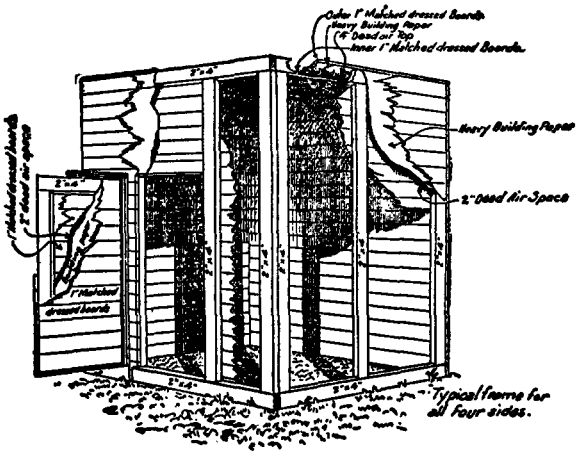


Fig. 5258-5. Dry-Pipe Valve Enclosure — Combustible Construction.

This enclosure is for use where dry valves are subject to freezing. It should be provided with an electric light where possible and should be heated either by steam or by electricity. Where the enclosure is located as on a pier, or other exposed place, the floor must be constructed similarly to the walls. The outside part of wall must be protected by sheet iron and the corners by 2-in. angle iron. Not suitable for outside use in severe climates as no provision is made to carry foundations below frost line. The dimensions are the minimum ones to permit of easy access to the valve.



PLAN



SECTIONAL VIEW

Fig. 5258-6. Dry-Pipe Valve Enclosure — For Mild Climates, and Location Inside Building.

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 inches long in the feed main as shown in Fig. 5262–1. Such fittings in conjunction with the flushing connections specified in Paragraph 3064 would permit examination of the entire lengths of the cross mains. Branch lines may be examined by backing the pipe out of fittings.

(b) Wherever feed mains change direction. Facilities are needed for direct observation of every length of feed main within the refrigerated area. This may be accomplished by means of 2-inch capped nipples or blind flanges on fittings.

(c) Wherever 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-inch flanged removable section in the warm room as shown in Fig. 5262–2.

5263. Whenever the opportunity offers, fittings such as specified above and illustrated in Figs. 5262–1 and 5262–2, as well as flushing connections specified in Paragraph 3064, should be provided in existing systems.

5264. Risers should be located in stair towers or other locations outside of refrigerated areas, where possible. This would reduce the probabilities of ice or frost formation within the riser (supply) pipe.

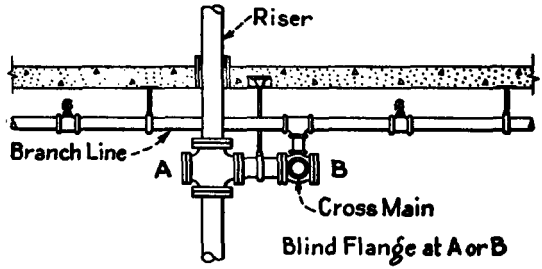
5265. Cross mains should be connected to risers or feed mains with flanges. In general, flanged fittings should be installed at points which would allow easy dismantling of the system. Split ring or other easily removable types of hangers will facilitate the dismantling.

5266. A low air-pressure alarm is desirable on sprinkler systems supplying freezer sections.

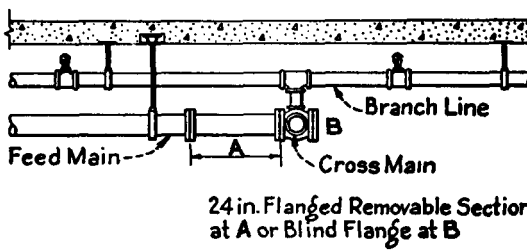
5267. Piping in cold storage rooms should be installed with ample pitch, as outlined in Section 3210.

5268. The air supply for dry-pipe systems in cold storage plants should be taken from the freezers of lowest temperature or through a chemical dehydrator.

5269. Compressed nitrogen gas in cylinders can be used in place of air in dry-pipe systems to eliminate introducing moisture. Cylinder pressure should be reduced to somewhat less than maximum allowable system pressure, and regulated by the usual



(a) Elevation at Riser and Cross Main



(b) Elevation at Feed Main and Cross Main

Fig. 5262-1. Fittings to Facilitate Examination of Feed Mains, Risers, and Cross Mains in Freezing Areas.

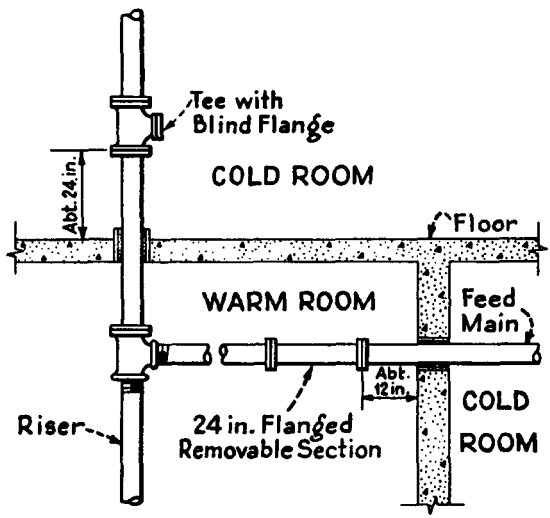


Fig. 5262-2. Fittings in Feed Main or Riser Passing Through Wall or Floor from Warm Room to Cold Room.

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

5270. Air Pressure and Supply.

5271. Maintenance of Air Pressure. Air pressure shall be maintained on dry-pipe systems throughout the year.

5272. Air Supply. The compressed air supply shall be from a reliable source available at all times and having a capacity of restoring normal air pressure in the system within 30 minutes except for low differential dry-pipe systems where this time may be 60 minutes. The compressor should draw its air supply from a place where the air is dry and not too warm. Moisture may cause trouble from condensation in the system. The air compressor, when the only supply and nonautomatic, shall be driven independently of all plant shafting. Where low differential dry-pipe valves are used, the air supply shall be maintained automatically.

5273. Air Filling Connection. The connection pipe from the air compressor should not be less than ¾ inch and enter the system above the priming water level of the dry-pipe valve. In this air line there shall be installed a check valve and on the supply side of this check valve a shutoff valve of renewable disc type.

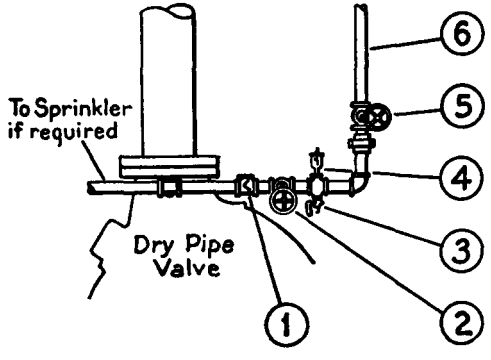


Fig. 5270. Air Supply from Shop System.

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

5274. RELIEF VALVE. An approved relief valve shall be provided between compressor and controlling valve and set to relieve at a pressure five pounds in excess of maximum air pressure which should be carried in the system.

5275. SHOP AIR SUPPLY. Where the air supply is taken from a shop system having a normal pressure greater than that required for dry-pipe systems, the relief valve shall be installed between two control valves in the air line and a small air cock, which is normally left open, installed in fitting below relief valve.

5276. AUTOMATIC AIR COMPRESSOR. Where 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. More than one dry-pipe system should not be connected to a single automatic air maintenance device where the air supply piping to the systems is subdivided only by check valves. Otherwise when one dry-pipe valve operates leakage past check valves could water column other dry-pipe valves.

5277. AIR PRESSURE TO BE CARRIED. Excess air pressure in dry-pipe systems is undesirable. The pressure to be carried will depend upon the normal tripping pressure of the dry-pipe valve. The instruction chart furnished with dry-pipe valves should be consulted to determine the air pressure to be carried. The maximum air pressure needed has been found in most cases to be 15 to 20 lbs. in excess of the normal tripping pressure of the dry-pipe valve. The permitted rate of air leakage shall be as specified in Paragraph 1642. The design of some dry-pipe valves includes an excess pressure relieving device which is intended to automatically limit the air pressure.

5280. Devices for Test and Maintenance Purposes.

5281. PRESSURE GAUGES. Approved pressure gauges conforming to Paragraph 2822 shall be connected as specified in Paragraphs 5282–5286, inclusive.

5282. On the water side and air side of dry-pipe valve.

5283. At the air pump supplying the air receiver.

5284. At the air receiver.

5285. In each independent pipe from air supply to dry-pipe system.

5286. At exhausters and accelerators.

5300. Pre-Action and Deluge Systems.

5310. Definitions.

5311. PRE-ACTION SYSTEM. A system employing automatic sprinklers attached to a piping system containing air that may or may not be under pressure, with a supplemental heat responsive system of generally more sensitive characteristics than the automatic sprinklers themselves, installed in the same areas as the sprinklers; actuation of the heat responsive 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.

5312. DELUGE SYSTEM. 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 heat responsive 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.

5320. 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 heat-responsive devices and provided with manual means for operation which are independent of the sprinklers. Systems may have equipment of the types described in Paragraphs 5321–5328, inclusive. (See Paragraphs 5352 and 5362.)

5321. Automatic sprinklers with both sprinkler piping and heat-responsive devices automatically supervised.

5322. Automatic sprinklers with sprinkler piping and heat-responsive devices not automatically supervised.

5323. Open sprinklers with only heat-responsive devices automatically supervised.

5324. Open sprinklers with heat-responsive devices not automatically supervised.

5325. Combination of open and automatic sprinklers with heat-responsive devices automatically supervised.

5326. Combination of open and automatic sprinklers with heat-responsive devices not automatically supervised.

5327. Open head systems operated by both heat-responsive devices of the rate of temperature rise and fixed temperature types in combination, in which case the heat-responsive devices should be automatically supervised.

5328. Outside sprinklers for protection against exposure fire; the heat-responsive devices should be automatically supervised if more than 20 sprinklers on the system.

5330. General.

5331. Where required by the authority having jurisdiction, sprinkler systems shall be of the pre-action or deluge type.

5332. Conditions of occupancy or special hazards may require quick application of large quantities of water and in such cases deluge systems are likely to be needed.

5333. Care should be exercised to select heat-responsive devices having an adjustment to assure proper operation and to guard against premature operation of the system from normally fluctuating temperatures.

5334. In locations where temperatures, at ceilings, are likely to be high from sources of heat other than fire conditions, such as manufacturing processes, boiler rooms and dry kilns, it is necessary to give special consideration to the selection of heat-responsive devices operating normally at higher than ordinary temperatures and which are capable of withstanding the normal high temperatures for long periods of time.

5335. Where corrosive conditions exist that may affect the heat-responsive devices or systems, consideration should be given to the use of types of materials or protective coatings designed to resist corrosion.

5336. Stock of extra fusible elements of heat-responsive devices, not less than two of each temperature, shall be maintained on the premises for replacement purposes.

5337. 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.

5338. All new pre-action or deluge systems shall be tested hydrostatically as specified in Paragraph 1631. In testing deluge systems plugs shall be installed in fittings and replaced with open sprinklers after the test is completed, or automatic sprinklers should be installed and the links, etc., knocked out after test is completed.

5339. To help avoid ice formation in piping because of accidental tripping of dry pipe valves in cold storage rooms, a deluge automatic water control valve may be used on the supply side of the dry pipe valve. When this combination is employed:

Dry systems may be manifolded to a deluge valve, the protected area not exceeding 40,000 square feet. The distance between valves should be as short as possible to minimize water hammer.

The dry pipe valves should be pressurized to 50 pounds per square inch to reduce the possibility of dry pipe valve operation from water hammer.

5340. Location and Spacing of Heat-Responsive Devices

5341. Spacing of heat-responsive devices shall be in accordance with their listing by nationally recognized testing laboratories, unless conditions indicate the need for a closer spacing.

5342. Distance Between Devices and Walls.

(a) Where ceilings are level, one-half the distance allowed between rows of heat-responsive devices.

(b) With sloping ceilings, slope more than 1½ inches per foot, lowest row of heat-responsive devices two-thirds the distance allowed between rows of heat-responsive devices. Distance may be measured horizontally for both level and sloping ceilings.

(c) In areas requiring only a single row of heat-responsive devices the distance between the end device and the end wall shall be one-third the allowable distance between heat-responsive devices.

5343. Ceiling Heights. Where ceiling heights exceed 35 feet the heat-responsive devices should be so spaced that the area covered by each device will not exceed 75 per cent of the area normally covered.

5344. Special Hazards. In occupancies involving unusual hazards where it is necessary to discharge water through open sprinklers on the fire instantaneously, special arrangement of heat-responsive devices should be made in accordance with recognized good practice for such hazards.

5345. Two or More Systems. Where there are two or more systems in one area controlled by separate systems of heat-responsive devices, the heat-responsive devices on each system shall be spaced up to the dividing line between systems as to a

wall or partition or draft stop.

5346. MONITORS. Flat or sloping surfaces between monitors do not require heat-responsive devices, except when their width is such that the distance between rows of heat-responsive devices in adjoining monitors or between wall and rows of heat-responsive devices in adjoining monitors exceeds the allowable distance, in which case install heat-responsive devices under the flat or sloping sections in accordance with the rules governing the shape of ceiling and type of construction.

5347. DECKS INSIDE BUILDINGS. Decks, not enclosed and not more than 10 feet in width, should not ordinarily require the installation of heat-responsive devices.

5348. STAIR TOWERS, ELEVATOR SHAFTS AND OTHER ENCLOSURES. Where sprinklers are installed in stair towers, elevator shafts and other enclosures, heat-responsive devices shall be installed in each such enclosure.

5350. Pre-Action Systems.

5351. SIZE OF SYSTEMS. Not more than 1,000 closed sprinklers shall be controlled by any one pre-action valve.

5352. SUPERVISION. The sprinkler piping and heat-responsive devices shall be automatically supervised unless otherwise approved by the authority having jurisdiction.

5353. PIPE SCHEDULES. See Sections 3030, 3040, 3050 and Chapter 7.

5354. PENDENT SPRINKLERS. Automatic sprinklers installed in the pendent position shall be of the approved dry pendent type only if installed in an area subject to freezing.

5360. Deluge Systems.

5361. The number of open head sprinklers controlled by any one deluge valve should be as follows:

1½ in. valve	5 sprinklers
2 in. valve	10 sprinklers
2½ in. valve	27 sprinklers
3 in. valve	40 sprinklers
4 in. valve	75 sprinklers
6 in. valve	150 sprinklers

5362. SUPERVISION. The heat-responsive devices or systems shall be automatically supervised unless otherwise approved by the authority having jurisdiction.

5370. Pipe Schedule for Deluge Systems.

5371. The following pipe schedule is given only as a guide for installations having no unusual features. The pipe schedule for deluge systems (½-inch orifice sprinklers or equivalent discharge) is as follows:

1 in. pipe	1 sprinkler
1¼ in. pipe	2 sprinklers
1½ in. pipe	5 sprinklers
2 in. pipe	8 sprinklers
2½ in. pipe	15 sprinklers
3 in. pipe	27 sprinklers
3½ in. pipe	40 sprinklers
4 in. pipe	55 sprinklers
5 in. pipe	90 sprinklers
6 in. pipe	150 sprinklers

5372. Deluge systems are usually applied to severe conditions of occupancy. In designing the piping system the water supply should be based on not less than an average discharge of 15 gallons per minute per sprinkler. Adjustment in pipe sizes to provide uniform sprinkler discharge should be based on a variation of plus or minus 15 per cent from the assumed average discharge per sprinkler. Where practical to obtain the required degree of uniformity of discharge by sizing of piping this should be done rather than by using sprinklers having orifices smaller than ½ inch. See Chapter 7.

5373. Pipe sizes should be calculated in accordance with the standards for Hydraulically Designed Sprinkler Systems as given in Chapter 7.

5374. Where change is made in pipe sizes this should not be effected by means of reducing flanges.

5375. Where 8-inch piping is employed to reduce friction losses in a system operated by heat-responsive devices a 6-inch pre-action or deluge valve and 6-inch gate valve between taper reducers may be used.

5380. Valves.

5381. An approved indicating valve shall be installed to control the water supply to each pre-action or deluge valve.